INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**					
Course Title	**LINEAR ALGEBRA AND CALCULUS**					
Course Code	AHSC02					
Program	B.Tech					
Semester	I					
Course Type	Foundation					
Regulation	UG - 20					
Course Structure	Theory			Practical		
	Lecture	Tutorials	Credits	Laboratory	Credits	
	3	1	4	-	-	
Course Coordinator	Dr S Jagadha, Associate Professor					

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of Algebra and Calculus

II COURSE OVERVIEW:

The Linear algebra is a sub-field of mathematics concerned with vectors, matrices, and linear transforms. Calculus is the branch of mathematics which majorly deals with derivatives and integrals. Linear algebra is a key foundation to the field of machine learning. The course includes types of Matrices, Rank, methods of finding rank, Eigen values and Eigen vectors, maxima and minima of functions of several variables, solutions of higher order ordinary differential equations and Fourier series. Matrices are used in computer animations, color image processing. Eigen values are used by engineers to discover new and better designs for the future. The laws of physics are generally written down as differential equations. So, differential equations and Fourier series expansions have wide applications in various engineering and science disciplines. This course enables the students to gain basic knowledge on the mathematics which is used in modeling the real time engineering problems very often.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Linear Algebra and Calculus	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE.

10 %	Remember
30 %	Understand
60 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

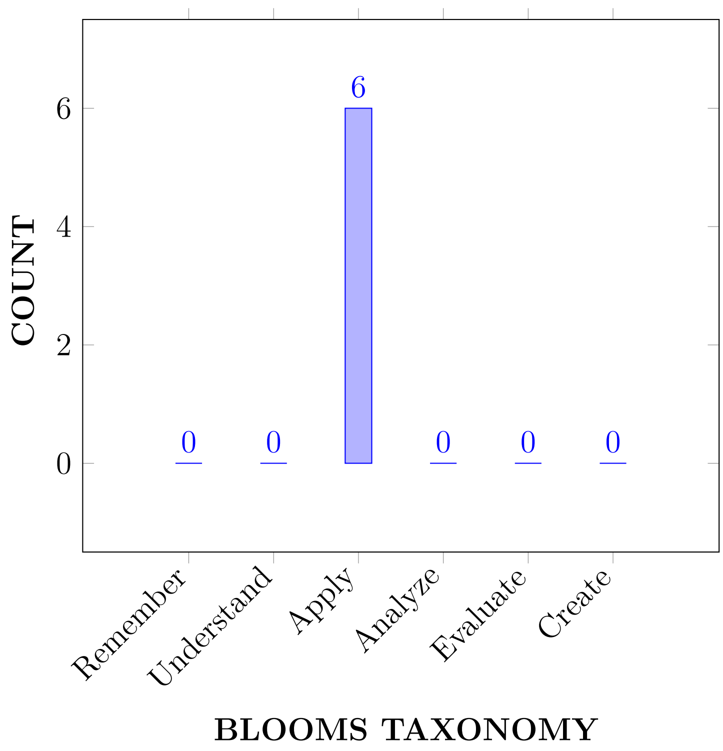
I	The principles of Eigen value analysis and linear transformations, Matrix rank finding methods.
II	The calculus of functions of several variables and the concept of maxima-minima for a three-dimensional surface.
III	The analytical methods for solving higher order differential equations with constant coefficients.
IV	Fourier series expansions in standard intervals as well as arbitrary intervals.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Compute** the rank and inverse of real and complex matrices with elementary transformation methods.	Apply
CO 2	**Use** the Eigen values, Eigen vectors for developing modal and Spectral matrices from the given matrix..	Apply
CO 3	**Make use of** Cayley Hamilton theorem for finding positive and negative powers of the matrix.	Apply
CO 4	**Utilize** the mean–value theorems and partial derivatives in estimating the extreme values for functions of several variables	Apply
CO 5	**Solve** the Second and higher order linear differential equations with constant coefficients by using substitution and method of variation of parameters..	Apply
CO 6	**Apply** the Fourier Series expansion of periodic, even and odd functions in analyzing the square wave, sine wave rectifiers.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-

PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-		-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Explain** the role of rank and inverse of real and complex matrices in solving **complex engineering problems** by using elementary transformation methods **(principles of mathematics).**	2
CO 2	PO 1	**Determine** the Eigen values, Eigen vectors, Spectral matrix **complex engineering problems modeled by matrices** with help of Characterstic Equation **(principles of mathematics).**	2
	PO 2	**Model** the problem into matrices, prepare precise **statement** of the problem and apply the concepts of Eigen values and Eigen vectors to **develop the solution** and **interpret, validate** the results through proper **documentation**	6
CO 3	PO 1	**Make use of** Cayley Hamilton theorem for finding positive and negative powers of the matrix and apply them in the **complex engineering problems** modeled by matrices **(principles of mathematics).**	2
CO 4	PO 1	**Explain** the mean–value theorems for the single variable functions andthe extreme values for functions of several variables apply them in the **complex engineering problems** Ordinary and Partial derivatives .	2

CO 5	PO 1	**Determine**the solution of **complex engineering problems** modeled by Second and higher order linear differential equations with constant coefficients by using substitution method and method of variation of parameters.	2
	PO 2	**Model** the problem with the help of ordinary differential equations, prepare precise **statement** of the problem and apply method of variation of parameters and other analytical methods to **develop the solution** and **interpret, validate** the results through proper **documentation**	6
CO 6	PO 1	**Build** the Fourier series expansion **for the complex engineering problems** modeled by given periodic, even and odd functions in various intervals with the help of Fourier coefficients formulae **(principles of mathematics).**	2
	PO 2	**Model** the problem with the help of suitable periodic functions, prepare precise **statement** of the problem and apply Fourier series expansions to **develop the solution** and **interpret, validate** the results through proper **documentation**	6

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/No.of Key Competencies Matched												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0\% \leq C \leq 5\%$ – No correlation
1 - $5\% < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	9	-	-	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assign-ments	-	Seminars	-
Labora-tory Practices	-	Student Viva	-	Mini Project	-	Certifica-tion	-
Term Paper	-	Tech - talk	✓	Concept Video	PO 1, PO 2	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

x	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**THEORY OF MATRICES**
	Real matrices: Symmetric, Skew-Symmetric and Orthogonal matrices; Complex matrices: Hermitian, Skew- Hermitian and Unitary matrices; Elementary row and column transformations, finding rank of a matrix by reducing to Echelon form and Normal form; Finding the inverse of a matrix using Gauss-Jordan method
MODULE II	**LINEAR TRANSFORMATIONS**

	Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Linear transformation; Eigen values and Eigen vectors of a matrix; Diagonalization of matrix.
MODULE III	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES**
	Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem-without proof; Functions of several variables: Partial differentiation, Jacobian, functional dependence, maxima and minima of functions with two variables and three variables. Method of Lagrange multipliers.
MODULE IV	**HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS**
	Linear differential equations of second and higher order with constant coefficients. Non-homogeneous term of the type f(x) = e^{ax} , sinax , cosax , x^n , e^{ax}v(x) and Method of variation of parameters.
MODULE V	**FOURIER SERIES**
	Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval;

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition, 2010
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint 2010.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9^{th} Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, Linear Algebra: A Modern Introduction, 2^{nd} Edition, Brooks/Cole, 2005.

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/108/111108157/

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Outcome based education	-	-
CONTENT DELIVERY (THEORY)			
2	Theory of Matrices: Types of Real Matrices	CO 1	T2:32.1 R1:4.1
3	Real Matrices: Symmetric, Skew-Symmetric Matrices	CO 1	T2:32.1 R1:4.2
4	Real Matrices: Orthogonal Matrices	CO 1	T2:32.1 R1:4.3
5	Complex Matrices: Hermitian, Skew- Hermitian	CO 1	T2:32.1 R1:4.3
6	Complex Matrices: Unitary Matrices	CO 1	T2:32.5 R1:4.6
7	Elementary Operations: Elementary Row and Column Transformations	CO 1	T2:32.5 R1:4.6
8	Rank of a Matrix by Echelon Form	CO 1	T2:32.4 R1:4.5
9	Rank of a Matrix by Normal Form	CO 1	T2:32.7 R1:4.8
10	Inverse of a Matrix by Gauss-Jordan Method	CO 1	T2-7.1 R1:7.4
11	Eigen Values of a Matrix	CO 2	T2-7.1 R1:7.4
12	Eigen Vectors of a Matrix	CO 2	T2-7.1 R1:7.4
13	Diagonalization of Matrix by Linear Transformation.	CO 2	T2:7.1 R1:7.4
14	Cayley-Hamilton Theorem- Statement, Verification	CO 3	T2:7.1 R1:7.4
15	Applications of Cayley – Hamilton: Finding Inverse and Powers of a Matrix	CO 3	T3-2.9 R1:2.1
16	Linear Dependence and Independence of Vectors	CO 2	T3-2.5 R1:2.8
17	Mean Value Theorems:1: Rolle's Theorem	CO 4	T3-2.5 R1:2.8
18	Mean Value Theorems:2: Lagrange's Theorem	CO 4	T3-2.5 R1:2.8

19	Mean Value Theorems:3: Cauchy's Theorem	CO 4	T3-2.5 R1:2.8
20	Functions of Several Variables: Partial Differentiation	CO 4	T3-2.5 R1:2.8
21	Jacobian Transformations	CO 4	T3-2.61 R1:2.10
22	Functional Dependence	CO 4	T1-7.1 R2:7.5
23	Maxima and Minima of Functions with Two Variables	CO 4	T3-2.61 R1:2.10
24	Maxima and Minima of Functions with Three Variables	CO 4	T1-7.1 R2:7.6
25	Application Method of Lagrange Multipliers	CO 4	T1-7.1 R2:7.7
26	Method of Lagrange Multipliers	CO 4	T3-2.5 R1:2.8
27	Linear Differential Equations of Second and Higher Order with Constant Coefficients	CO 5	T3-2.5 R1:2.8
28	Linear Differential Equations of Second and Higher Order with Constant Coefficients	CO 5	T3-2.5 R1:2.8
29	Non-Homogeneous term of the type F (X) = e^{ax}	CO 5	T3-2.5 R1:2.8
30	Non-Homogeneous term of the type F (X) = Sinax , Cosax	CO 5	T2-7.1 R1:7.4
31	Non-Homogeneous term of the type F (X) = X^n	CO 5	T2:7.1 R1:7.4
32	Non-Homogeneous term of the type F (X) = e^{ax}v(X)	CO 5	T2:7.1 R1:7.4
33	Method of Variation of Parameters	CO 5	T3-2.9 R1:2.1
34	Fourier Expansion of Periodic Function in a Given Interval of Length 2π	CO 6	T3-2.5 R1:2.8
35	Fourier Expansion of Periodic Function in a Given Interval of Length (-π,π)	CO 6	T3-2.5 R1:2.8
36	Fourier Series of Even Functions in a Given Interval of Length (-π,π)	CO 6	T2:7.1 R1:7.4
37	Fourier Series of Odd Functions in a Given Interval of Length (-π,π)	CO 6	T3-2.9 R1:2.1
38	Fourier Series in an Arbitrary Interval (0,2l)	CO 6	T3-2.5 R1:2.8
39	Fourier Series in an Arbitrary Interval (-l,l)	CO 6	T2:7.1 R1:7.4
40	Half- Range Fourier Sine Expansions in a Given Interval of Length (0,π)	CO 6	T3-2.9 R1:2.1

41	Half- Range Fourier Cosine Expansions in a Given Interval of Length (0,π)	CO 6	T3-2.5 R1:2.8
PROBLEM SOLVING/ CASE STUDIES			
42	Rank of the Matrix by Echelon and Normal Form	CO 1	T2:32.1 R1:4.2
43	Eigen Values and Eigen Vectors of The Matrix	CO 2	T2:32.1 R1:4.3
44	Finding Powers of the Matrix by Cayley Hamilton Theorem	CO 3	T2:32.1 R1:4.3
45	Finding Spectral Matrix by Linear Transformation.	CO 2	T2-7.1 R1:7.4
46	Jacobian Transformation in Cartesian and Polar Forms	CO 4	T2-7.1 R1:7.4
47	Finding Functional Relationship.	CO 4	T2:7.1 R1:7.4
48	Finding Critical Points.	CO 4	T2:7.1 R1:7.4
49	Solving Non-Homogeneous Differential Equations.	CO 5	T3-2.5 R1:2.8
50	Solving Second Order Non-Homogeneous Differential Equations by Method of Variation of Parameters.	CO 5	T3-2.5 R1:2.8
51	Finding Fourier Series	CO 6	T3-2.5 R1:2.8
52	Fourier Expansion of Periodic Function in a Given Interval of Length 2π	CO 6	T3-2.5 R1:2.8
53	Fourier Expansion of Periodic Function in a Given Interval of Length (-π,π)	CO 6	T3-2.61 R1:2.10
54	Fourier Series in An Arbitrary Interval (-l,l)	CO 6	T2:7.1 R1:7.4
55	Finding Fourier Sine Series in Interval (0,l)	CO 6	T3-2.9 R1:2.1
56	Finding Fourier Cosine Series in Interval (0,l)	CO 6	T3-2.5 R1:2.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Real, Complex Matrices and Rank of a Matrix	CO 1	T3-2.5 R1:2.8
58	Eigen Values and Eigen Vectors, Diagonalization	CO 2,C0 3	T3-2.5 R1:2.8
59	Mean Value Theorems, Jacobian Transformations, Functionally Dependent and Independent	CO 4	T3-2.5 R1:2.8
60	Higher Order Differential Equations	CO 5	T3-2.5 R1:2.8
61	Fourier Series (Even, Odd, Neither Functions)	CO 6	T3-2.61 R1:2.10

DISCUSSION OF QUESTION BANK			
62	Theory of Matrices	CO 1	T2:7.1 R1:7.4
63	Linear Transformations	CO 2,C0 3	T3-2.9 R1:2.1
64	Functions of Several Variables	CO 4	T3-2.5 R1:2.8
65	Higher Order Differential Equations	CO 5	T2:32.1 R1:4.3
66	Fourier Series.	CO 6	T2-7.1 R1:7.4

Signature of Course Coordinator **HOD, CSE (AI & ML)**
Dr S Jagadha, Associate Professor

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COMPUTER SCIENCE AND ENGINEERING(AI & ML)
COURSE DESCRIPTION

Course Title	**CHEMISTRY**				
Course Code	AHSC06				
Program	B.Tech				
Semester	I	Artificial Intelligence and Machine Learning			
Course Type	FOUNDATION				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	2	-	-
Course Coordinator	Dr V Anitha Rani, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of chemistry

II COURSE OVERVIEW:

The course discusses elements and compounds and their applied industrial applications. It deals with topics such as batteries, corrosion and control of metallic materials, water and its treatment for different purposes, engineering materials such as plastics, elastomers and biodegradable polymers, their preparation, properties and applications, energy sources and environmental science. Sustainable chemistry that focuses on the design of the products and processes that minimize or eliminate the use and generation of hazardous substances is also included.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Chemistry	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOCs
x	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

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"either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
50%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

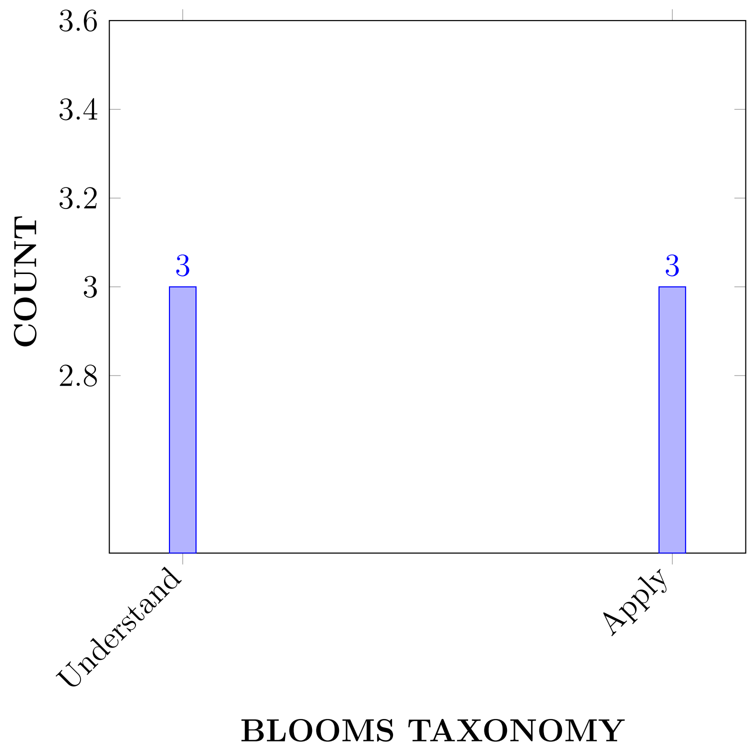
I	The concepts of electrochemical principles and causes of corrosion in the new development and breakthroughs efficiently in engineering and technology.
II	The different parameters to remove causes of hardness of water and their reactions towards the complexometric method.
III	The polymerization reactions with respect to mechanisms and its significance in industrial applications.
IV	The significance of green chemistry to reduce pollution in environment by using natural resources.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Explain** the electrochemical principles, corrosion process in metals for protection of different metals from corrosion	Understand
CO 2	**Utilize** electrochemical cell parameters, electrochemical active surface area, current and over potential under given condition for calculating the electromotive force and electrode potential.	Apply
CO 3	**Identify** the hardness of water by different treatment methods for finding the hardness causing salts in water.	Apply
CO 4	**Compare** different types of polymerization reactions, mechanism of lubrication for utilizing in industries.	Understand
CO 5	**Make use** of green synthesis methods, different types of solid, liquid and gaseous fuels in terms of calorific value for utilizing in industries and automobiles.	Apply
CO 6	**Outline** the different types of natural resources and their applicability for understanding the effect of pollutants on air, water and soil that cause the environmental pollution.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	CIE/SEE/AAT
PO 7	**Environment and sustainability:** understand the impact of the professional engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development. .	3	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)..	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓		-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Outcomes (COs)	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	**Explain** the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using **principles of** science for solving **engineering problems**.	2

CO 2	PO 1	**Choose** different electrodes for finding pH of unknown solutions by applying **mathematical** expressions of cell potential by using **principles of science** and mathematics for solving **engineering** problems	3
	PO 2	**Identify** the problem **formulation and abstraction** for calculating electrode potential under non standard conditions by applying Nernst equation from the provided **information.**	2
CO 3	PO 1	**Explain** different treatment methods to produce soft water from raw water for solving **engineering problems** by applying the **principles of science.**	2
	PO 2	**Identify** the problem and formulate for finding the hardness of water in terms of CaCO3 equivalents with given **information and data** by applying **principles of science.**	2
CO 4	PO 1	**Illustrate** different types of polymerization reactions for synthesizing polymers from monomers, different types of lubricants to reduce friction in machines working under various temperature conditions by using **principles of science** for solving **engineering** problems	2
CO 5	PO 1	**Explain** the importance of green synthesis to minimize the generation of hazardous substances, different types of solid, liquid and gaseous fuels with their characteristics and calorific value by applying **mathematical** expressions for finding calorific value using **principles of science** and mathematics for solving engineering problems.	3
	PO 2	**Identify the given problem** and **formulate** for finding the calorific value of fuel with the given **information and data** by applying principles of science.	2
	PO 7	Make use of gaseous fuels like LPG, CNG to reduce the pollutants in atmosphere and know the impact in **socio economic and environmental** contexts for sustainable development.	2
CO 6	PO 1	**Explain** the concept of **living** and non living resources and the utility of these resources, effect of pollutants on air, water and soil that causes the environmental pollution for solving engineering problems by applying the **principles of science**	2
	PO 7	**Make use** of renewable and non renewable resources, control measures for air pollution, water pollution, soil pollution and noise pollution in **socio economic** an **environmental** contexts for sustainable development.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.6	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	20	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
2 - 40 % $<C<$ 60% –Moderate
1-5 $<C\leq$ 40% – Low/ Slight
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
TOTAL	18	3	-	-	-	-	6	-	-	-	-	-	-	-	-
AVERAGE	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO1,PO2,PO7	SEE Exams	PO1,PO2,PO7	Seminars	PO1,PO2,PO7
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	PO1,PO2,PO7	5 Minutes Video	PO1,PO2,PO7	Open Ended Experiments	PO1,PO2,PO7
Assignments	PO1,PO2,PO7				

XVII ASSESSMENT METHODOLOGY INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**ELECTROCHEMISTRY AND BATTERIES**
	Electro chemical cells: Electrode potential, standard electrode potential, Calomel electrode and Nernstequation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery, Li-ion battery). Corrosion: Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current Cathodic protection; Surface coatings: Metallic coatings- Methods of coating- Hot dipping- galvanization and tinning, electroplating
MODULE II	**WATER TECHNOLOGY**
	Introduction: Hardness of water, causes of hardness; types of hardness: temporary and permanent hardness, expression and units of hardness; estimation of hardness of water by complexometric method; potable water and its specifications, Steps involved in the treatment of water, disinfection of water by chlorination and ozonization; External treatment of water; Ion-exchange process; Desalination of water: Reverse osmosis, numerical problems
MODULE III	**ENGINEERING MATERIALS**
	Polymers-classification with examples, polymerization-addition, condensation and co-polymerization; Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Biodegradable polymers. Elastomers: Natural rubber, processing of natural rubber, vulcanization; Buna-s and Thiokol rubber; Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication, properties – flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.

MODULE IV	**GREEN CHEMISTRY AND FUELS**
	Introduction: Definition of green chemistry, methods of green synthesis: aqueous phase, microwave method, phase transfer catalyst and ultra sound method. Fuels: definition, classification of fuels ; Solid fuels: coal; analysis of coal: proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Gaseous fuels: Composition, characteristics and applications of LPG and CNG; Calorific value: Gross Calorific value(GCV) and Net Calorific value(NCV), numerical problems.
MODULE V	**NATURAL RESOURCES AND ENVIRONMENTAL POLLUTION**
	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Land resources; Energy resources: renewable and non-renewable energy sources, use of alternate energy source. Environmental pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution and noise pollution.

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1. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 16th Edition, 2017.
2. Shashi Chawla, "Engineering Chemistry", Dhanat Rai and Company, 2011, 1st Edition.
3. Prashanth rath, B.Rama Devi, Ch.Venkata Ramana Reddy, Subhendu Chakroborty, Cengage Learning Publishers, 1st Edition, 2018
4. Anubha Kaushik, C.P.Kaushik, "Environmental Studies" New Age International publishers, 4th Edition, 2015.
5. Dr B.N.Srinivas, P.Kishore, K.Subba Rao "Engineering Chemistry" University Science Press,2015,1st Edition.

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1. 1. Dr.Bharathi Kumari, "A text book of Engineering Chemistry", VGS Book Links, 8th Edition,2016.
2. 2. B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015.
3. 3. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand Co, New Delhi, 12thEdition, 2006.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	W1
CONTENT DELIVERY (THEORY)			
1	Outcome Based Education.		

2	Recall the concept of electro chemical cells.	CO 1	T1:6.1,R1: 2.6
3	Explain the electrode potential, standard electrode potential, electrochemical series and its applications.	CO 2	T1:6.2,R1: 2.9
4	Derive Nernst equation , numerical problems on cell potential.	CO 2	T1:6.5,R1: 2.6.3
5	Demonstate about calomel electrode. Batteries: primary (dry cell).	CO 1	T1: 6.7, R1:2.12
6	Explain the secondary batteries (Lead-acid storage battery), Li-ion battery.	CO 1	T1:6.12,R1: 2.12
7	Recognize the causes and effects of corrosion, chemical corrosion.	CO 1	T1:7.1, R1:2.14
8	Explain the electrochemical corrosion, mechanism of electrochemical corrosion.	CO 1	T1:7.2, R1:2.17
9	Explain about cathodic protection, sacrificial anode and impressed current.	CO 1	T1:7.14, R1:2.20
10	Apply metallic coatings, methods of coatings, hot dipping, galvanizing , tinning and electroplating.	CO 1	T1:7.14,R1: 2.22
11	Recall the hardness of water, causes of hardness.	CO 3	T1:1.3,R1: 1.4
12	Explain the types of hardness, temporary and permanent, units of hardness.	CO 3	T1:1.3,1.5,
13	Estimation of hardness of water by complexometric method,	CO 3	T1:1.5,R1: 1.6.2
14	Estimation of hardness of water by complexometric method.	CO 3	T1:1.14,R1: 1.6.4
15	Define potable water and its specifications, steps involved in treatment of water, disinfection of water by chlorination and ozonization.	CO 3	T1:1.12,R1: 1.6.5
16	Explain about external treatment of water; ion-exchange process.	CO 3	T1:1.11, R1:1.8.1
17	Explain about desalination of water: reverse osmosis.	CO 3	T1:1.13, R1:1.10
18	Recall polymers-classification with examples and Explain about the polymerization-addition, condensation and co- polymerization	CO 4	T1: 3.5,R1: 3.1
19	Explain the concept of compounding of plastics.	CO 4	T1:1.4, R1: 3.1.4
20	Expalin the preparation, properties and applications of polyvinyl chloride, teflon.	CO 4	T1:3.5,R1: 3.2
21	Explain the bakelite and nylon-6, 6.	CO 4	T1: 3.12,R1: 3.2.2
22	Define biodegradable polymers, synthetic biodegradable polymers.	CO 4	T1:3.14,R1: 3.2.3
23	Explain rubbers, natural rubber its process and vulcanization, Buna-s and thiokol rubber.	CO 4	T1: 3.15, R1:3.2.3
24	Elastomers: Synthetic rubbers,Buna-s and thiokol rubber.	CO 4	T1: 3.22, R1:3,3.4

25	Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication.	CO 4	T1: 3.24,R1: 3.5
26	Properties–flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.	CO 4	T1: 3.25,R1: 3.7
27	Definition and importance of green chemistry, methods of green synthesis: aqueous phase method.	CO 5	T5:6.8, T2:1.1
28	Explain the microwave method and phase transfer catalyst.	CO 5	T5: 6.8.3,T2: 8.1
29	Explain the ultra sound method.	CO 5	T5: 6.8.3, T2:9.2
30	Define fuels, classification of fuels and characteristics of a good fuels.	CO 5	T1:4.2, R1:6.2.1
31	Explain solid fuels, coal, Analysis of coal, proximate and ultimate analysis.	CO 5	T1:4.4.1, R1:7.1
32	Explain liquid fuels, petroleum and its refining.	CO 5	T1:4.5.2, R1:15.2
33	Explain the gaseous fuels, Composition, characteristics and applications of LPG and CNG.	CO 5	T1:4.6, R1:9.2
34	Apply the concept of calorific value, gross calorific value (GCV) and Net calorific value(NCV) to find calorific value of fuel, numerical problems.	CO 5	T1:4.8, R1:5.2
35	Recall natural resources: classification of resources, living and nonliving resources.	CO 6	T4:2.1
36	Explain the water resources: use and over utilization of surface and ground water, floods and droughts, Dams, benefits and problems.	CO 6	T4:2.2
37	Define energy resources, renewable and non-renewable energy sources.	CO 6	T4:2.3
38	Explain the alternate energy sources, land resources	CO 6	T4:2.5,5.2
39	Define environmental pollution, causes, effects and control of air pollution.	CO 6	T4: 4.2
40	Explain the causes, effects and control of water pollution.	CO 6	T4: 4.6
41	Explain the causes, effects and control of soil pollution and noise pollution.	CO 6	T4:4.12
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on EMF of voltaic cell	CO 2	T1:6.2,R1: 2.9
43	Problems on EMF of a cell	CO 2	T1:6.5,R1: 2.6.3
44	Problems on electrode potential of the half cell by using Nernst equation	CO 2	T1:6.2,R1: 2.9
45	Problems on electrode potential of EMF of the cell by using Nernst equation.	CO 2	T1:6.5,R1: 2.6.3
46	Problems on temporary and permanent hardness in Degree French.	CO 3	T1:1.5, R1: 1.6.2
47	Problems on temporary, permanent and total hardness in ppm	CO 3	T1:1.14,R1: 1.6.4
48	Problems on the temporary, permanent and total hardness of water in Degree Clark.	CO 3	T1:1.5,R1: 1.6.2

49	Problems on the temporary, permanent and total hardness of water in Mg/L.	CO 3	T1:1.14,R1: 1.6.4
50	Problems on the total hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
51	Problems on the permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.14,R1: 1.6.4
52	Problems on the temporary hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
53	Problems on the higher and lower calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
54	Problems on the gross and net calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
55	Problems on HCV and LCV	CO 5	T1:4.8, R1:5.2
56	Problems on GCV and NCV	CO 5	T1:4.8, R1:5.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions & terminology discussion on electrochemistry and corrosion	CO 1	T1:1.3,R1: 1.4
58	Definitions & terminology discussion on water technology	CO 3	T1: 3.5,R1: 3.1
59	Definitions & terminology discussion on engineering	CO 4	T1: 3.5,R1: 3.1
60	Definitions & terminology discussion on green chemistry and fuels	CO 5	T1:4.2, R1:6.2.1
61	Definitions & terminology discussion on natural resources and environmental pollution	CO 1, CO 6	T4:2.1,2.8
DISCUSSION OF QUESTION BANK			
62	Question bank discussion on electrochemistry and Corrosion	CO 1	T1: 6.1, R1:2.12
63	Question bank discussion on water technology	CO 3	T1:1.3, R1: 1.4
64	Question bank discussion on engineering materials	CO 4	T1: 3.5,R1: 3.1
65	Question bank discussion on green chemistry and fuels	CO5	T1:4.2, R1:6.2.1
66	Question bank discussion on natural resources and environmental Pollution	CO 6	T4:2.1,2.8

Course Coordinator: HOD, CSE(AI& ML)
Dr V Anitha Rani,Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
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COURSE DESCRIPTION

Department	Computer Science and Engineering(AI & ML)				
Course Title	Python Programming				
Course Code	ACSC01				
Program	B.Tech				
Semester	I	CSE(AI & ML)			
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr.B Padmaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	NIL

II COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java. The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python,object-oriented programming and graphical user interfaces.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Python Programming	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.3 %	Remember
50 %	Understand
16.66 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

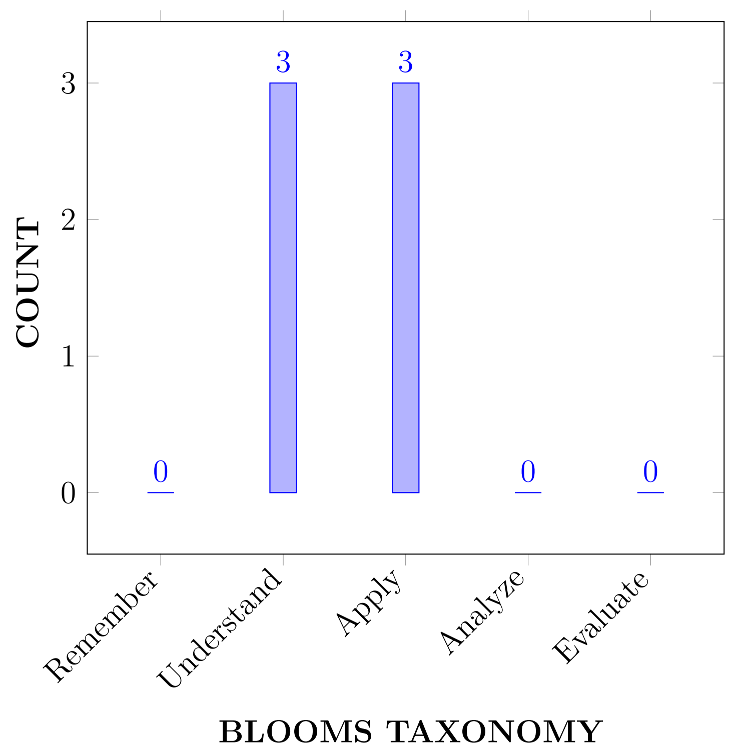
I	**Acquire programming skills in core Python**
II	**Acquire Object-oriented programming skills in Python.**
III	**Develop the skill of designing graphical-user interfaces (GUI) in Python.**
IV	**Develop the ability to write database applications in Python.**
V	**Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.**

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the basic concepts of python programming with the help of data types,operators, expressions, and console input/output.	Understand
CO 2	**Make use of** control statements for altering the sequential execution of programs in solving problems.	Apply
CO 3	**Demonstrate** operations on built-in container data types (list, tuple, set, dictionary) and strings.	Understand
CO 4	**Illustrate** operations and applications on strings with the help of built in functions.	Understand
CO 5	**Solve** the problems by using modular programming concepts through functions.	Apply
CO 6	**Identify** object oriented programming constructs for developing large, modular and reusable real-time programs.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature,and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques,resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	CIE/SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations,and give and receive clear instructions..	3	Tech Talk/Open Ended Experiments/Concept Vedios
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	CIE/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	CIE/Quiz/ AAT

PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	✓	-	-	-	-	✓	-	-	✓		-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-	✓
CO 3	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-	✓
CO 4	✓	-	✓	-	✓	-	-	-	-	✓	-	✓	✓	-	✓
CO 5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	-
CO 6	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand (knowledge) the basic concept of operators, precedence of operators and associativity while evaluating mathematical expressions in program statements. These concepts provide an insight into expression evaluation by applying the principles of mathematics and science.	3
CO 1	PO 5	With the help of modern engineering tools we can easily Understand the basic concept of operators, precedence of operators and associativity while evaluating mathematical expressions in program statements These concepts provide an insight into expression evaluation by applying the principles of mathematics and science.	1
CO 1	PO 10	Extend the knowledge of Python programming to communicate effectively with the Engineering community and society at large.	3
CO 1	PSO 1	Understand features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data and Artificial Intelligence	3
CO 2	PO 1	By applying the knowledge of mathematics,science and engineering fundameentals we can effectively use control statements.	3
CO 2	PO 2	Apply control statements in problem indentification,statement and validation .	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 3	Apply control statements to investigate and understand different complex engineering problems complex problems efficiently.	8
CO 2	PO 5	By applying control statements to model complex engineering activities	1
CO 2	PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	3
CO 2	PSO 1	Apply features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data and Artificial Intelligence	3
CO 2	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time for building successful career and doing higher studies.	3
CO 3	PO 1	Summarize indexing and slicing mechanisms for extracting a portion of data in a sequence using principles of mathematics, and engineering fundamentals.	3
CO 3	PO 3	Demonstrate the importance of indexing mechanisms in sequences such as lists, strings, sets, tuple and dictionary while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	6
CO 3	PO 5	Demonstarte lists,tuples and dictionaries With the usage of modern tools	1
CO 3	PSO 1	Summarize indexing mechanisms to design and develop efficient real-time computational problems.	3
CO 3	PSO 3	Infer sufficient knowledge of container data types and apply it in real-time for building successful career and doing higher studies.	3
CO 4	PO 1	Demonstrate different modules/packages in Python while developing solutions using the fundamentals of mathematics, science, and engineering.	3
CO 4	PO 3	Understand the usage of modules/packages while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	8
CO 4	PO 5	Interpret different string functions by using modern tools	1
CO 4	PO 10	Extend the focus to understand the usage of modules/packages and communicate effectively with the Engineering community and with society at large.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PO 12	Summarize string handling functions to implement in project management	7
CO 4	PSO 1	Demonsrtate different modules to understand, design and analyze computer programs in reducing time and space complexities of various applications.	3
CO 4	PSO 3	Illustrate modern computer tools in implementing string handling mechanisms for various applications to become a successful professional in the domains.	3
CO 5	P0 1	Make use of parameter passing and different types of arguments in user-defined functions to design efficiently modular programs by applying the knowledge of mathematics, science, Engineering fundamentals.	3
CO 5	P0 2	Apply modular programming concepts for problem identification,formulation and data collection .	8
CO 5	PO 3	Select strong foundation of writing efficient modular programs using parameter passing mechanisms for career building by understanding the requirements and communicating effectively with engineering community.	7
CO 5	PO 5	Develop different functions by using modern tools	1
CO 5	PSO 1	Develop design and analyse python programming in the areas of concept of passing of parameters and arguments in functions to do modular programming.	3
CO 6	PO 1	Apply scientific principles and methodologies, Mathematical principles and other engineering disciplines for the procedural and object-oriented programming concepts used in Python.	3
CO 6	PO 2	Apply object oriented concepts in problem indentification,statement and validation .	7
CO 6	PO 3	Identify the need of object-oriented concepts while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions..	7
CO 6	PO 5	Develop object oriented principles using modern tools	1
CO 6	PO 10	Apply the knowledge of Python programming to communicate effectively with the Engineering community and society at large.	3
CO 6	PO 12	Identify the need of object oriented principles for preparation ad ability to engage in independent and lifelong learning	6
CO 6	PSO 1	Focus on writing programs using procedural and object oriented concepts for applications such as computational geometry, machine learning, Big data and AI by understanding and applying the engineering principles learning	3
CO 6	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time for building successful career and doing higher studies.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	1	-	-	-		3	-		3	-	-
CO 2	3	5	8	-	1	-	-	-	-	3	-	-	3	-	3
CO 3	3		6		1	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	8	-	1	-	-	-	-	3	-	7	3		3
CO 5	3	8	7	-	1	-	-	-	-	-	-	-	3	-	-
CO 6	3	7	7	-	1	-	-	-	-	3	-	6	3	-	3

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	12	1	3	2
CO 1	100	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	100	0.0	0.0
CO 2	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	100	0.0	100
CO 3	100	0.0	60	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100
CO 4	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	88	100	0.0	100
CO 5	100	80	70	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 6	100	80	70	0.0	100	0.0	0.0	0.0	0.0	60	0.0	75	100	0.0	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	3	-	-	-	-	3	-	-	3	-	-
CO 2	3	2	3	-	3	-	-	-	-	3	-	-	3	-	3
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	3	-	3	-	-	-	-	3	-	3	3	-	3
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	3	-	-
CO 6	3	3	3	-	3	-	-	-	-	3	-	3	3	-	3
TOTAL	18	7	15	-	18	-	-	-	-	12	-	6	18	-	12
AVERAGE	3.0	2.3	3	-	3.0	-	-	-	-	3.0	-	3.0	3.0	-	3.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	case studies	-
Assignments	-	Open ended experiments	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**Introduction to Python**
	Introduction to Python: Features of Python, History and Future of Python, Working with Python – interactive and script mode, Identifiers and Keywords, Comments, Indentation and Multi-lining, Data types – built-in data types, Operators and Expressions, Console Input/Output, Formatted printing,Built-in Functions, Library Functions.
MODULE II	**DECISION CONTROL STATEMENTS**
	Selection/Conditional Branching Statements: if, if-else, nested if, if-elif-else statement(s), Basic Loop Structures/ Iterative Statements – while and for loop, Nested loops, break and continue statement, pass Statement, else Statement used with loops..
MODULE III	**CONTAINER DATA TYPES**
	Lists: Accessing List elements, List operations, List methods, List comprehension; Tuples: Accessing Tuple elements, Tuple operations, Tuple methods, Tuple comprehension, Conversion of List comprehension to Tuple, Iterators and Iterables, zip() function. Sets: Accessing Set elements, Set operations, Set functions, Set comprehension;Dictionaries: Accessing Dictionary elements, Dictionary operations, Dictionary Functions, Nested Dictionary, Dictionary comprehension.s.
MODULE IV	**STRINGS AND FUNCTIONS**
	Strings: Accessing string elements, string properties, string operations. Functions: Communicating with functions, Variable Scope and lifetime, return statement, Types of arguments, Lambda functions, Recursive functions..
MODULE V	**CLASSES AND OBJECTS**
	Classes and Objects – Defining Classes, Creating Objects, Data Abstraction and Hiding through Classes, Class Method and self Argument, Class variables and Object variables, init() and de () method, Public and private data members, Built-in Class Attributes, Garbage Collection. OOPs Features:Abstraction, Encapsulation, Inheritance, and Polymorphism.

TEXTBOOKS:

1. Reema Thareja, “Python Programming - Using Problem Solving Approach”, Oxford Press, 1st Edition, 2017.
2. Dusty Philips, “Python 3 Object Oriented Programming”, PACKT Publishing, 2nd Edition,2015.

REFERENCE BOOKS:

1. Yashavant Kanetkar, Aditya Kanetkar, “Let Us Python”, BPB Publications, 2nd Edition, 2019.
2. Martin C. Brown, “Python: The Complete Reference”, Mc. Graw Hill, Indian Edition, 2018.
3. Michael H. Goldwasser, David Letscher, “Object Oriented Programming in Python”, Prentice Hall, 1st Edition, 2007.
4. Taneja Sheetal, Kumar Naveen, “Python Programming – A Modular Approach”, Pearson, 1st Edition, 2017
5. Nageswar Rao, “Core Python Programming”, Dreamtech Press, 2018.

COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference T1: 4.1
OBE DISCUSSION			
	Discussion on mapping COs with POs. (OBE)		
CONTENT DELIVERY (THEORY)			
1-2	Introduction to Python: Features of Python, History and Future of Python	CO 1	T1:3.1 –3.3
3-4	Working with Python – interactive and script mode, Identifiers and Keywords, Comments, Indentation and Multi-lining, Databtypes – built-in data types	CO 1	T1:3.4-3.9
5-8	Operators and Expressions	CO 1	T1:3.12
9-10	Console Input/Output, Formatted printing, Built-in Functions, Library Functions	CO 1	T1:3.15
11-14	Control Statement(s)	CO 2	T1: 4.1 –4.8
15-17	Lists and Tuples	CO 3	T1:3.15
18-19	Conversion of List comprehension to Tuple, Iterators and Iterables, zip() function	CO 3	T1:3.15
20-21	Sets, Dictionaries:	CO 3	T1:3.15
22-23	Nested Dictionary, Dictionary comprehension	CO 3	T1:3.15
24-25	Strings: Accessing string elements, string properties, string operations	CO 4	T1: 6.1 –6.8
26-27	Functions: Communicating with functions, Variable Scope and lifetime, return statement	CO 5	T1:5.1 –5.5

28-29	Types of arguments, Lambda functions, Recursive functions	CO 5	T1:5.6 –5.8
30-31	Classes and Objects – Defining Classes, Creating Objects	CO 6	T1 : 9.1 – 9.3
32-33	Data Abstraction and Hiding through Classes, Class Method and self Argument	CO 6	T1: 9.2 – 9.4
34-36	Class variables and Object variables, init() and del () method	CO 6	T1:9.5 – 9.7
37-38	Public and private data members, Built-in Class Attributes, Garbage Collection	CO 6	T1:9.8 – 9.13
39-41	OOPs Features: Abstraction, Encapsulation, Inheritance, and Polymorphism	CO 6	T1:10.1-10.3
PROBLEM SOLVING/ CASE STUDIES			
1	Data Types	CO 1	T1:3.7.1-3.7.4
2	Operators and Expressions	CO 1	T1:3.12.1-3.12.10
3	Built-in Functions , Library functions	CO 1	T1:6.4-6.10
4	Conditional branching Statements	CO 2	T1:4.1-4.2
5	Iterative Statements	CO 2	T1:4.3-4.8
6	Lists	CO 3	T1:8.2-8.2.10
7	Tuples	CO 3	T1:8.4.1
8	Sets	CO 3	T1:8.5.1
9	Dictionaries	CO 3	T1:8.6.1-8.6.12
10	Strings	CO 4	T1:6.1-6.10
11	Functions	CO 5	T1:5.1:5.10
12	Classes and Objects	CO 6	T1:9.1-9.15
13	___init()___and ___del___() method	CO 6	T1:9.4-9.6
14	Inheritance	CO 6	T1:10.1-10.4
15	Polymorphism	CO 6	T1:10.2.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Define bound and unbound variable.	CO 1	T1:9.1
2	Define a control structure?	CO 2	T1:4.1-4.8
3	How to slice lists in Python?	CO 3	T1:8.2-8.6
4	Write the syntax of defining a function?	CO 5	T1:5.1-5.2

5	List out the features of object oriented programming.	CO 6	T19.1-9.3
DISCUSSION OF QUESTION BANK			
1	Write the features and applications of Python programming language?	CO 1	T1:3.1-3.3
2	Write a program to calculate the roots of a quadratic equation?	CO 1	T1:3.5-3.7
3	Write a program to remove all duplicate elements from a list?	CO 3	T1:8.2-8.6
4	Write a program that accepts a string from user and redisplays the same string after removing vowels from it?	CO 4	T1:6.1-6.3
5	Write a program that has a class Person string name and date of birth (DOB) of a person. The program should subtract the DOB from today's date to find out whether a person is eligible for vote or not?	CO 6	T1:9.1-9.3

Signature of Course Coordinator **HOD CSE(AI & ML))**
Dr.B Padmaja

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI & ML)**				
Course Title	**BASIC ELECTRICAL ENGINEERING**				
Course Code	AEEC01				
Program	B.Tech				
Semester	I	CSE(AI&ML)			
Course Type	Foundation				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. P Shiva Kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	Linear Algebra and Calculus

II COURSE OVERVIEW:

The Basic Electrical Engineering enables knowledge on electrical quantities such as current, voltage, and power, energy to know the impact of technology in global and societal context. This course provides knowledge on basic DC and AC circuits used in electrical and electronic devices, highlights the importance of transformers, electrical machines in generation, transmission and distribution of electric power, identify the types of electrical machines suitable for particular applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Fluid Dynamics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
17%	Remember
50%	Understand
33%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

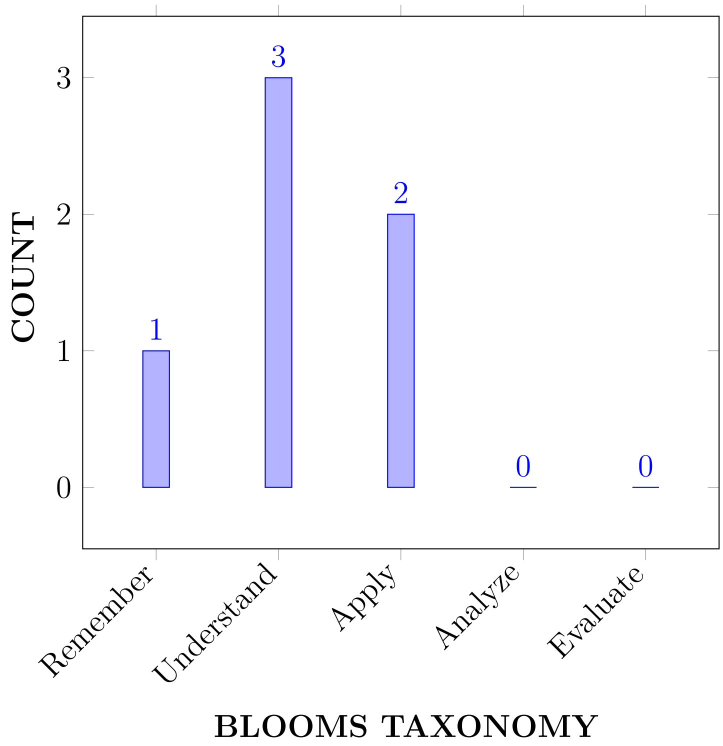
I	The fundamentals of electrical circuits and analysis of circuits with DC excitation using circuit laws.
II	The application of circuit laws in network theorems and graph theory to simplify complex networks.
III	The construction and working principle of DC generator, DC motor, andtypes of DC machines based on field excitation method.
IV	The theory of Faraday's law of mutual induction and working of single phase transformer.
V	The concept of rotating magnetic field and constructional features, principle and types of AC machines.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Solve** complex electrical circuits by applying network reduction techniques for reducing into a simplified circuit.	Apply
CO 2	**Define** basic nomenclature of single phase AC circuits for obtaining impedance, admittance of series and parallel circuits.	Remember
CO 3	**Make use of** various network theorems and graph theory for simplifying complex electrical networks.	Apply
CO 4	**Demonstrate** the construction, principle and working of DC machines for their performance analysis.	Understand
CO 5	**Illustrate** working , construction and obtain the equivalent circuit of single phase transformers.	Understand
CO 6	**Explore** electromagnetic lawsused for the construction and opertaion of synchronous and asynchronous machines.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
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PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Understand design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	1	Quiz

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 6	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	Recollect the concept of electricity is described through scientific principles, importance Kirchhoff laws in relation with law of conservation of energy and charge circuits are explained using mathematics, engineering fundamentals and various source transformation techniques are adopted for solving complex circuits.	3
	PO 2	Derive standard expressions for equivalent resistances, inductances and capacitance by using series-parallel networks i.e mathematical calculations.	1
	PSO 1	Solve complex electrical circuits by applying basic circuit concepts by using computer programs.	1
CO 2	**PO 1**	Make use of Alternating quantity for obtaining form, peak factor concept of impedance and admittance using the knowledge of mathematics, science, and engineering fundamentals.	3
CO 3	**PO 1**	Demonstrate various network theorems in order to determine the same using principles of mathematics, science, and engineering fundamentals.	3
	PO 2	Verify various network theorems for their validation using mathematical calculations.	1
	PSO 1	Simplify complex electrical networks by applying various circuit theorems by using computer programs.	1
CO 4	**PO 1**	The principle of operation and characteristics of DC machines are explained by applying engineering fundamentals including device physics.	3
CO 5	**PO 1**	Understand how classification DC machines are done and their power flow with the knowledge of mathematics and engineering sciences.	3
	PSO 1	Develop equivalent circuit of single phase transformer referred to both sides by developing computer programs.	1
CO 6	**PO 1**	Understand the working of induction motors and alternators using engineering principles and mathematical equations.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	10	-	-	-	-	-	-	-	-	-	-	25	-	-
CO 2	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	10	-	-	-	-	-	-	-	-	-	-	25	-	-
CO 4	100	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 5	100	-	-	-	-	-	-	-	-	-	-	-	25	-	-
CO 6	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	2	-	-	-	-	-	-	-	-	-	-	3	-	-
AVERAGE	3.0	0.3	-	-	-	-	-	-	-	-	-	-	0.5	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO ELECTRICAL CIRCUITS**
	Circuit concept: Ohm's law, Kirchhoff's laws, equivalent resistance of networks, Source transformation, Star to delta transformation, mesh and nodal analysis; Single phase AC circuits: Representation of alternating quantities, RMS, average, form and peak factor, concept of impedance and admittance.
MODULE II	**NETWORK THEOREMS AND NETWORK TOPOLOGY**
	Network Theorems: Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer for DC excitations circuits. Network Topology: Definitions, Graph, Tree, Incidence matrix, Basic Cut Set and Basic Tie Set Matrices for planar networks.
MODULE III	**DC MACHINES**
	DC generators: Principle of operation, construction, EMF equation, types of DC generators. Losses and efficiency. DC motors: Principle of operation, back EMF, torque equation, types of DC motors, Losses and efficiency, numerical problems.
MODULE IV	**SINGLE PHASE TRASNFORMERS**
	Single Phase Transformers: Principle of operation, construction, types of transformers, EMF equation, operation of transformer under no load and on load, Phasor diagrams, equivalent circuit, efficiency, regulation and numerical problems.
MODULE V	**AC MACHINES**
	Three Phase Induction motor: Principle of operation, slip, slip -torque characteristics, efficiency and applications; Alternators: Introduction, principle of operation, constructional features, calculation of regulation by synchronous impedance method and numerical problems.

TEXTBOOKS

1. A Chakrabarti, "Circuit Theory", Dhanpat Rai Publications, 6thEdition,2004.
2. K S Suresh Kumar, "Electric Circuit Analysis", Pearson Education, 1stEdition,2013.
3. WillianmHayt, Jack E Kemmerly S M Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 7thEdition,2010.
4. J P J Millman, C CHalkias, SatyabrataJit, "Millman s Electronic Devices and Circuits", Tata McGraw Hill, 2ndEdition,1998.

5. R L Boylestad, Louis Nashelsky, "Electronic Devices and Circuits", PEI / PHI, 9th Edition, 2006.

6. V K Mehta, Rohit Mehta, Principles of electrical engineering, S CHAND, 1st Edition, 2003.

REFERENCE BOOKS:

1. David A Bell, "Electric Circuits", Oxford University Press, 9thEdition,2016.

2. U A Bakshi,Atul P Godse "Basic Electrical and Electronics Engineering"TechnicalPublications, 9thEdition,2016.

3. A Bruce Carlson, "Circuits", Cengage Learning, 1stEdition,2008.

4. M Arshad, "Network Analysis and Circuits", Infinity Science Press, 9thEdition,2016.

WEB REFERENCES:

1. http://www.igniteengineers.com
2. http://www.ocw.nthu.edu.tw
3. http://www.uotechnology.edu.iq

COURSE WEB PAGE:

1. https://www.iare.ac.in/?q=courses/computer-science-engineering-autonomous/basic -electrical-engineering

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
2	Electrical Circuits: Basic definitions, Types of elements	CO 1	T1-5.2 to 5.3
3	Ohm's Law, Kirchhoff Laws	CO 1	T1-5.4 to 5.5
4	Series, parallel circuits	CO 2	T1-5.5 to 5.8
5	Derivation for Star-delta and delta-star transformations	CO 2	T1-5.8 to 5.9
6	Mesh analysis and Nodal Analysis	CO 2	T1-5.11 to 5.12
7	Representation of alternating quantities	CO 3	T1-5.14 to 5.15

8	RMS and Average values of an AC signal	CO 2	T1-5.16 to 5.16
9	Form and peak factor, concept of impedance and admittance	CO 2	T1-5.16 to 5.16
10	Superposition theorem for DC excitations circuits	CO 3	T1-6.1 to 6.3
11	Reciprocity theorem for DC excitation	CO 3	T1-6.8 to 6.9
12	Thevenin's theorem for DC excitations circuits	CO 3	T1-6.2 to 6.3
13	Norton's theorem for DC excitations circuits	CO 3	T1-6.3 to 6.4
14	Maximum power transfer theorem for DC excitations circuits	CO 3	T1-11.1
15	Incidence matrix for planar networks	CO 3	T1-11.2 to 11.3
16	Basic Cut Set matrix for planar networks	CO 4	T1-11.2 to 11.3
17	Basic Tie Set matrix for planar networks	CO 3	T1-11.9 to 11.10
18	Principle of operation for DC generators	CO 4	R2-7.1 to 7.2
19	Construction and EMF equation for DC generators	CO 4	R2-7.4
20	Types of DC generators	CO 4	R2-7.3
21	Principle of operation for DC motors	CO 4	R2-7.3.1 to 7.3.2
22	Back EMF, torque equation for DC motors	CO 4	R2-7.3.3 to 7.3.6
23	Types of DC motors	CO 4	R2-7.6
24	Losses and efficiency for DC generators, motors	CO 4	T1-13.1 to 13.3
25	Principle of operation for Single Phase Transformers	CO 5	T1-13.1 to 13.3
26	Construction and EMF equation for Single Phase Transformers	CO 5	T1-13.5 to 13.6
27	Types of transformers and turns ratio	CO 5	T1-13.6 to 13.7
28	Operation of transformer under no load	CO 5	T1-13.7 to 13.9
29	Operation of transformer under on load	CO 5	T1-13.8
30	Equivalent circuit for Transformers	CO 5	T1-17.1 to 17.2
31	Phasor diagrams of transformer	CO 5	T1-17.3 to 17.4
32	Losses of Transformers	CO 5	T1-17.6 to 17.7
33	Efficiency of Transformers	CO 5	T1-13.11
34	Regulation for Transformers	CO 5	T1-13.12

35	Three Phase Induction motor: Principle of operation	CO 5	T1-13.13
36	slip, slip -torque characteristics	CO 6	T1-13.14
37	Efficiency of Induction motor	CO 6	T1-13.16 to 13.18
38	Applications of Induction motor	CO 6	T1-13.19
39	Alternators: Introduction, principle of operation	CO 6	T1-13.19
40	Constructional features	CO 6	T1-13.20
41	Calculation of regulation by synchronous impedance method and numerical problems.	CO 6	T1-13.20
PROBLEM SOLVING/ CASE STUDIES			
42	Numerical Examples on electrical quantities, Ohm's law, KCL, KVL	CO 2	T1-5.8 to 5.9
43	Numerical Examples on series, parallel elements and star to delta transformation and mesh analysis	CO 2	T1-5.5 to 5.8
44	Numerical Examples on nodal analysis and alternating quantities	CO 3	T1-6.8 to 6.9
45	Numerical Examples on Superposition theorem	CO 3	T1-6.2 to 6.3
46	Numerical Examples on reciprocity and maximum power transfer theorems	CO 3	R2-7.1 to 7.2
47	Numerical Examples on Thevenin's and Norton's theorems	CO 3	T1-13.1 to 13.3
48	Numerical Examples on Basic cut set and Tie set matrices	CO 3	T1-13.5 to 13.6
49	Numerical Examples on EMF equation and types of DC generators	CO 4	T1-13.6 to 13.7
50	Numerical Examples on torque equation of DC motor	CO 4	T1-13.1 to 13.3
51	Numerical Examples on types of DC motors	CO 4	T1-13.13
52	Numerical Examples on EMF equation and equivalent circuit of 1 phase transformer	CO 5	T1-13.16 to 13.18
53	Numerical Examples on, efficiency for Transformers	CO 5	T1-13.14
54	Numerical Examples on, regulation for Transformers	CO 5	T1-13.16 to 13.18
55	Numerical Examples on EMF of Alternators	CO 6	T1-13.19
56	Numerical Examples on regulation of Alternators	CO 6	T1-13.20
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions and terminology from basics of electrical circuits	CO 1	T1-5.1 to 5.3
58	Definitions on network theorems	CO 3	T1-6.1 to 6.3
59	Definitions on DC machines	CO 4	R2-7.1 to 7.2
60	Definitions on single phase transformers	CO 5	T1-13.1 to 13.3
61	Definitions on AC machines	CO 6	T1-13.11

DISCUSSION OF QUESTION BANK			
62	Questions from electrical circuits	CO 1	T1-5.1 to 5.3
63	Questions from network theorems	CO 3	T1-6.1 to 6.3
64	Questions from DC machines	CO 4	R2-7.1 to 7.2
65	Questions from single phase transformers	CO 5	T1-13.1 to 13.3
66	Questions from AC machines	CO 6	T1-13.11

Course Cordinator **HOD,CSE(AI & ML)**
Mr. P Shiva Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Course Title	**PYTHON PROGRAMMING LABORATORY**				
Course Code	ACAC02				
Program	B.Tech				
Semester	I	AI & ML			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms Jalaja Vishnubhotla, Assistant Professor CSE (AI&ML)				

I COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java.The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python, object-oriented programming and graphical user interfaces.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
PYTHON PROGRAMMING LABORATORY	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	Acquire programming skills in core Python.
II	Acquire Object-oriented programming skills in Python.
III	Develop the skill of designing graphical-user interfaces (GUI) in Python.
IV	Develop the ability to write database applications in Python
V	Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.

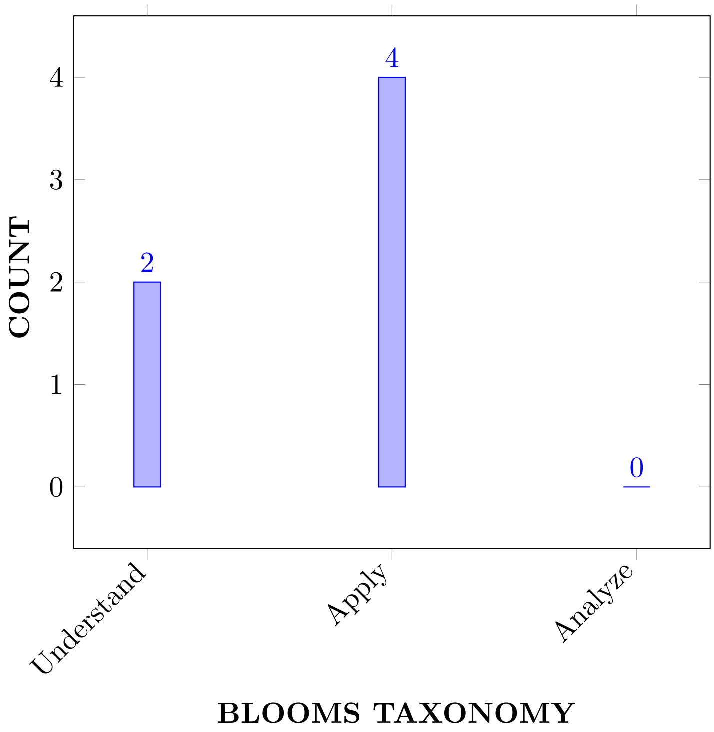
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the basic concepts of python programming with the help of data types, operators and expressions, console input/output	Understand
CO 2	**Make use of** control statements for altering the sequential execution of programs in solving problems.	Apply
CO 3	**Demonstrate** operations on built-in container data types (list, tuple, set, dictionary) and strings.	Understand

CO 4	**Make use of** operations and applications on strings with the help of built in functions	Apply
CO 5	**Solve** the problems by using modular programming concepts through functions.	Apply
CO 6	**Identify** object-oriented programming constructs for developing large, modular and reusable real-time programs	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design next-generation computer systems, networking devices, search engines, soft computing and intelligent systems, web browsers, and knowledge discovery tools.	3	Lab Exercises
PSO 2	Focus on mobile and web applications development and learn the emerging technologies and frameworks in demand with employers and contemporary challenges		
PSO 3	Practical experience in shipping real world software, using industry standard tools and collaboration techniques will equip to secure and succeed in first job upon graduation in IT industry.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Demonstrate the data types of Python Programming by understating their importance and applicability (apply) in. **solving (complex) engineering problems by applying the principles of Mathematics and Engineering.**	3

	PO 2	Demonstrate the data types of Python Programming **with provided information and data in reaching substantiated conclusions by the interpretation of results.** .	3
	PO 5	Demonstrate the data types,operators,expressions and console I/O of Python Programming **for solving problems with the help of built in functions in Python programming**.	3
	PSO 3	Use datatypes,operators and expressions of Python Programming **in solving mathematical and statistical problems**	3
CO 2	PO 1	Illustrate the usage of control statements in solving real world problems **by applying principles of Mathematics, Science and Engineering.**	3
	PO 2	Illustrate the usage of control statements in solving real world problems **for visualizing the distribution of data in solving analysis problems.** .	2
	PO 5	Illustrate the usage of control statements along with built in functions of Python programming **for visualizing distribution of data with the help of built in function in Python programming language** .	3
	PSO 3	Use real time data to implement machine learning basics with Python programming **by analyzing the data and its relationships.** .	3
CO 3	PO 1	Illustrate the operations on built in container data types and strings **by applying the principles of Mathematics, Science and Engineering.** .	3
	PO 2	Illustrate the operations on built in container data types and strings in solving (complex) data centric engineering problems **from the provided information and substantiate with the interpretation of variations in the results.** .	3
	PSO 3	Implement the Python Programming basics **by exploring data analysis to solve complex problems.** .	3
CO 4	PO 1	Conclude the insights of data using exploratory data analysis **by applying the principles of Mathematics, Science and Engineering.**.	3
	PO 5	Define the list of operations on strings using built in functions **Find the different ways to model data and understand the limitations.**.	2
	PSO 3	Implement all string related operations using Python Programming programming **by exploring data limitations for generating predictions.** .	3
CO 5	PO 1	Apply the Modular Approach real world problems **by understanding the concepts of functions and code reusability**.	3

	PO 3	Understand the given problem statement and formulate (complex) engineering system **for developing a modular approach in solving problems that meet specified needs**.	2
	PO 5	Make use of functions **for creating the concept of code reusability**.	3
	PSO 3	Understand the concept of modularity by implementing different user defined and built functions **from real world problems to visualize the data to analyze the complexity.**.	3
CO 6	PO 1	Apply the knowledge of **engineering fundamentals**, and an **Mathematics and Engineering fundamentals principles to create a object oriented model on real time problems**.	3
	PO 3	Apply object oriented and modular concepts on **solving real world problems** reaching **and reusable conclusions**.	3
	PSO 3	Use built in functions in Python **for solving modular and reusable real time problems**.	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES				PROGRAM OUTCOMES		
	PO 1	PO 2	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	2		2	3			3
CO 2	3		3				3
CO 3	3	2	3				3
CO 4	3		3				3
CO 5	3	2	3				3
CO 6	3	2	3				3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**OPERATORS**
	a.Read a list of numbers and write a program to check whether a particular element is present or not using membership operators. b. Read your name and age and write a program to display the year in which you will turn 100 years old c. Read radius and height of a cone and write a program to find the volume of a cone d.Write a program to compute distance between two points taking input from the user (Hint: use Pythagorean theorem)
WEEK 2	**CONTROL STRUCTURES**
	a. Read your email id and write a program to display the no of vowels, consonants, digits and white spaces in it using if…elif…else statement. b. Write a program to create and display a dictionary by storing the antonyms of words. Find the antonym of a particular word given by the user from the dictionary using while loop c. Write a Program to find the sum of a Series 1/1! + 2/2! + 3/3! + 4/4! +…….+ n/n!. (Input :n = 5, Output : 2.70833)
WEEK 3	**LIST**
	a. Read a list of numbers and print the numbers divisible by x but not by y (Assume x = 4 and y = 5). b. Read a list of numbers and print the sum of odd integers and even integers from the list.(Ex: [23, 10, 15, 14, 63], odd numbers sum = 101, even numbers sum = 24) c. Read a list of numbers and print numbers present in odd index position. (Ex: [10, 25, 30, 47, 56, 84, 96], The numbers in odd index position: 25 47 84) d. Read a list of numbers and remove the duplicate numbers from it. (Ex: Enter a list with duplicate elements: 10 20 40 10 50 30 20 10 80, The unique list is: [10, 20, 30, 40, 50, 80])
WEEK 4	**TUPLE**
	a. Given a list of tuples. Write a program to find tuples which have all elements divisible by K from a list of tuples. testlist = [(6, 24, 12), (60, 12, 6), (12, 18, 21)], K = 6, Output : [(6, 24, 12), (60, 12, 6)] b. Given a list of tuples. Write a program to filter all uppercase characters tuples from given list of tuples. (Input: testlist = [("GFG", "IS", "BEST"), ("GFg", "AVERAGE"), ("GfG",), ("Gfg", "CS")], Output : [(GFG, IS, BEST)]). c. Given a tuple and a list as input, write a program to count the occurrences of all items of the list in the tuple. (Input : tuple = ('a', 'a', 'c', 'b', 'd'), list = ['a', 'b'], Output : 3)
WEEK 5	**SET**

	a.Write a program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x). b.Write a program to perform union, intersection and difference using Set A and Set B. c.Write a program to count number of vowels using sets in given string (Input : "Hello World", Output: No. of vowels : 3) d.Write a program to form concatenated string by taking uncommon characters from two strings using set concept (Input : S1 = "aacdb", S2 = "gafd", Output : "cbgf").
WEEK 6	**DICTIONARY**
	a. Write a program to do the following operations: i. Create a empty dictionary with dict() method ii. Add elements one at a time iii. Update existing keys value iv. Access an element using a key and also get() method v. Deleting a key value using del() method b. Write a program to create a dictionary and apply the following methods: i. pop() method ii. popitem() method iii. clear() method c.Given a dictionary, write a program to find the sum of all items in the dictionary
WEEK 7	**STRINGS**
	a. Given a string, write a program to check if the string is symmetrical and palindrome or not. A string is said to be symmetrical if both the halves of the string are the same and a string is said to be a palindrome string if one half of the string is the reverse of the other half or if a string appears same when read forward or backward. b. Write a program to read a string and count the number of vowel letters and print all letters except 'e' and 's'. c. Write a program to read a line of text and remove the initial word from given text. (Hint: Use split() method, Input : India is my country. Output : is my country) d. Write a program to read a string and count how many times each letter appears. (Histogram)
WEEK 8	**USER DEFINED FUNCTIONS**
	a. A generator is a function that produces a sequence of results instead of a single value. Write a generator function for Fibonacci numbers up to n. b.Write a function mergedict(dict1, dict2) to merge two Python dictionaries. c.Write a fact() function to compute the factorial of a given positive number. d.Given a list of n elements, write a linearsearch() function to search a given element x in a list.
WEEK 9	**BUILT-IN FUNCTIONS**

	a. Write a program to demonstrate the working of built-in statistical functions mean(), mode(), median() by importing statistics library b. Write a program to demonstrate the working of built-in trignometric functions sin(), cos(), tan(), hypot(), degrees(), radians() by importing math module c. Write a program to demonstrate the working of built-in Logarithmic and Power functions exp(), log(), log2(), log10(), pow() by importing math module.
WEEK 10	**CLASS AND OBJECTS**
	a.Write a program to create a BankAccount class. Your class should support the following methods for i) Deposit ii) Withdraw iii) GetBalanace iv) PinChange b.Create a SavingsAccount class that behaves just like a BankAccount, but also has an interest rate and a method that increases the balance by the appropriate amount of interest (Hint:use Inheritance). c.Write a program to create an employee class and store the employee name, id, age, and salary using the constructor. Display the employee details by invoking employeeinfo() method and also using dictionary dict. d.Access modifiers in Python are used to modify the default scope of variables. Write a program to demonstrate the 3 types of access modifiers: public, private and protected.
WEEK 11	**MISCELLANEOUS PROGRAMS**
	Write a program to find the maximum and minimum K elements in Tuple using slicing and sorted() method (Input: testtup = (3, 7, 1, 18, 9), k = 2, Output: (3, 1, 9, 18)) b. Write a program to find the size of a tuple using getsizeof() method from sys module and built-in sizeof() method c.Write a program to check if a substring is present in a given string or not d. Write a program to find the length of a string using various methods: i. Using len() method ii. Using for loop and in operator iii. Using while loop and slicing
WEEK 12	**ADDITIONAL PROGRAMS - FILE HANDLING**
	a. Write a program to read a filename from the user, open the file (say firstFile.txt) and then perform the following operations: i. Count the sentences in the file. ii. Count the words in the file. iii. Count the characters in the file. b. Create a new file (Hello.txt) and copy the text to other file called target.txt. The target.txt file should store only lower case alphabets and display the number of lines copied c.Write a Python program to store N students records containing name, roll number and branch. Print the given branch students details only.

TEXTBOOKS

1. Michael H Goldwasser, David Letscher, “Object Oriented Programming in Python”, Prentice Hall, 1st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, “Let us Python”, BPB publication, 1st Edition, 2019

3. Ashok Kamthane, Amit Kamthane, “Programming and Problem Solving with Python”, McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, “Python Programming – A modular approach”, Pearson, 2017

REFERENCE BOOKS:

1. www.oikostat.ch.
2. https://realpython.com/python3-object-oriented-programming//
3. https://python.swaroopch.com/oop.html#syllabus.
4. https://python-textbok.readthedocs.io/en/1.0/ObjectOrientedProgramming.html/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
1	Operators	CO 1	R1: 1
2	Control structures	CO 1	R3: 2
3	List	CO 2	R1: 7
4	Tuple	CO 2	R1: 8
5	Set	CO 3	R1: 2.4
6	Dictionary	CO 3	R1: 9
7	Strings	CO 4	R1: 10
8	User Defined Functions	CO 4	R3: 15
9	Built in Functions	CO 5	R1: 9
10	Class and Objects	CO5	R1: 10
11	Miscelaneous Programs	CO 6	R4:7
12	Additionaal programs - File Handling	CO 6	R4:10

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Python program to Right rotate a numpy array to n.
2	Python program to multiply all elements in a Dictionary.
3	Python Program to put positive and negative numbers in a seperate list.
4	Python program to remove given key from a Dictionary.

Signature of Course Coordinator **HOD, CSE(AI&ML)**
Ms Jalaja Vishnubhotla, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUITER SCIENCE AND ENGINEERING (AI & ML)
COURSE DESCRIPTION

Course Title	**BASIC ELECTRICAL ENGINEERING LABORATORY**				
Course Code	AEEC04				
Program	B.Tech				
Semester	I	CSE/CSE(AI&ML)/CSE(CS)/CS&IT/CSE(DS)/IT			
Course Type	Foundation				
Regulation	IARE - R20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms. T Saritha Kumari, Associate Professor				

I COURSE OVERVIEW:

The objective of the Basic Electrical Engineering Laboratory lab is to expose the students to the electrical circuits and give them experimental skill. The purpose of lab experiment is to continue to build circuit construction skills using different circuit element. It provides hands-on experience by examining the electrical characteristics of various AC and DC machines.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHSC02	I	Linear ALgebra and Calculus

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Basic Electrical Engineering Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

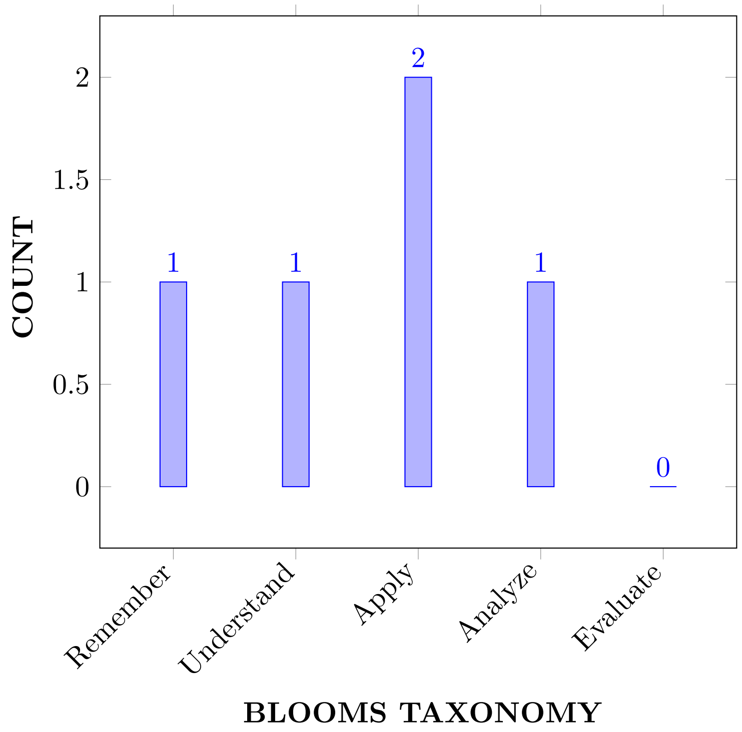
I	The basic laws, network reduction techniques and theorems for different circuits.
II	The performance characteristics of AC series and parallel circuits for measurement of electrical quantities using digital simulation tools.
III	The elementary experimental and modelling skills for handling problems with electrical machines in the industries and domestic applications to excel in professional career.
IV	The intuitive knowledge needed to test and analyse the performance leading to design of electric machines by conducting various tests and calculate the performance parameters.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Analyze** an electric circuit using Ohm's and Kirchhoff's laws, nodal and mesh analysis.	Analyze
CO 2	**Apply** various network theorems for reducing complex networks into simple equivalent network.	Apply
CO 3	**Examine** the alternating quantities for different periodic wave forms and the passive networks.	Understand
CO 4	**Analyze** the performance characteristics of DC shunt machine at various loading conditions.	Analyze
CO 5	**Examine** the performance of single-phase transformers, induction motors and alternator by conducting a suitable test.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Laboratory experiments, internal and external lab exam

PO 5	**Modern Tool Usage:** Create,select and apply appropriate techniques,resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of limitation.	1	Laboratory experiments, internal and external lab exam
PO 8	**Ethics:** Apply ethical principles and commit to professikonal ethics and responsibilties and norms of the engineering practice.	3	Laboratory experiments, internal and external lab exam
PO 9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Laboratory experiments, internal and external lab exam
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Laboratory experiments,internal and external lab exam
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Laboratory experiments, internal and external lab exam

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Recollect the concept of electricity is described through scientific principles, importance Kirchhoff laws in relation with law of conservation of energy and charge circuits are explained using **knowledge of mathematics, science and engineering fundamentals.**and various source transformation techniques are adopted for solving complex circuits.	3
	PO 5	Create,select and apply appropriate techniques,resources and modern engineering and IT tools **in solving the circuits**	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in solving the circuits**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in solving the circuits**.	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in solving the circuits**.	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in solving the circuits**.	3
	PSO 1	Solve complex electrical circuits by applying basic circuit concepts **by using computer programs.**	1
CO 2	PO 1	Demonstrate the various network theorems in order to determine the same **using principles of mathematics, science and engineering fundamentals.**	3
	PO 5	Create,select and apply appropriate techniques,resources and modern engineering and IT tools **in solving the complex circuits**	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in solving complex circuits by using theroems**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in solving complex circuits by using theroems**	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in solving complex circuits by using theroems**	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in solving the circuits by using theroems**	3

	PSO 1	Simplify complex electrical networks by applying various circuit theorems **by using computer programs.**	1
CO 3	PO 1	Understand the concept of alternating quantities with peak, average and root mean square values for different periodic wave forms and impedance of series RC,RL and RLC circuits by **knounderstanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 5	Create,select and apply appropriate techniques,resources and modern engineering and IT tools **in solving the circuits**	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in understanding concept of alternating quantities with peak, average and root mean square values for different periodic wave forms and impedance of series RC,RL and RLC circuit**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in understanding concept of alternating quantities with peak, average and root mean square values for different periodic wave forms and impedance of series RC,RL and RLC circuits**	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in understanding concept of alternating quantities with peak, average and root mean square values for different periodic wave forms and impedance of series RC,RL and RLC circuits**	5
CO 4	PO 1	Apply (knowledge) magnetization characteristics DC shunt generator and performance characteristics of DC shunt machine by **analyzing complex engineering problems using the principles of mathematics, engineering science.**	3
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in applying magnetization characteristics DC shunt generator and performance characteristics of DC shunt machine**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in applying magnetization characteristics DC shunt generator and performance characteristics of DC shunt machine**	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in applying magnetization characteristics DC shunt generator and performance characteristics of DC shunt machine**	5

CO 5	PO 1	Understand the performance characteristics of transformer, Imduction motors and alternator by using principles of **mathematics and engineering science**	3
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **by understanding the performance characteristics of transformer, Imduction motors and alternator**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **by understanding the performance characteristics of transformer, Imduction motors and alternator**	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **by understanding the performance characteristics of transformer, Imduction motors and alternator**	5
	PSO 1	Understand the performance characteristics of transformer, Imduction motors and alternator **by using computer programs.**	1

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES
	PO 1	PO 5	PO 8	PO 9	PO10	PO12	PSO1
CO 1	3	1	1	3	3	3	1
CO 2	3	1	1	3	3	3	1
CO 3	3	1	1	3	3		
CO 4	3		1	3	3		
CO 5	3		1	3	3		1

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**OHM'S LAW, KVL AND KCL**
	Verification of Ohm's, Verification of Kirchhoff's current law and Voltage law using hardware and digital simulation.
WEEK II	**MESH ANALYSIS**
	Determination of mesh currents using hardware and digital simulation
WEEK III	**NODAL ANALYSIS**
	Measurement of nodal voltages using hardware and digital simulation.
WEEK IV	**IMPEDANCE OF SERIES RL AND RC CIRCUIT**
	Examine the impedance of series RL and RC circuit using hardware and digital simulation
WEEK V	**IMPEDANCE OF SERIES RLC CIRCUIT**
	Measure the impedance of series RLC Circuit using hardware and digital simulation.
WEEK VI	**SINGLE PHASE AC CIRCUITS**
	Determination of average value, RMS value, form factor, peak factor of sinusoidal wave using digital simulation.
WEEK VII	**SUPERPOSITION AND MAXIMUM POWER TRANSFER THEOREM**
	Verification of superposition and maximum power transfer theorem using hardware and digital simulation.
WEEK VIII	**THEVENIN'S AND NORTON'S THEOREM**
	Verification of Thevenin's and Norton's theorem using hardware and digital simulation.
WEEK IX	**SWINBURNE'S TEST**
	Predetermination of efficiency of DC shunt machine.
WEEK X	**MAGNITETIZATION CHARACTERISTICS**
	Determine the critical field resistance from magnetization characteristics of DC shunt generator.
WEEK XI	**BRAKE TEST ON DC SHUNT MOTOR**
	Study the performance characteristics of DC shunt motor by brake test
WEEK XII	**SPEED CONTROL OF DC SHUNT MOTOR**
	Verify the armature and field control techniques of DC shunt motor.
WEEK XIII	**OPEN CIRCUIT AND SHORT CIRCUIT TEST ON SINGLE PHASE TRANSFORMER**
	Determination of losses and efficiency of single-phase transformer.
WEEK XIV	**SYNCHRONOUS IMPEDENCE METHOD**
	Determine the regulation of alternator using synchronous impedance method.

TEXTBOOKS

1. A Sudhakar, Shyammohan S Palli, “Circuits and Networks”, Tata McGraw-Hill, 4th Edition, 20103

2. P S Bimbhra, “Electrical Machinery”, Khanna Publishers, 1 st Edition,2011.

REFERENCE BOOKS:

1. A Chakrabarti, “Circuit Theory”, Dhanpat Rai Publications, 6th Edition, 2006.
2. K S Suresh Kumar, “Electric Circuit Analysis”, Pearson Education, 1st Edition, 2013.
3. Etter, “Introduction to MATLAB 7”, Pearson Education, 1st Edition, 2008.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
1	Verification of Ohm’s, Verification of Kirchhoff’s current law and voltage law using hardware.	CO 1	T1:1.1
2	Determination of mesh currents using hardware.	CO 2	T1:2.1
3	Measurement of nodal voltages using hardware.	CO 2	T1:2.4
4	Examine the impedance of series RL and RC circuit.	CO 3	T1:6.1
5	Measure the impedance of series RLC Circuit using hardware.	CO 3	T1:4.6
6	Determination of average value, RMS value, form factor, peak factor of sinusoidal wave.	CO 3	T1:5.1
7	Verification of superposition and maximum power transfer theorem using hardware and digital simulation.	CO 2	R3: T1:4.1
8	Verification of Thevenin’s and Norton’s theorem using hardware.	CO 2	T1:4.7
9	Predetermination of efficiency of DC shunt machine.	CO 4	T2:4.11
10	Determine the critical field resistance from magnetization characteristics of DC shunt generator.	CO 4	T2:4.11
11	Study the performance characteristics of DC shunt motor by brake test.	CO 4	T2:4.12
12	Speed control of DC shunt motor.	CO 4	T2:4.14
13	Determination of losses and efficiency of single-phase transformer.	CO 5	T2:1.1
14	Determine the regulation of alternator using synchronous impedance method.	CO 5	T2:5.4

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Verification of reciprocity theorem.
2	Determination of efficiency by load test in DC shunt generator.
3	Determination of efficiency by load test on DC series generator.
4	Determination of efficiency by load test on DC compound generator.
5	Determination of efficiency by load test on a single-phase transformer

Signature of Course Coordinator **HOD,CSE (AI & ML)**
Mrs. T Saritha Kumari, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)
COURSE DESCRIPTION

Course Title	**ENGINEERING WORKSHOP PRACTICE**				
Course Code	AMEC04				
Program	B.Tech				
Semester	I	AI & ML			
Course Type	FOUNDATION				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Mr. Gooty Rohan, Assistant Professor				

I COURSE OVERVIEW:

Engineering workshop Practice is intended to enhance the learning experience of the student about engineering tools for cutting and measuring used in a workshop. Students are expected to gain experience in hands on training as well as knowledge to carry out a particular process for making a product using the basic manufacturing devices used in Workshop.

II COURSE PRE-R‘EQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	-	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Engineering Workshop Practice	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day-to-day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

B. Programming Based

Purpose	**Algorithm**	**Program**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

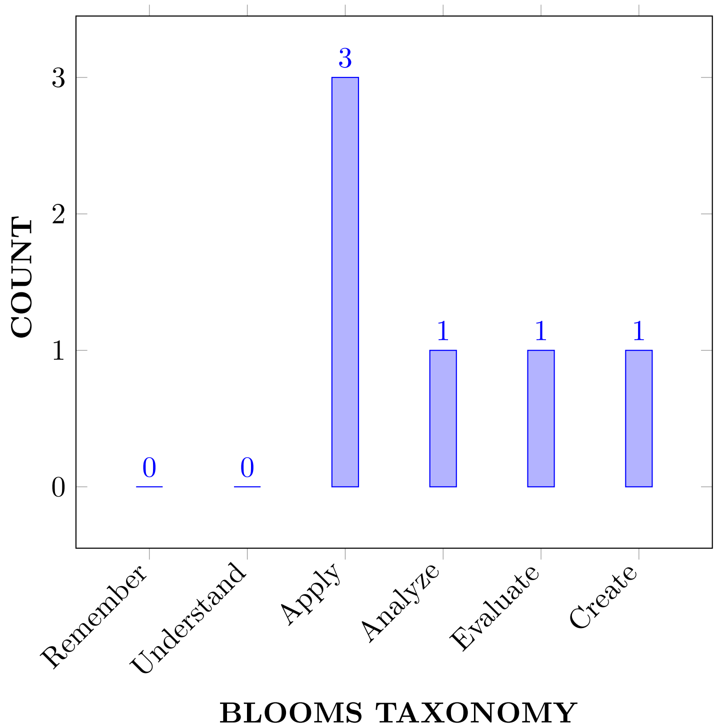
I	The application of jigs and fixtures, measuring, marking and cutting tools in various types of manufacturing processes.
II	The preparation of different joints in carpentry and fitting and also familiarizes wood working machinery.
III	The concepts of forming processes by forging, black-smithy and tin-smithy with an application extracts of Engineering Drawing.
IV	The standard electrical wiring practices for domestic and industrial appliances.
V	The current advancements in developing the prototype models through digital manufacturing facilities.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the conventional representation of materials and machine elements for making a desired product with given work piece.	Apply
CO 2	**Determine** the ability to Produce Fitting jobs as per specified dimensions in addition to demonstrating proficiency with hand tools common in fitting.	Evaluate
CO 3	**Create** a desired shape with given metal rod by using fire and furnaceto convert given shape into useable elements using basic blacksmith techniques.	Create
CO 4	**Organize** the moulding techniques along with suitable tools for producing casting of different and complex shapes using various patterns.	Apply
CO 5	**Develop** the various engineering and household products by using tin simthy instruments/machinesfor manufacturing the tin boxes, cans, funnels, ducts etc., from a flat sheet of metal.	Apply
CO 6	**Compare** various electrical circuits by using conduit system of wiring to prepare different types of electrical connection on the given circuit boards using appropriate electrical tools.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	CIA
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Lab Exercises
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge of engineering fundamentals to join given wooden pieces according to given sketch to develop required joint.	1

	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components	2
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 2	PO 1	Apply the knowledge of engineering fundamentals to join given metal pieces according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 3	PO 1	Apply the knowledge of engineering fundamentals to make metal rod into given required shape according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 4	PO 1	Apply the knowledge of engineering fundamentals to make the casting product from given materials according to given sketch to develop required shape.	1
	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
CO 5	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation.	2

	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
CO 6	PO 1	Apply the knowledge of engineering fundamentals to make the required electrical connection according to given circuit diagram to develop connection.	1
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE	PROGRAM OUTCOMES				PSO'S
OUTCOMES	PO 1	PO 3	PO 5	PO 11	PSO 3
CO 1	1	2	2	2	2
CO 2	1	-	2	2	2
CO 3	1	-	2	-	2
CO 4	1	2	-	2	-
CO 5	-	-	2	2	-
CO 6	1	-	2	2	2

3 = High; 2 = Medium; 1 = Low

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, PO 3, PSO 3	SEE Exams	PO 1,PO 3, PO 5, PSO 3	Seminars	-
Laboratory Practices	PO 1,PO 3, PO 5, PSO 3	Student Viva	PO 1, PO 5	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**CARPENTRY-I**
	Batch I: Preparation of Tenon joint as per given dimensions. Batch II: Preparation of Mortise joint as per given taper angle.
WEEK 2	**CARPENTRY-II**
	Batch I: Preparation of dove tail joint as per given taper angle. Batch II: Preparation of lap joint as per given dimensions.
WEEK 3	**FITTING - I**
	Batch I: Make a straight fit for given dimensions. Batch II: Make a square fit for given dimensions.
WEEK 4	**FITTING - II**
	Batch I: Make a V fit for given dimensions. Batch II: Make a semicircular fit for given dimensions.
WEEK 5	**BLACKSMITHY- I**
	Batch I: Prepare S-bend for given MS rod using open hearth furnace. Batch II: Prepare J-bend for given MS rod using open hearth furnace.
WEEK 6	**BLACKSMITHY- II**
	Batch I: Prepare Fan hook for given dimensions. Batch II: Prepare Round to Square for given dimensions.
WEEK 7	**MOULD PREPARATION-I**
	Batch I: Prepare a wheel flange mould using a given wooden pattern. Batch II: Prepare a bearing housing using an aluminum pattern.
WEEK 8	**MOULD PREPARATION-II**
	Batch I: Prepare a bearing housing using an aluminum pattern. Batch II: Prepare a wheel flange mould using a given wooden pattern.
WEEK 9	**TINSMITHY- I**
	Batch I: Prepare the development of a surface and make a rectangular tray for given dimensions. Batch II: Prepare the development of a surface and make a round tin for given dimensions.
WEEK 10	**TINSMITHY- II**
	Batch I: Prepare the development of a surface and make a Square Tin, for given dimensions. Batch II: Prepare the development of a surface and make a Conical Funnel for given dimensions.
WEEK 11	**ELECTRICAL WIRING-I**
	Batch I: Make an electrical connection of two bulbs connected in series. Batch II: Make an electrical connection of two bulbs connected in parallel.
WEEK 12	**ELECTRICAL WIRING-II**
	Batch I: Make an electrical connection of one bulb controlled by two switches connected. Batch II: Make an electrical connection of tube light.

TEXTBOOKS

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Media promoters and publishers private limited, Mumbai, Vol. I 2008 and Vol. II 2010.
2. Kalpakjian S, Steven S. Schmid, Manufacturing Engineering and Technology, Pearson Education India Edition, 4th Edition, 2002.
3. Gowri P. Hariharan, A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
4. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall India, 4 th Edition, 1998.
5. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, Tata McGraw-Hill House, 2017

REFERENCE BOOKS:

1. Gowri P. Hariharan, A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall India, 4th Edition, 1998.
3. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Tenon joint and Mortise joint.	CO 1, CO 2	T1:1.4, R1:1.2
2	Dove tail joint and Lap joint.	CO 1, CO 2	T1:1.5, R1:1.3
3	Straight fit and Square fit.	CO 3, CO 4	T2:12.2, R2:13.1
4	V fit and Semicircular fit.	CO 3, CO 4	T2:12.3, R2:13.4
5	S-bend and J-bend.	CO 5, CO 6	T3:9.1, R3:3
6	Fan and Round to Square shape.	CO 5, CO 6	T3:9.1, R3:3
7	Wheel flange and bearing housing.	CO 7, CO 8	T4:1.9, R2:1.8
8	Bearing housing and Wheel flange.	CO 7, CO 8	T4:2, R2:1.9
9	Rectangular tray and Round tin.	CO 9, CO 10	T5:1.4, R1:1.2
10	Make a Square Tin and Conical Funnel.	CO 9, CO 10	T5:1.7, R2:1.3
11	Series connection and parallel Connection.	CO 11, CO 12	T4:1.4, R1:1.2

12	One bulb controlled by two switches and tube light connection.	CO 11, CO 12	T5:7.1, R3:3.8

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Divided Tenon Joint:** It is the simplest form of Mortise and tenon joint and this joint is made by fitting a short tenon into a continuous groove. This joint has the advantage of being easy to cut and is often used to make cabinet doors and other light duty frame and panel assemblies.
2	**Cross Fitting:** It is the fundamental of type of fitting which are used fitting trade and it is formed by joining the two inclined shaped cut specimens together and is often used to join the universal bearings.
3	**Hexagonal Headed Bolt:** Hexagonal bolts are large bolts with a six-sided head used to fasten wood to wood, or metal to wood. These will have a tendency to spin as you tighten them.
4	**Open scoop:** Open scoop is used for accurately dispensing powders and granules hygienically. It is suitable for any hygienic application.
5	**T-Pipe Joint:** T-pipe is a type of fitting which is T-shaped having two outlets at 90 degrees to the main line. It is short piece of pipe with a lateral outlet.it is widely used as pipe fittings.
6	**Grooved Pulley:** Grooved pulley often used to for holding a belt, wire rope or rope and incorporated into a pulley. These sheave pins on a axle or bearing inside the frame of the pulley. This allows wire or rope to move freely, minimizing friction and wear on the cable.
7	**Bell Indicator circuit:** Bell indicator circuit is used where a bell and buzzers are needed to control from different locations. Bell indicator circuit is also known as hoteling circuit where an electric bell is controlled from more than one locations.

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Mr.Gooty Rohan, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**ENGLISH**				
Course Code	AHSC01				
Program	B. Tech				
Semester	II				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	2	-	-
- Course Coordinator	Dr. M.Sailaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The principle aim of the course is that the students will have awareness about the importance of English language in the contemporary times and also it emphasizes the students to learn this language as a skill (listening skill, speaking skill, reading skill and writing skill). Moreover, the course benefits the students how to solve their day-to-day problems in speaking English language. Besides, it assists the students to reduce the mother tongue influence and acquire the knowledge of neutral accent. The course provides theoretical and practical knowledge of English language and it enables students to participate in debates about informative, persuasive, didactic, and commercial purposes.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
English	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	LCD / PPT	x	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
37%	Remember
63 %	Understand
-	Apply
-	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

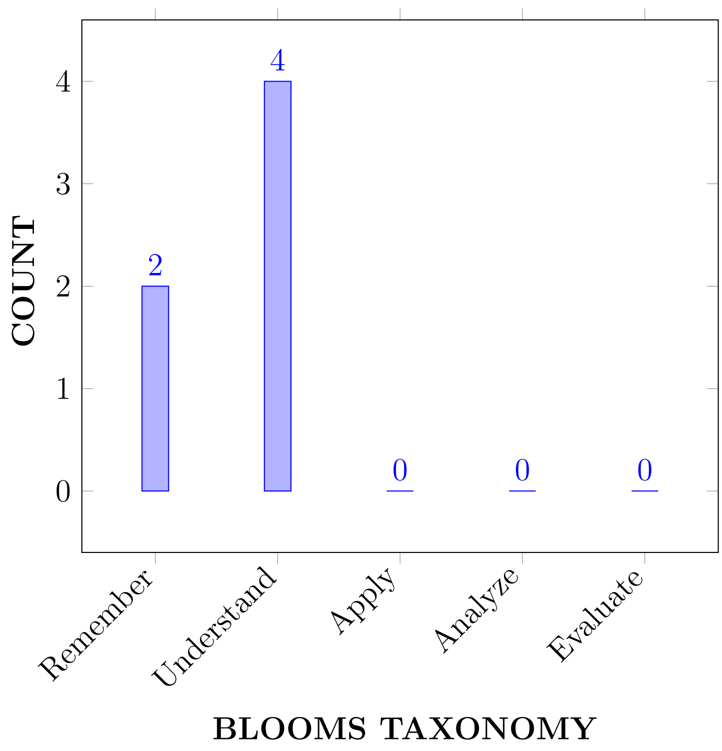
I	Standard pronunciation, appropriate word stress, and necessary intonation patterns for effective communication towards achieving academic and professional targets.
II	Appropriate grammatical structures and also using the nuances of punctuation tools for practical purposes.
III	A critical aspect of speaking and reading for interpreting in-depth meaning between the sentences.
IV	A conceptual awareness on writing in terms of unity, content, coherence, and linguistic accuracy.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Discuss** the prime necessities of listening skill for academic and non-academic purposes.	Remember
CO 2	**Illustrate** appropriate speaking strategies to explain a topic in a clear-cut manner.	Understand
CO 3	**Choose** acceptable language for developing life skills to overcome the challenges at professional platform.	Understand
CO 4	**Interpret** the grammatical aspects effectively in speaking and writing at functional usage.	Understand
CO 5	**Describe** the importance of reading skill and various strategies to enhance professional growth and success.	Remember
CO 6	**Summarize** writing skills for fulfilling the academic and non-academic requirements of various written communicative functions.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 10	**Communication :** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (Communication). "Students should demonstrate the ability to communicate effectively in writing / Orally." 1. Clarity (Writing); 2. Grammar/Punctuation (Writing); 3. References (Writing); 4. Speaking Style (Oral); 5. Subject Matter (Oral).	5	Seminar/ Conferences/ Research Papers IE/AAT / Discussion

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	✓-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 5	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 10	Discuss the heeds of functional grammar and punctuation tools in speaking and writing by generating the clarity of an audio text.	5
CO 2	PO 10	Illustrate essential aspects of grammar as well as punctuation marks for speaking or writing towards a discussion on a topic to give the clarity.	5
CO3	PO 10	Choose suitable grammatical structures and punctuation marks at speaking and writing areas maintaining clarity at professional platform.	5
CO4	PO 10	Interpret the grammatical knowledge and punctuation marks systematically towards providing the clarity in speaking and writing.	5
CO5	PO 10	Demonstrate the role of grammar and punctuation marks understanding the meaning between the sentences as well as paragraphs in speaking or writing for a clarity.	5
CO6	PO 10	Describe the clarity of grammatical usage and the obligation of punctuation marks in speaking and writing.	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 4	-	-	-	-		-	-	-	-	5	-		-	-	-
CO 5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	5	-		-	-	- -

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	100	-		-	-	-
CO 2	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
CO 3	-		-	-	-	-	-	-	-	100	-	-	-	-	-
CO 4	-	-	-	-		-	-	-	-	100	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	100	-	-	- -	-	-
CO 6	-	-	-	-		-	-	-	-	100	-		-	-	- -

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $< C \leq 40\%$ – Low/ Slight

2 - 40 % $< C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	
CO 2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-
AVERAGE	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	GENERAL INTRODUCTION AND LISTENING SKILL
	Introduction to communication skills; Communication process; Elements of communication; Soft skills vs. hard skills; Importance of soft skills for engineers; Listening skills; Significance; Stages of listening; Barriers and effectiveness of listening; Listening comprehension.
MODULE II	SPEAKING SKILL
	Significance; Essentials; Barriers and effectiveness of speaking; Verbal and non-verbal communication. Generating talks based on visual prompts; Public speaking; Exposure to structured talks; Addressing a small group or a large formal gathering; Oral presentation; Power point presentation.
MODULE III	VOCABULARY AND GRAMMAR
	The concept of Word Formation; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms; Antonyms; Standard abbreviations; Idioms and phrases; One-word substitutes Sentence structure; Uses of phrases and clauses; Punctuation; Subject verb agreement; Modifiers; Articles; Prepositions.
MODULE IV	READING SKILL
	Significance, Techniques of reading, Skimming-Reading for the gist of a text, Scanning - Reading for specific information, Intensive, Extensive reading, Reading comprehension, Reading for information transfer, Text to diagram, Diagram to text.
MODULE V	WRITING SKILL
	Significance; Effectiveness of writing; Organizing principles of Paragraphs in documents; Writing Introduction and conclusion; Techniques for writing precisely, Letter writing; Formal and Informal letter writing, E-mail writing, Report Writing.

TEXTBOOKS

1. Handbook of English (Prepared by the faculty of English, IARE).

REFERENCE BOOKS:

1. 1. Norman Whitby, Business Benchmark: Pre-Intermediate to Intermediate – BEC Preliminary, Cambridge University Press, 2nd Edition,2008.
2. Devaki Reddy, Shreesh Chaudhary, Technical English, Macmillan, 1st Edition,2009.
3. Rutherford, Andrea J, Basic Communication Skills for Technology, Pearson Education,2nd Edition, 2010.
4. Raymond Murphy, Essential English Grammar with Answers, Cambridge University Press, 2nd Edition,2010.
5. Dr. N V Sudershan, President Kalam's Call to the Nation, Bala Bharathi Publications, Secunderabad, 1st Edition,2003

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Discussion on mapping COs with POs. (OBE)		
CONTENT DELIVERY (THEORY)			
2	Introduction to communication skills.	CO 1	T1:06.06
3	Communication process.	CO 1	T1:06.09
4	Soft skills vs hard skills.	CO 3	T1:09.10
5	Significance of LSRW skills.	CO 1	T1:10.11
6	Significance of listening skill.	CO 1	TI:12.16
7	Different stages of listening.	CO 1	T1:16.18
8	Barriers of listening skill.	CO 1	TI:18.21
9	Different types of listeners.	CO 1	TI:21.22
10	Effectiveness of listening skill.	CO 1	T1:22.24
11	Phonetics: Listening to the sounds of English language.	CO 1	T1:24.29
12	Introduction to speaking skills.	CO 2	T1:30.32
13	Effectiveness of speaking skills.	CO 2	T1:33.34
14	Verbal and non-verbal communication.	CO 2	T1:34.35
15	Generating talks based on visual or written prompts.	CO 2	T1:36.37
16	Developing public speaking skills.	CO 2	T1:38.39
17	Oral presentation with power-point.	CO 3	TI:39.42
18	The concept of word formation.	CO 4	T1:43.100
19	Antonyms and synonyms.	CO 4	TI:49.56
20	Idioms and phrases.	CO 4	TI:57.60
21	One-word substitutes.	CO 4	TI:60.62
22	Root words from foreign languages and their usage in English.	CO 4	TI:60.62
23	Sentence structure.	CO 4	T1:58.62
24	Punctuation tools and their role in a language.	CO 4	TI:63.66
25	Subject-verb agreement.	CO 4	TI:66.69
26	Usage of Adjectives.	CO 4	TI:70.73
27	Significance of articles and their usage.	CO 4	TI:74.75
28	The usage of prepositions.	CO 4	T1:76.77
29	Significance of reading skill.	CO 5	T1:78.79
30	Different techniques of reading skill.	CO 6	T1:80.82
31	How to Read Your Textbook More Efficiently.	CO 6	TI:83.85
32	Different types of reading comprehension.	CO 6	TI:85.86
33	Reading for information transfer.	CO 6	TI:85.96
34	Significance and effectiveness of writing skill.	CO 6	TI:96.98

35	Organizing principles of a paragraph in documents and types of paragraphs.	CO 5	T1:101.103
36	Writing introduction and conclusion.	CO 5	T1:103.103
37	Techniques for writing precis.	CO 6	T1:103.103
38	Introduction to informal letters.	CO 5	TI:105.108
39	Introduction to formal letters.	CO 5	TI:109.110
40	Introduction of email writing and formal and informal emails.	CO 5	TI:111.112
41	Significance of Report Writing.	CO 6	TI: 113. 114
PROBLEM SOLVING/ CASE STUDIES			
42	The aspects to improve listening comprehension Discuss in detail.	CO 1	TI:10,11
43	Different types of listeners with examples.	CO 1	TI: 19,21
44	The sounds of English language	CO 1	TI:23,27
45	verbal communication or written communication.	CO 2	TI: 27,30
46	Various difficulties in public speaking.	CO 2	TI: 32,33
47	Different ways of greeting people in formal and informal situation and discuss how do they matter in communication?	CO 2	TI: 35,37
48	'Oral presentation requires a good planning'.	CO 2	TI:36,38
49	Power point presentation and the ways to make Power point presentation.	CO 2	TI: 37,38
50	Methods that are used to establish the process of building vocabulary with examples from the most used words in spoken English.	CO 4	TI:39,41
51	The usage of idioms and phrases in spoken English.	CO 4	TI: 47,50
52	'Structure proposition-evaluation' -Reading technique.	CO 5	TI:56,58
53	Active reading, detailed reading, and speed-reading techniques used in different situations.	CO 5	TI: 79,81
54	The elements of paragraph writing in detail.	CO 6	TI:100,102
55	Logical bridges and Verbal bridges in writing.	CO 6	TI:102,104
56	Soft skills and Interpersonal Communication.	CO 6	TI:102,104
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Soft skills and Interpersonal Communication.	CO 1	TI 8,9
58	Language acquisition is a process.	CO 1	TI: 11,12
59	Communication.	CO 1	TI: 14,16
60	Time management.	CO 3	TI:9,10
61	Stress management.	CO 3	TI:9,10
DISCUSSION OF QUESTION BANK			
62	Soft Skills for difficult situations in terms of reassurance and reliability.	CO 3	TI:9,10
63	Verbal and non-verbal communication.	CO 2	TI: 34,35

64	Honesty, Respect, Self-Control and Accountability their role in building long lasting interpersonal skills?	CO 3	TI: 9,10
65	Etiquette and manners. Its importance in social, personal and professional communication.	CO 3	TI: 9,10
66	Problem solving and decision making.	CO 3	TI: 9,10

Signature of Course Coordinator **HOD**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**APPLIED PHYSICS**				
Course Code	**AHSC09**				
Program	**B. Tech.**				
Semester	**II**				
Course Type	**FOUNDATION**				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	-	3	1.5
Course Coordinator	Dr.Santosh Singh, Associate Professor.				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of Semiconductors

II COURSE OVERVIEW:

This course is structured specifically to make the students understand some of the core topics in physics essential for further studies in engineering. It focuses on illustrating and developing an understanding of the interplay between problem solving and their practical applications which include experimental techniques and modern equipment. The topics include quantum mechanics, semiconductors, opto-electronic devices, magnetism, dielectrics, LASER and fiber optics. At the end, this course helps students to appreciate the diverse real-time applications in technological fields in respective branches.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Applied Physics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
0 %	Remember
60 %	Understand
40 %	Apply
0 %	Analyze

Table 1: The expected percentage of cognitive level of questions in SEE

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 10 marks for Alternative Assessment Tool (AAT) (Table 3).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Table 2: Assessment pattern for CIA

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT):
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3.

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

Table 3: Assessment pattern for CIA

VI COURSE OBJECTIVES:

The students will try to learn:

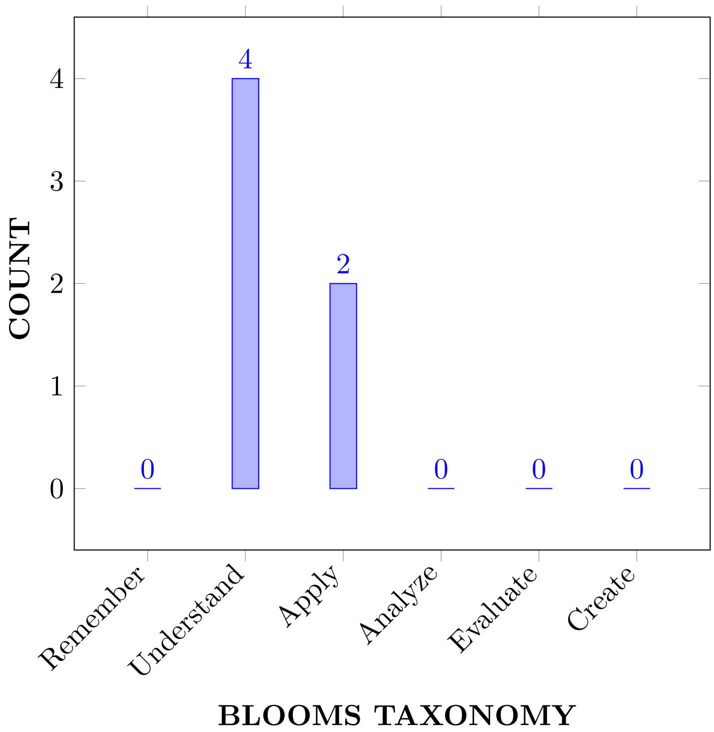
I	Basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description.
II	Fundamental properties of semiconductors including the band gap, charge carrier concentration, doping and transport mechanisms.
III	The metrics of optoelectronic components, LASER, optical fiber communication and be able to incorporate them into systems for optimal performance.
IV	The appropriate magnetic and dielectric materials required for various engineering applications.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** the concepts of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.	Apply
CO 2	**Demonstrate** the classification of Solids and important aspects of semiconductors in terms of carrier concentration and Fermi level.	Understand
CO 3	**Make use of** the key concepts of semiconductors to explain the basic working mechanism of optoelectronic device characteristics of light-emitting diodes, photodetectors and solar cells.	Apply
CO 4	**Illustrate** the properties of dielectric and magnetic materials suitable for engineering applications.	Understand
CO 5	**Compare** the concepts of LASER and normal light in terms of mechanism and working principles for applications in different fields and scientific practices.	Understand
CO 6	**Explain** functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Seminar

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	
PSO3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas..	3	

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH POs, PSOs:

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSOs**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO/PSO) MAPPING -DIRECT:

Course Outcomes	**POs PSOs**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 1	PO 1	**Outline** drawbacks of classical mechanics, basic principles **dual nature** of matter wave, **derive** mathematical wave equation of matter waves and come to **conclusion** of quantization of energy used in quantum dots.	3

Course Outcomes	**POs PSOs**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
	PO 2	**Explain** the given **problem statement** and formulate quantum confinement problems related to particle enclosed in small dimension from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of results**.	4
	PSO 1	**Make use of** Quantum technology in design of next-generation computer systems	1
CO 2	PO 1	**Illustrate** the charge transport mechanism in intrinsic and extrinsic semiconductors using energy level diagrams, calculate their charge carrier concentration and use those expressions to integrate with other engineering disciplines .	3
	PO 4	**Identify** the use of these semiconductors under study and their conduction mechanism for the **research based knowledge** and **technological development**.	2
CO 2	PO 2	**Explain** the given **problem statement** and formulate mobility and conductivity aspects of a material from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of Hall coefficient value**.	4
CO 3	PO 1	**Acquire** detailed **knowledge** of fundamental and applied aspects of optoelectronic device physics, **analyze** key parameters and **apply** them to the functioning of electronic devices.	3
	PO 2	**Illustrate** the given **problem statement** and **formulate** light interaction aspects of direct band gap materials from the provided **information** and **data** by the **interpretation of carrier generation and recombination** in opto-electronic devices	4
CO 4	PO 1	**Relate** principles of different types of polarization mechanism and expression for polarizability to the properties of functional materials and for solving engineering problems by applying these principles of science.	3
	PO 2	**Explain** the given **problem statement** and **formulate** polarization versus applied electric field related to ferroelectric materials from the provided **information** and **data** by the **interpretation of hysteresis loop**.	4
	PO 1	**Utilize** spin and orbital motion of electrons in determining **magnetic moment** of materials in terms of Bohr magneton materials having specific **engineering applications**.	3
	PO 4	**Identify** the use of magnetic materials and their magnetization values for the **research based knowledge** and **technological development.**	2
CO 5	PO 1	**Compare** the concepts of LASER and normal light in terms of mechanism and **working principle** for applications in different fields and scientific practices.	3

Course Outcomes	POs PSOs	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	PO 1	**Explain** functionality of components in optical fiber communication **system** by using the **basics** of signal propagation, attenuation and dispersion.	3
	PO 2	**Identify the given problem** and **formulate** expressions for acceptance angle and numerical aperture with the given **information** and **data** by applying principles of information propagation through optical waveguides.	4

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO/PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	4	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	4	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	4	-	-	-	-	-	-	-	-	-		-	-	-
CO 4	3	4	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	40	-	-	-	-	-	-	-	-	-	-	30	-	-
CO 2	100	40	-	20	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	100	40	-	20	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (CO-PO/PSO MAPPING):

CO’S and PO’S and CO’S and PSO’S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq$ C$\leq$ 5% – No correlation
1-5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	-	1		-	-	-	-	-	-		-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-		-	-	-
CO 4	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3		-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	10	-	2	-		-	-	-	-	-	-	1	-	-
AVERAGE	3	2	-	1	-		-	-	-	-	-	-	1	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 1, PO 2, PO 4	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

x	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**QUANTUM MECHANICS**
	Introduction to quantum physics, de broglie hypothesis, Wave-particle duality, Davisson and Germer's experiment, Time-independent Schrödinger equation for wave function, Physical significance of the wave function, Schrödinger equation for one dimensional problems - particle in a box.
MODULE II	**INTRODUCTION TO SOLIDS AND SEMICONDUCTORS**
	Introduction to classical free electron theory and quantum theory, Bloch's theorem for particles in a periodic potential (Qualitative treatment), Kronig-Penney model (Qualitative treatment), classification: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Hall effect.
MODULE III	**SEMICONDUCTOR DEVICES**
	Direct and indirect band gaps, p-n junction, V-I characteristics, Energy Band diagram, Biasing of a junction, Zener diode. Construction and working of LED, Photo detectors, PIN, Avalanche photodiode, Solar cell.
MODULE IV	**ENGINEERED ELECTRIC AND MAGNETIC MATERIALS**

	Polarisation, Permittivity, Dielectric constant, Internal field in solids, Clausius Mosotti equation, Electronic, Ionic and Orientational polarization (Qualitative) Ferroelectricity;Magnetisation, Permeability, Susceptibility, Classification of dia, para and ferro magnetic materials on the basis of magnetic moment, Hysteresis curve.
MODULE V	**LASERS AND FIBER OPTICS**
	Characteristics of LASER, Spontaneous and stimulated emission of radiation, Metastable state, Population inversion, Lasing action, Ruby LASER, He-Ne LASER and applications of LASER.Principle and construction of an optical fibre, Acceptance angle, Numerical aperture, Types of optical fibers (Single mode, multimode, step index, graded index), Optical fibre communication system with block diagram and Application of optical fibres.

TEXTBOOKS

1. Dr. K Vijay Kumar and Dr. S Chandralingam Modern Engineering Physics‖ Volume-1 & 2, S Chand. Co, 2018.
2. Dr. M. N. Avadhanulu, Dr. P. G. Kshirsagar A Text Book of Engineering Physics‖, S. Chand.
3. B. K Pandey and S. Chaturvedi Engineering physics‖, Cengage learning.

REFERENCE BOOKS:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology‖, McGraw-Hill Inc. (1995).
2. P. Bhattacharya, Semiconductor Optoelectronic Devices‖, Prentice Hall of India (1997).
3. Monica Katiyar and Deepak Gupta on NPTEL.Online course: ”Optoelectronic Materials and Devices”.

WEB REFERENCES

1. http://link.springer.com/book
2. http://www.thpys.physics.ox.ac.uk
3. http://sciencedirect.com/science
4. http://www.e-booksdirectory.com

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details & course_id=17

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		

CONTENT THEORY(DELIVERY)			
2	Introduction to Quantum Physics	CO 1	T2:5.15; R1:1.16
3	Wave-Particle duality of radiation	CO 1	T2:5.17; R1:1.13.1
4	De-broglie hypothesis and de-broglie wavcelength	CO 1	T2:5.18; R1:1.13.2
5	Properties of Matter waves	CO 1	T2:5.19 R1:1.13.3,
6	Davisson and Germer's experiment	CO 2	T2:5.20; R1:1.17.1
7	Schrödinger time independent wave equation	CO 1	T2:5.24; R1:1.17.3
8	Physical significance of wavefunction	CO 1	T2:6.1; R1:2.3
9	Particle in a one dimensional potential box	CO 1	T2:6.3; R1:2.6.1
10	Free electron theory and Quantum theory of solids, Electron in a Periodic potential – Bloch's theorem	CO 2	T2:6.5; R1:2.6.2
11	Kronig-Penney model, Band theory of solids	CO 2	T2:7.3; R1:2.8
12	Origin of energy bands in solids, Classification of solids into insulators, conductors and semiconductors	CO 2	T2:7.5,7.6; R1:2.9.2
13	Introduction to intrinsic and extrinsic semiconductors, Intrinsic carrier concentration	CO 2	T2:7.7; R1:2.10
14	Carrier concentration and Fermi level in p-type semiconductors	CO 2	T2:7.7; R1:2.10
15	Carrier concentration and Fermi level in n-type semiconductors	CO 2	T2:7.11; R2:2.10.2
16	Hall effect and its applications	CO 2	T2:7.11; R2:2.32
17	Direct and indirect band gaps	CO 3	T2:7.11; R2:2.10
18	p-n junction, V-I characteristics	CO 3	T2:7.12; R2:2.10.3
19	Energy Band diagram of PN Junction	CO 3	T2:7.12; R2:2.10.3
20	Biasing of PN junction	CO 3	T2:7.13; R1:2.10.4
21	Zener diode	CO 3	T2:7.14 R1:2.10.6
22	Construction and working of LED	CO 3	T2:7.15; R1:2.10.7
23	Construction and working of Photodiode, PIN and Avalanche Photodiode	CO 3	T1:7.15; R2:2.10.7

24	Construction and working of Solar cell	CO 3	T1:7.15; R2:2.10.7
25	Introduction to dielectric materials, Polarization, Permittivity, Dielectric constant	CO 4	T1:7.15; R2:2.10.7
26	Internal fields in solids	CO 4	T1:16.9 R2:8.11.1
27	Clausius – Mosotti equation	CO 4	T1:16.9; R2:8.11.2
28	Ionic, Electronic and Orientational polarization	CO 4	T1:15.2; R4:8.2
29	Ferroelectricity	CO 4	T2:15.7; R4:8.3.3
30	Magnetic materials, Magnetization, Permeability, Susceptibility	CO 4	T2:15.13 R4:8.7.2
31	Diamagnetic and Paramagnetic materials	CO 4	T2:15.13; R4:8.7.2
32	Ferromagnetic materials	CO 4	T2:15.16; R1:8.7.3
33	Hysteresis curve	CO 4	T1:11.9; R2:12.24
34	Characteristics of LASER, Spontaneous and Stimulated emission	CO 5	T1:11.9; R3:12.25
35	Metastable state, Population inversion, Lasing action	CO 5	T1:3.2; R3:3.2
36	Ruby LASER	CO 5	T1:3.3.1; R3:3.2
37	He-Ne LASER, Applications of LASER	CO 5	T2:16.5; R3:8.10
38	Principle and construction of optical fibers	CO 6	T2:16.5; R3:8.10
39	Acceptance angle, Acceptance cone, Numerical Aperture	CO 6	T1:3.3.1; R3:3.2
40	Types of optical fibers	CO 6	T2:16.5; R3:8.10
41	Optical fiber communication system, Applications of optical fibers	CO 6	T2:16.5; R3:8.10
PROBLEM SOLVING			
1	De-broglie wavelength	CO 1	T1:3.3.1; R3:3.2
2	Energies associated with one dimensional potential box	CO 1	T2:16.5; R3:8.10
3	Intrinsic carrier concentration, Fermi level in semiconductors	CO 2	T2:16.5; R3:8.10
4	Carrier concentration based on Hall coefficient	CO 2	T1:3.3.1; R3:3.2

5	Mobility and conductivity based on Hall coefficient	CO 2	T2:16.5; R3:8.10
6	Diffusion and drift	CO 3	T2:16.5; R3:8.10
7	Energy gap in indirect bandgap semiconductors	CO 3	T1:3.3.1; R3:3.2
8	Dielectric constant, capacitance, permittivity	CO 4	T2:16.5; R3:8.10
9	Electric susceptibility, Polarization vector	CO 4	T2:16.5; R3:8.10
10	Polarizability	CO 7	T1:3.3.1; R3:3.2
11	Magnetic moment, Magnetic induction, Permeability	CO 4	T2:16.5; R3:8.10
12	Intensity of magnetization, Magnetic susceptibility	CO 4	T2:16.5; R3:8.10
13	Wavelength and Energy bandgap, Divergence	CO 5	T2:16.5; R3:8.10
14	Relative population of two states, Number of photons emitted	CO 5	T1:3.3.1; R3:3.2
15	Acceptance angle and Numerical Aperture	CO 6	T2:16.5; R3:8.10
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Quantum Mechanics	CO 1	T2:16.5; R3:8.10
2	Introduction to Solids and Semiconductors	CO 2	T1:3.3.1; R3:3.2
3	Semiconductor devices	CO 3	T2:16.5; R3:8.10
4	Engineered electric and magnetic materials	CO 4	T2:16.5; R3:8.10
5	LASER, Fiber optics	CO 5, CO 6	T2:16.5; R3:8.10
DISCUSSION OF QUESTION BANK			
1	Quantum Mechanics	CO 1	T1:3.3.1; R3:3.2
2	Introduction to Solids and Semiconductors	CO 2	T2:16.5; R3:8.10
3	Semiconductor devices	CO 3	T2:16.5; R3:8.10
4	Engineered electric and magnetic materials	CO 4	T1:3.3.1; R3:3.2
5	LASER, Fiber optics	CO 5, CO 6	T2:16.5; R3:8.10

Signature of Course Coordinator **HOD, CSE(AI& ML)**
Dr. Santosh Singh, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUER SCIENCE AND ENGINEERING(AI & ML)**				
Course Title	**PROBABILITY AND STATISTICS**				
Course Code	AHSC08				
Program	B.Tech				
Semester	II	CSE			
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms. P Naga Lakshmi Devi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Fundamentals of Statistics

II COURSE OVERVIEW:

Probability theory is the branch of mathematics that deals with modelling uncertainty. Inferential Statistics and regression analysis together with random variate distributions are playing an exceptional role in designing data driven technology which is familiarly known as data centric engineering. They also have wide variety applications in telecommunications and other engineering disciplines. The course covers advanced topics of probability and statistics with applications. The course includes: random variables, probability distributions, hypothesis testing, confidence intervals, and linear regression. There is an emphasis placed on real-world applications to engineering problems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Probability and Statistics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
30 %	Understand
60%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

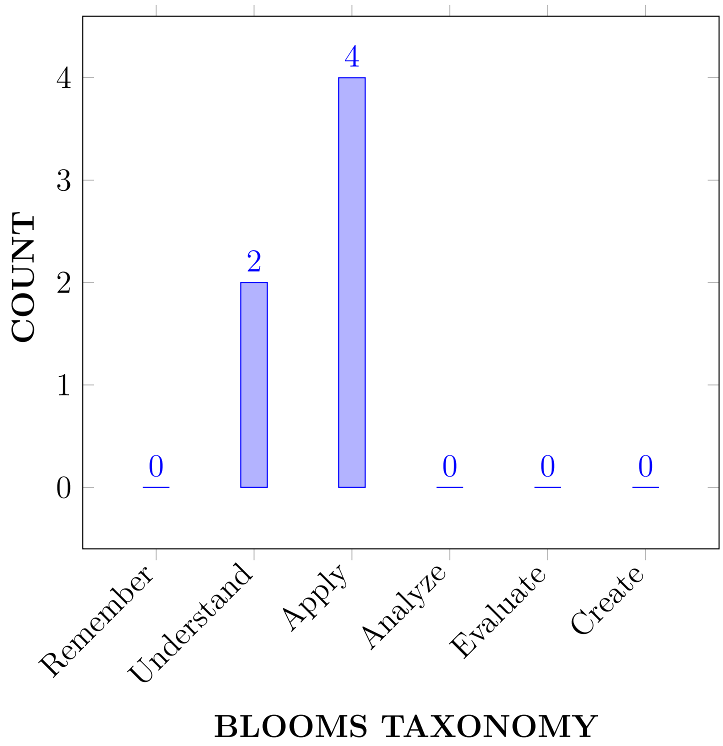
I	The theory of random variables, basic random variate distributions and their applications.
II	The Methods and techniques for quantifying the degree of closeness among two or more variables and the concept of linear regression analysis.
III	The Estimation statistics and Hypothesis testing which play a vital role in the assessment of the quality of the materials, products and ensuring the standards of the engineering process.
IV	The statistical tools which are essential for translating an engineering problem into probability model.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Explain** the role of random variables and types of random variables, expected values of the discrete and continuous random variables under randomized probabilistic conditions.	Under-stand
CO 2	**Interpret** the parameters of random variate Probability distributions such as Binomial, Poisson and Normal distribution by using their probability functions, expectation and variance.	Under-stand
CO 3	**Apply** Bivariate Regression as well as Correlation Analysis for statistical forecasting.	Apply
CO 4	**Make Use of** estimation statistics in computing confidence intervals, Regression analysis and hypothesis testing.	Apply
CO 5	**Identify** the role of statistical hypotheses, types of errors, confidence intervals, the tests of hypotheses for large samplein making decisions over statistical claims in hypothesis testing	Apply
CO 6	**Identify** the tests of hypothesis for small sample in making decisions over statistical claims in hypothesis testing	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	CIE/Quiz/AAT
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Seminar/ Conferences/ Research Papers
PO 5	**Modern Tool Usage:** Use research-based knowledge and research methods including design of eConduct investigations of complex problems:xperiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Assignments/ Discussion

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	CIE/Quiz/ AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	✓	✓	-	-	-	-	-	-		-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	Explain (understanding) the concept of random variables and their role in solving complex engineering problems involving random events and uncertainty by using Mathematical functions (principles of mathematics).	2
	PO 4	The expected values, variances for the given discrete random variables will be quantitatively measured by using statistical computer software (R-software).	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	**PO 1**	Interpret the Probability distributions such as Binomial, Poisson and Normal distribution (Understanding) with the support of evaluation of integrals (principles of mathematics) and appreciate their importance and applicability (Apply) in solving complex engineering problems involving uncertainty.	2
	PO 2	Understand the statement and formulation of a complex engineering problem which involves the events of uncertainty, Model it with suitable probability distribution and Apply the concepts of discrete or continuous distributions along with basic principles of mathematics to develop the solution and reaching substantiated conclusions by the interpretation of results	5
CO 3	**PO 1**	Interpret (Understand) the results of Bivariate and Correlation Analysis by using ratios, square roots, straight lines and planes (principles of mathematics) for statistical forecasting (Apply)in complex engineering problems involving bivariate or multivariate data.	2
CO 4	**PO 1**	Select appropriate statistical methods (understand) for solving some real-time complex engineering problems governed by correlation with the knowledge of fundamental principles of mathematics.	2
	PO 4	Interpret the results of Bivariate and Multivariate Regression and quantifying the degree of closeness between two or more variables by using statistical computer software (R-software, SPSS-software).	1
CO 5	**PO 1**	Apply tests of hypotheses which involves the role of mathematical tools like statements, sets, ratios and percentages (principles of mathematics) for both large samples and small samples (knowledge) in making decisions over statistical claims that arise in complex engineering problems which requires sampling inspections.	2
	PO 2	Understand the statement and formulation of a complex engineering problem which needs verification of truth values of numerical or statistical hypothesis, collect the necessary information and data through sampling techniques, apply tests of hypotheses (both large and small samples) along with basic principles of mathematics to develop the solution and reaching substantiated conclusions by the interpretation of results	5
	PO 4	Make Use of R software package in computing confidence intervals, statistical averages and hypothesis testing. (Computer software relevance)	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	**PO 1**	Identify the role of types of statistical hypotheses, types of errors, sampling distributions of means and confidence intervals with the aid of statements and sets, percentages (principles of mathematics) in hypothesis testing of complex engineering problems which requires sampling inspections.	2
	PO 4	Test for the assessment of goodness of fit of the given probability distribution model by using statistical quantitative methods and statistical computer software (R-software).	1
	PO 5	Make Use of R software package a in modeling complex Engineering activities which involves computation of confidence intervals, statistical averages and regression analysis, hypothesis testing.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	1	-	-	-	-	-	-	-		-	-	-
CO 5	2	5	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	1	1	-	-	-	-	-	-		-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	-	-	9.0	-	-	-	-	-	-	-		-	-	-
CO 2	66.7	50.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.7	-	-	9.0	-	-	-	-	-	-	-	-	-	-	-
CO 5	66.7	50.0	-	9.0	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.7	-	-	9.0	100	-	-	-	-	-	-		-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	1	3	-	-	-	-	-	-		-	-	-
TOTAL	18	4	-	4	3	-	-	-	-	-	-	-	-	-	-
AVER-AGE	3	2	-	1	3	-	-	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	Tech Talk	✓	Concept video	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**PROBABILITY AND RANDOM VARIABLES**
	Random variables: Basic definitions, discrete and continuous random variables; Probability distribution: Probability mass function and probability density functions; Mathematical expectation.
MODULE II	**PROBABILITY DISTRIBUTION**
	Binomial distribution; Mean and variances of Binomial distribution, Recurrence formula for the Binomial distribution; Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Recurrence formula for the Poisson distribution; Normal distribution; Mean, Variance, Mode, Median, Characteristics of normal distribution.
MODULE III	**CORRELATION AND REGRESSION**
	Correlation: Karl Pearson's Coefficient of correlation, Computation of correlation coefficient, Rank correlation, Repeated Ranks; Properties of correlation. Regression: Lines of regression, Regression coefficient, Properties of Regression coefficient, Angle between two lines of regression.

MODULE IV	**TEST OF HYPOTHESIS – I**
	Sampling: Definitions of population, Sampling, Parameter of statistics, standard error; Test of significance: Null hypothesis, alternate hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two-sided test. Large sample test: Test of significance for single mean, Test of significance for difference between two sample means, Tests of significance single proportion and Test of difference between proportions.
MODULE V	**TEST OF HYPOTHESIS – II**
	Small sample tests: Student t-distribution, its properties: Test of significance difference between sample mean and population mean; difference between means of two small samples. Snedecor's F-distribution and its properties; Test of equality of two population variances Chi-square distribution and it's properties; Chi-square test of goodness of fit.

TEXTBOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons Publishers, 9th Edition, 2014.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.

WEB REFERENCES:

1. http://e4uhu.com/down/Applied/9th
2. https://toaz.info/32fa2f50-8490-42cf-9e6a-f50cb7ea9a5b
3. http://www.mathworld.wolfram.com

COURSE WEB PAGE:

https://www.youtube.com/playlist?list=PLzkMouYverAJ1gjLBz4sA5O0ymIi01or6

REFERENCE BOOKS:

1. N. P. Bali, "Engineering Mathematics", Laxmi Publications, 9th Edition, 2016.
2. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics", S. Chand and Co., 10th Edition, 2000.
3. Richard Arnold Johnson, Irwin Miller and John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	Course outcomes	Reference
OBE DISCUSSION			
1	Identify the types of sampling (random, stratified, systematic, cluster). Identify the misuses of statistics. Student will use appropriate statistical methods to collect, organize, display, and analyze relevant data. Probability & Statistics introduces students to the basic concepts and logic of statistical reasoning and gives the students introductory-level practical ability to choose, generate, and properly interpret appropriate descriptive and inferential methods. Identify the types of data (qualitative, quantitative, discrete, and continuous).		
CONTENT DELIVERY (THEORY)			
2	Probability Basic definitions	CO 1	T2:26.3
3	Probability	CO 1	R2:21.48
4	Axioms of Probability	CO 1	T2:26.6 R2:21.50
5	Conditional Probability	CO 1	T2:26.7 R2:21.51
6	Random Variables	CO 1	T2:26.8
7	Discrete and Continuous random variables	CO 1	T2:26.10
8	Probability distribution	CO 1	T2:26.14 R2:21.55
9	Probability mass function	CO 1	T2:26.15 R2:21.58
10	Probability Density Function	CO 1	T2:26.16 R2:21.61
11	Mathematical Expectation	CO 2	T2:25.12 R2:21.24
12	Binomial Distribution	CO 2	T2:25.16 R2:21.29
13	Mean, Variance and Mode of Binomial Distribution	CO 2	T2:25.14 R2:21.31
14	Expected Frequency of Binomial Distribution	CO 2	T2:25.14 R2:21.33
15	Poisson Distribution	CO 2	R2:21.33
16	Mean, Variance and Mode of Poisson distribution	CO 2	T2:27.2 R2:21.64
17	Expected Frequency of Poisson Distribution	CO 2	T2:27.2
18	Normal distribution – I	CO 2	T2:27.2 R2:21.67

19	Mean and Variance of Normal Distribution	CO 2	T2:27.2
20	Mode and Median of Normal distribution	CO 2	T2:27.3 R2:21.71
21	Normal distribution – II	CO 2	T2:27.4 R2:21.68
22	Correlation	CO 3	T2:27.7 R2:21.74
23	Rank Correlation	CO 3	T2:27.12 R2:21.75
24	Rank Correlation for Repeated Ranks	CO 3	T2:27.8 R2:21.72
25	Regression Lines-I	CO 4	T2:27.8 R2:21.73
26	Regression Lines-II	CO 4	T2:27.14 R2:21.78
27	Regression Lines-III	CO 4	T2:27.19 R2:21.814
28	Sampling distribution – I	CO 5	T2:27.12 R2:21.82
29	Sampling distribution – II	CO 5	T2:27.18 R2:21.82
30	Testing of hypothesis for Large Samples	CO 5	T2:26.15 R2:21.58
31	Test of hypothesis for single mean	CO 5	T2:26.16 R2:21.61
32	Test of hypothesis for difference of means	CO 5	T2:25.14 R2:21.33
33	Test of hypothesis for single proportion	CO 5	R2:21.33
34	Test of hypothesis for difference of proportions	CO 5	T2:27.2 R2:21.64
35	Testing of hypothesis for small samples	CO 6	T2:27.2
36	Student's t-distribution for single mean	CO 6	T2:26.16 R2:21.61
37	Student's t-distribution for difference of means	CO 6	T2:25.12 R2:21.24
38	F-distribution	CO 6	T2:25.16 R2:21.29
39	Chi-Square distribution – I	CO 6	T2:27.14 R2:21.78
40	Chi-Square distribution – II	CO 6	T2:27.19 R2:21.814
41	Chi-Square distribution – III	CO 6	T2:27.12 R2:21.82
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on Probability	CO 1	T2:26.3
43	Problems on Discrete and Continuous random variables	CO 1	R2:21.48

44	Problems on Probability mass function	CO 1	T2:26.6 R2:21.50
45	Problems on Probability density function	CO 1	T2:26.7 R2:21.51
46	Problems on Binomial Distribution	CO 2	T2:26.8
47	Problems on Poisson Distribution	CO 2	T2:26.10
48	Problems on Normal Distribution	CO 2	T2:26.14 R2:21.55
49	Problems on Correlation	CO 3	T2:26.15 R2:21.58
50	Problems on Regression	CO 4	T2:26.16 R2:21.61
51	Problems on Sampling distribution	CO 5	T2:25.12 R2:21.24
52	Problems on Test of hypothesis for single mean and difference of means	CO 5	T2:25.16 R2:21.29
53	Problems on Test of hypothesis for single proportion and difference of proportions	CO 6	T2:25.14 R2:21.31
54	Problems on t-distribution	CO 6	T2:25.14 R2:21.33
55	Problems on F-distribution	CO 6	R2:21.33
56	Problems on Chi-Square distribution	CO 6	T2:27.2 R2:21.64
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions terminology discussion on probability and random variables	CO 1	T2:26.6 R2:21.50
58	Probability and Random variables	CO 2	T2:26.7 R2:21.51
59	Definitions& terminology discussion on correlation and regression.	CO 3, CO 4	T2:25.14 R2:21.33
60	Definitions & terminology discussion on Tests of Hypothesis.	CO 5	R2:21.33
61	Definitions & terminology discussion on Tests of significance.	CO 6	R2:21.33

DISCUSSION OF QUESTION BANK			
62	Question bank discussion on Probability, Random variables and Probability Distributions	CO 1	T2:26.6 R2:21.50
63	Question bank discussion on probability distributions.	CO 2	T2:26.7 R2:21.51
64	Question bank discussion on correlation and regression.	CO 3,CO 4	T2:25.14 R2:21.33
65	Question bank discussion on Tests of Hypothesis.	CO 5	R2:21.33
66	Question bank discussion on Tests of significance.	CO 6	R2:21.33

Course Coordinator: **HOD, CSE(AI & ML)**
Ms. P Naga Lakshmi Devi

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING(AI & ML)
Course Title	PROGRAMMING FOR PROBLEM SOLVING USING C
Course Code	ACSC04
Program	B.Tech
Semester	II
Course Type	FOUNDATION
Regulation	UG-20

Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. B Padmaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	Basic Programming Concepts

II COURSE OVERVIEW:

The course emphasis on the problem-solving aspects in using C programming. It is the fundamental course and is interdisciplinary in nature for all engineering applications. The students will understand programming language, programming, concepts of loops, reading a set of data, step wise refinements, functions, control structures, arrays, dynamic memory allocations, enumerated data types, structures, unions, and file handling. This course provides adequate knowledge to solve problems in their respective domains.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
PPSC	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

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Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

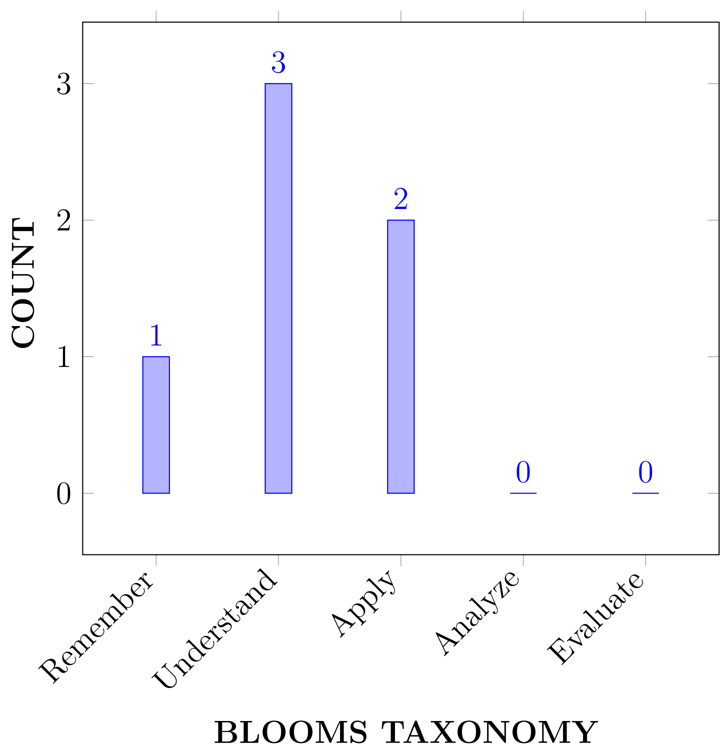
I	Problem-solving through programming.
II	Programming language, programming, reading a set of Data, stepwise refinement, concepts of Loops, Functions, Control structure, Arrays, Structure, Pointer and File concept.
III	To build efficient programs in C language essential for future programming and software engineering courses.
IV	Acquire programming skills in C Programming.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Define** the algorithms and draw flowcharts for solving Mathematical and Engineering problems.	Remember
CO 2	**Construct** programs for decision structures and loops.	Apply
CO 3	**Interpret** various types of functions, arrays, and strings for complex problem solving.	Under-stand
CO 4	**Illustrate** he dynamic memory allocation, structures, unions and enumerations to solve problems.	Under-stand
CO 5	**Interpret** file input and output functions to do integrated programming.	Under-stand
CO 6	**Utilize** the algorithms in C language to real-life computational problems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems	2	CIE/Quiz/ AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	-	✓	-	-	-	-	-	-		-	-	-
CO 5	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Developing algorithms and draw flowcharts for solving **mathematical** and **engineering problems** related to **areas of computer science.**	3
	PO 2	Understand the various symbols to **draw** a flowchart, **identify** the appropriate symbols to solve a problem, then **formulate** the solution, and **interpret** the result for the **improvement** of the **solution.**	6
	PSO 1	Understand the features of procedural programming for **designing** and **analyzing** computer programs for **problem-solving.**	3
CO 2	PO 1	Understand branching statements, loop statements, and apply the fundamentals of **mathematics**, **science** and **engineering**.	3
	PO 2	Understand the **problem statement**, **control** the flow of data, **design** the solution and **analyze** the same to **validate** the results in a program to solve **complex** engineering problems.	6
	PO 3	**Recognize** an appropriate control structure to **design** and **develop** a solution for a **real-time** scenario, and **communicating** effectively with engineering community.	5
CO 3	PO 1	Recognize the importance of recursionfor developing programs in real-time scenarios using principles of **mathematics**, and **engineering fundamentals**.	3
	PO 2	Understand the various kinds of **functions**, **identify** the suitable type of function to **solve** a problem, **formulate** the solution, and **interpret** the result for the **improvement** of the solution.	6
	PO 5	Apply techniques of **structured decomposition** to dividea problem into smaller pieces with an understanding of its limitations.	1

CO 4	PO 1	Extend the focus on the usage of heterogeneous data types as a **basic building block** in problem solving using principles of **science**, and **engineering** fundamentals.	3
	PO 2	**Recognize** the representation of the structure, **assess** in solving a problem, **express the solution**, and **analyze** the result for **solution enhancement**.	5
	PO 5	Understand pointers conceptually and apply them in modeling a **complex engineering** activity.	1
CO 5	PO 1	Make a use of an appropriate type of file to store a large volume of **persistent data** and give solution to **engineering problems**.	2
	PO 5	To identify appropriate mode to access a file and run the same **program** multiple times.	1
CO 6	PO 12	**Realize** the need and the desire to **train** and **invest** in autonomous and **lifelong learning** in the widest sense of **technical transition** to achieve **employability expertise** and excel advanced **engineering concepts**.	7
	PSO 3	Attain the **knowledge** and **skills** for employability and to succeed in national and international level **competitive examinations**.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	3	6	5	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	-	-	1	-	-	-	-	-	-	-	-		-
CO 4	3	5	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	7	-	-	3

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	60	-	-	-	-	-	-	-	-	-	-	50	-	-
CO 2	100	60	50	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	60	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 4	100	50	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 5	66	-	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	58	-	-	50

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	3	-	-	-	-	-	-	-	-		-
CO 4	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
TOTAL	15	11	2	-	9	-	-	-	-	-	-	2	2	-	2
AVERAGE	3	2.7	2.5	-	3	-	-	-	-	-	-	2	2	-	2

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Introduction to components of a computer: Memory, processor, I/O Devices, storage, operating system; Concept of assembler, compiler, interpreter, loader and linker. **Idea of Algorithms:** Algorithms, Flowcharts, Pseudo code with examples, From algorithms to Programs. **Introduction to C Programming Language:** History of C, Basic structure of a C program, Process of compiling and running a C program; C Tokens: Keywords, Identifiers, Constants, Strings, Special symbols, Variables, Data types; Operators, Precedence of Operators, Expression evaluation, Formatted Input/Output functions, Type Conversion and type casting.
MODULE II	**CONTROL STRUCTRES**

	Decision Making Statements: Simple if, if-else, else if ladder, Nested if, switch case statement; **Loop control statements:** for, while and do while loops, nested loops; **Unconditional Control Structures:** break, continue and goto statements.
MODULE III	**ARRAYS AND FUNCTIONS**
	Arrays: Introduction, Single dimensional array and multi-dimensional array: declaration, initialization, accessing elements of an array; Operations on arrays: traversal, reverse, insertion, deletion, merge, search; **Strings:** Arrays of characters, Reading and writing strings, String handling functions, Operations on strings; array of strings. **Functions:** Concept of user defined functions, Function declaration, return statement, Function prototype, Types of functions, Inter function communication, Function calls, Parameter passing mechanisms; Recursion; Passing arrays to functions, passing strings to functions; Storage classes.
MODULE IV	**POINTERS AND STRUCTURES**
	Pointer: Basics of pointers, Pointer arithmetic, pointer to pointers, array of pointers, Generic pointers, Null pointers, Pointers as functions arguments, Functions returning pointers; Dynamic memory allocation. **Structures:** Structure definition, initialization, structure members, nested structures, arrays of structures, structures and functions, structures and pointers, self-referential structures; Unions: Union definition, initialization, accessing union members; bit fields, typedef, enumerations, Preprocessor directives.
MODULE V	**FILE HANDLING AND APPLICATIONS IN C**
	File Handling: Concept of a file, text files and binary files, streams, standard I/O, formatted I/O, file I/O operations, error handling, Line I/O, miscellaneous functions; Applications in C.

TEXTBOOKS

1. Byron Gottfried, "Programming with C", Schaum's Outlines Series, McGraw Hill Education, 3rd Edition, 2017
2. Reema Thareja, "Programming in C", Oxford university press, 2nd Edition, 2016.

REFERENCE BOOKS:

1. W. Kernighan Brian, Dennis M. Ritchie, "The C Programming Language", PHI Learning, 2nd Edition, 1988.
2. Yashavant Kanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003.
3. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.
4. R. S. Bichkar, "Programming with C", Universities Press, 2 nd Edition, 2012.
5. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.
6. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.

WEB REFERENCES:

1. https://www.nptel.ac.in/courses/108106073/
2. https://www.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Outcome Based Education, CO, PO and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Understand components of a computer	CO 1	T2: 1.1-1.2, R4: 1.1-1.3
3	Identify and apply algorithms and flowcharts for problem solving	CO 1	T2: 2.1-2.2, R4: 1.4
4	Understand pseudo code for a given problem	CO 1	T2: 2.1-2.2
5	Understand the basic structure, process of compiling and running a C program	CO 1	T2: 2.1-2.2,
6	Understand keywords, identifiers, constants, strings, special symbols, variables	CO 1	T2: 1.4 -1.5, R4: 2.1 - 2.4
7	Define the data types, and operators to write C Program	CO 1	T2: 2.1-2.2
8	Understand precedence of operators, expression evaluation	CO 1	T2: 2.3-2.6
9	Understand formatted input/output functions, Type Conversion and type casting in C Programming	CO 1	T2: 2.3-2.7
10	Identify and apply decision making statements in C programming	CO 2	T2: 3.1-3.5
11	Identify and apply loop control structures in C programming	CO 2	T2: 5.2-5.3
12	Identify and apply unconditional control structures in C programming	CO 2	T2: 6.1-6.6
13	Understand single dimensional array and multi-deimensional array: declaration, initialization, accessing	CO 3	T2: 6.7
14	Operations on arrays: traversal, reverse, insertion	CO 3	T2: 8.1-8.2, R4: 15.1
15	Operations on arrays: deletion, merge, search	CO 3	T2: 8.3, R4: 15.1
16	Arrays of characters, Reading and writing strings, String handling functions	CO 3	T2: 11.1-11.5
17	Operations on strings: array of strings	CO 3	T2: 4.1-4.5
18	Concept of user defined functions, Function declaration	CO 3	T1: 7
19	return statement, Function prototype	CO 3	T2: 6.9

20	Types of functions, Inter function communication	CO 3	T1: 10, T2:10.1-10.2
21	Function calls, Parameter passing mechanisms, Recursion	CO 3	T2: 10.3-10.4, R4:8.3-8.4
22	Passing arrays to functions, passing strings to functions	CO 3	T2:10.5
23	Storage classes	CO 3	T1: 8.9, R4:8.6.3
24	Basics of pointers, Pointer arithmetic	CO 4	T2: 3.1, R4:11.1
25	Pointer to pointers	CO 4	T2: 3.2
26	Array of pointers	CO 4	T2: 3.2
27	Generic pointer, Null pointers	CO 4	T2: 3.3
28	Pointers as function arguments, Functions returning pointers	CO 4	T2: 3.4-3.5
29	Dynamic memory allocation	CO 4	T2: 6.1-6.6
30	Structure definition, initialization, structure members	CO 4	T2: 12.3-12.4, R4:13.4
31	Nested structures	CO 4	T2: 12.3-12.4, R4:13.4
32	Arrays of structures, structures and functions	CO 4	T2: 2.1-2.2, R4:13.2
33	Structures and pointers, self-referential structures	CO 4	T2: 2.1-2.2
34	Union, bit fields, typedef	CO 4	T2: 12.4
35	Enumerations, Preprocessor directives	CO 4	T1: 8.9, T2: 2.3-2.5
36	Concept of a file, text files and binary files, streams	CO 5	T2: 10.4, R4:14.1-14.4
37	Standard I/O, formatted I/O, file I/O operations	CO 5	T2: 10.4, R4:14.1-14.4
38	Error handling	CO 5	R3: 12.1 - 12.3
39	Line I/O, miscellaneous functions	CO 5	R3: 12.1 - 12.3
40	Applications of C	CO 6	R4: 17
PROBLEM SOLVING/ CASE STUDIES			
1	Write a program in C that takes minutes as input, and display the total number of hours and minutes.	CO 1	T2:2.3-2.6

2	Write a program in C that reads a forename, surname and year of birth and display the names and the year one after another sequentially.	CO 1	T2:2.3-2.7
3	Write a C program to find the third angle of a triangle if two angles are given.	CO 2	T2:3.1-3.5
4	Write a program in C to display the such a pattern for n number of rows using a number which will start with the number 1 and the first and a last number of each row will be 1.	CO 2	T2:5.2-5.3
5	Write a program in C to find the prime numbers within a range of numbers.	CO 2	T2:5.2-5.3
6	Write a program in C to display the n terms of harmonic series and their sum.	CO 2	T2:6.1-6.6
7	Write a program in C to display the pattern like right angle triangle using an asterisk.	CO 2	T2:5.2-5.3
8	Program to accept N integer number and store them in an array AR. The odd elements in the AR are copied into OAR and other elements are copied into EAR. Display the contents of OAR and EAR	CO 3	T2: 6.7
9	Write a C program to illustrate how user authentication is made before allowing the user to access the secured resources. It asks for the user name and then the password. The password that you enter will not be displayed, instead that character is replaced by '*'	CO 3	T2: 8.3, R4:15.1
10	Write a C program to accept a matric and determine whether it is a sparse matrix. A sparse martix is matrix which has more zero elements than nonzero elements	CO 3	T2: 8.1-8.2, R4: 15.1
11	Write a C program to accept a amtric of order MxN and sort all rows of the matrix in ascending order and all columns in descendng order	CO 3	T2: 6.7
12	Write a C program to accept a set of names and sort them in an alphabetical order, Use structures to store the names	CO 4	T2:12.3-12.4, R4:13.4
13	Write a C program to find the sum of two one-dimensional arrays using Dynamic Memory Allocation	CO 4	T2:6.1-6.6
14	Write a program in C to find the content of the file and number of lines in a Text File.	CO 5	T2:10.4, R4:14.1-14.4
15	Write a program in C to replace a specific line with another text in a file.	CO 5	T2:10.4, R4:14.1-14.4
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Module I- Components of computers, C programming language	CO 1	T2:1.1-2.6, R4:1.1-2.4
2	Module II- Control structures	CO 2	T2:3.1-6.6

3	Module III- Arrays, Strings and Functions	CO 3	T1:7, T2:6.7-11.5
4	Module IV- Pointers and Structures	CO 4	T2:3.1-6.6, R4:11.1-13.4
5	Module V- File handling functions	CO 5	T2:10.4, R4:14.1-14.4, R3:12.1-12.3
DISCUSSION OF QUESTION BANK			
1	Module I- Components of computers, C programming language	CO 1	T2:1.1-2.6, R4:1.1-2.4
2	Module II- Control structures	CO 2	T2:3.1-6.6
3	Module III- Arrays, Strings and Functions	CO 3	T1:7, T2:6.7-11.5
4	Module IV- Pointers and Structures	CO 4	T2:3.1-6.6, R4:11.1-13.4
5	Module V- File handling functions	CO 5	T2:10.4, R4:14.1-14.4, R3:12.1-12.3

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr. B Padmaja, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)
COURSE DESCRIPTION

Course Title	PROGRAMMING FOR PROBLEM SOLVING LABORATORY				
Course Code	ACSC03				
Program	B.Tech				
Semester	II	AI & ML			
Course Type	Foundation				
Regulation	IARE - R20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. Ravinder, Assistant Professor				

I COURSE OVERVIEW:

The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the preprocessor. This course helps the students in gaining the knowledge to write simple C language applications, mathematical and engineering problems. This course helps to undertake future courses that assume this programming language as a background in computer programming. Topics include variables, data types, functions, control structures, pointers, strings, arrays and dynamic allocation principles. This course in reached to student by power point presentations, lecture notes, and lab involve the problem solving in mathematical and engineering areas..

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB02	II	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Programming Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	The hands on experience in design, develop, implementation and evaluation by using Asymptotic notation.
II	The demonstration knowledge of basic abstract data types (ADT) and associated algorithms for organizing programs into modules using criteria that are based on the data structures of the program.

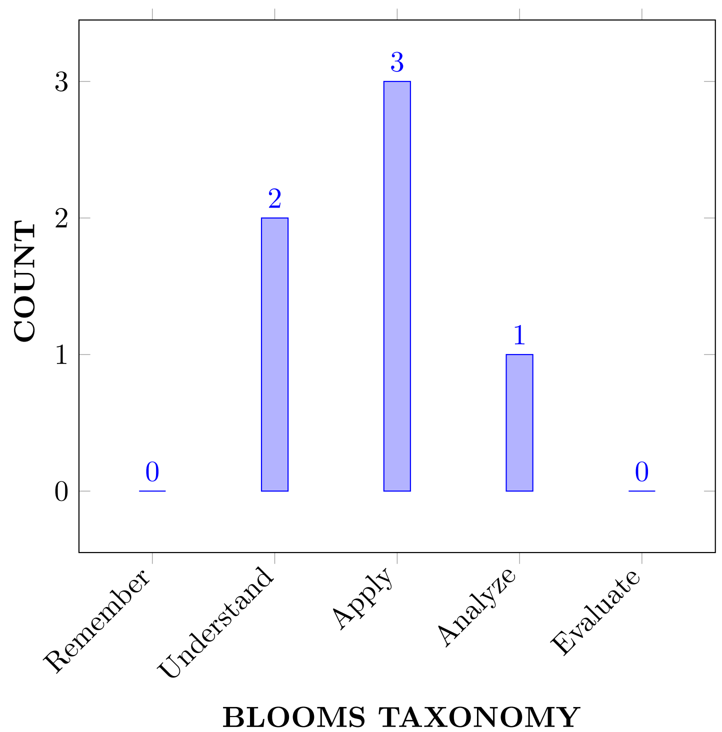
III	The practical implementation and usage of non linear data structures for solving problems of different domain.
IV	The knowledge of more sophisticated data structures to solve problems involving balanced binary search trees, AVL Trees, B-trees and B+ trees, hashing.
V	The graph traversals algorithms to solve real-world challenges such as finding shortest paths on huge maps and assembling genomes from millions of pieces

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** problem solving steps in terms of algorithms, pseudocode and flowcharts for Mathematical and Engineering problems. .	Understand
CO 2	**Make use** the concept of operators, precedence of operators, conditional statements and looping statements to solve real time applications.	Apply
CO 3	**Demonstrate** the concept of pointers, arrays and perform pointer arithmetic, and use the pre-processor.m.	Understand
CO 4	**Analyze** the complexity of problems, modularize the problems into small modules and then convert them into programs.	Apply
CO 5	**Implement** the programs with concept of file handling functions and pointer with real time applications of C.	Apply
CO 6	**Explore** the concepts of searching and sorting methods with real time applications using c	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:**Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Viva-voce/Laboratory Practices
PO 2	**Problem analysis:**Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Viva-voce/Laboratory Practices
PO 3	**Design/development of solutions:**Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Viva-voce/Laboratory Practices
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2	Viva-voce/Laboratory Practices
PO 10	**Communication:**Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Viva-voce/Laboratory Practices
PO 12	**Life-long learning:**Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Viva-voce/Laboratory Practices

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR). .	2	Viva-voce Laboratory Practices
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems .	2	Viva-voce Laboratory Practices

PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas. .	2	Viva-voce Laboratory Practices

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand (knowledge) the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science**	3
	PO 5	Understand the (given **knowledge**) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineerig activities with an understanding of the limitations.	3
CO 2	PO 1	Understand (knowledge)the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science.**	3
	PO 5	Understand the (**knowledge**) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2
CO 3	PO 1	Understand (**knowledge**) the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science.**	3
	PO 5	Understand the (knowledge) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	3
CO 4	PO 1	Describe (knowledge) the use sorting techniques as a basic building block in algorithm design and problem solving **using principles of mathematics, science, and engineering fundamentals.**	3
	PO 5	Understand the **knowledge** appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2

	PO 10	Apply (knowledge) concept of dimensional analysis and similarity parameters for predicting physical parameters (understanding) for the fluid flow analysis used in designing prototypes devices (apply) solving design problems by applying the **communicating effectively with engineering community.**	3
CO 5	PO 1	Outline the importance of searching algorithms to retrieve an element from any data structure where it is stored by **understanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 10	Understand the use of searching techniques that retrieve information stored within some data structure by **communicating effectively with engineering community**.	2
CO 6	PO 1	Outline the importance of searching algorithms to retrieve an element from any data structure where it is stored by **understanding and applying the fundamentals of mathematics, science and engineering**	2
	PO 10	Understand the use of searching techniques that retrieve information stored within some data structure by **communicating effectively with engineering communit.**	3
CO 7	PO 1	Make use of linear data structures to organize the data in a particular way so to use them in the most effective way by applying the **basic knowledge of mathematics, science, engineering fundamentals**	2
	PO 2	Build strong foundation of data Structures which tells the program how to store data in memory and forming some relations among the data and use them in **design and development of new products.**	2
	PO 3	Recognize the need of linear data structures such as linked list, array, stack and queue by **designing solutions for complex Engineering problems** in real-time.	1
	PSO 1	Acquire sufficient knowledge to develop real-time applications by making use of linear data structures in (**career building and higher studies.**	3
CO 8	PO 1	Describe (knowledge) the usage of data structures in organizing, managing, and storing different data formats that enables efficient access and modification by applying the **fundamentals of mathematics, science, and engineering.**	3
	PO 5	(**Modern Tool Usage:**)Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	

	PO 3	Understand the applications of basic data structures such as stacks, queues, linked lists in (**designing and developing solutions of complex engineering applications.**	4
	PSO 1	Make use of modern computer tools for applying the basic data structure concepts in building real-time applications for a successful career.	
CO 9	PO 1	Apply the sophisticated hierarchical data structures to organize keys in form of a tree to use in many real-life applications by **using the principles of mathematics and engineering fundamentals.**	3
	PO 2	Make use of non-linear data structures such as balanced trees in by **identifying, formulating and analyzing complex engineering problems** such as databases, syntax tree in compilers and domain name servers etc. **with the help of basic mathematics and engineering sciences**.	3
	PO 3	Extend the concept of tree data structures to **design and develop solutions for complex engineering problems**.	3
	PSO 1	Make use of modern computer tools in implementing non-linear data structures for various applications to become a successful professional in the domain.	3
CO 10	PO 1	Demonstrate different tree structures in Python to implement real-time problems by **applying basic knowledge of science and engineering fundamentals.**	3
	PO 2	Illustrate the importance of tree data structures used for various applications **by identifying, formulating and analyzing complex engineering problems** such as operating systems and compiler design.	3
	PO 3	Make use of tree data structures to **design and develop solutions for complex engineering problems** and which is the key organizing factor in software design. Data structures can be used to organize the storage and retrieval of information stored in both main memory and secondary memory.	3
	PSO 1	Acquire sufficient knowledge in field of data structures and its applications by using modern computer tools so that new product development can take place, which leads to become successful entrepreneur and or to obtain higher education.	3
CO 11	PO 1	Understand (knowledge) the benefits of dynamic and static data structures implementations and choose appropriate data structure for specified problem domain **using knowledge of mathematics, science and engineering fundamentals.**	3
	PO 2	Recognize the need of dynamic and static data structures **in identifying, formulating and analyzing complex engineering problems.**	3

	PO 3	Describe (knowledge) the usage of static and dynamic data structures in designing solutions for complex Engineering problems.	3
	PSO 1	Build sufficient knowledge of dynamic data structures by using modern tools so that new product can be developed, which leads to become successful entrepreneur in the present market.	3
CO 12	PO 1	Build strong foundation of quickly determining the efficiency of an algorithm or data structure for solving computing problems with respect to performance by using knowledge of mathematics, science and engineering fundamentals.	3
	PO 2	Recognize the importance of suitable data structures in checking the efficiency of algorithms used for complex engineering problems.	3
	PO 3	Make use of broad usage of data structures in designing and developing of complex engineering applications.	3
	PSO 1	Extend the concept of data structures in solving complex engineering problems using modern engineering tools to become a successful professional in the domain.	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			
	PO 2	PO 3	PO 5	PO 10	PSO 1
CO 1	3			2	
CO 2	3			2	
CO 3	3			2	3
CO 4	3			2	2
CO 5	2				2
CO 6	3				2
CO 7	3	2	2		2
CO 8	3		3	2	2
CO 9	2	2	3		2
CO 10	2	3	2		2
CO 11	3	2	2		2
CO 12	2	2	3		3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**SEARCHING TECHNIQUES**
	Write python program for implementing the following searching techniques. a. Linear search. b. Binary search. c. Fibonacci search.
WEEK II	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Bubble sort. b. Insertion sort. c. Selection sort.
WEEK III	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Quick sort. b. Merge sort.
WEEK IV	**IMPLEMENTATION OF STACK AND QUEUE**
	Write Python programs to a. Design and implement Stack and its operations using Lists. b. Design and implement Queue and its operations using Lists
WEEK V	**APPLICATIONS OF STACK**
	Write Python programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression. .
WEEK VI	**IMPLEMENTATION OF SINGLE LINKED LIST**
	Write Python programs for the following: a. Uses functions to perform the following operations on single linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal b. To store a polynomial expression in memory using linked list. .
WEEK VII	**IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on Circular linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal .
WEEK VIII	**IMPLEMENTATION OF DOUBLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on double linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal in both ways .
WEEK IX	**IMPLEMENTATION OF STACK USING LINKED LIST**
	Write Python programs to implement stack using linked list.
WEEK X	**MPLEMENTATION OF QUEUE USING LINKED LIST**
	Write Python programs to implement queue using linked list
WEEK XI	**GRAPH TRAVERSAL TECHNIQUES**
	Write Python programs to implement the following graph traversal algorithms: a. Depth first search. b. Breadth first search.

WEEK XII	**IMPLEMENTATION OF BINARY SEARCH TREE**
	Write a Python program that uses functions to perform the following: a. Create a binary search tree. b. Traverse the above binary search tree recursively in pre-order, post-order and in-order. Count the number of nodes in the binary search tree.

TEXTBOOKS

1. Sutton, G.P., et al., —Rocket Propulsion Elements, John Wiley Sons Inc., New York, 1993

2. Martin J.L Turner , Rocket Space Craft Propulsion, Springers oraxis publishing, 2001

REFERENCE BOOKS:

1. Mathur, M., and Sharma, R.P., —Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi 1998

2. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, J.W., Freeman & Co. Ltd., London, 1982.

3. Parker, E.R., Materials for Missiles and Spacecraft, McGraw-Hill Book Co. Inc., 1982.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Calibration of Venturimeter and Orifice meter.	CO 1	R1: 1.2
2	Determination of pipe flow losses in rectangular and circular pipes.	CO 2	R2: 3.5
3	Verification of Bernoulli's theorem	CO 3	R1: 3.4
4	Determination of Reynolds Number of fluid flow	CO 4	R1: 2.2
5	Determine the reaction forces produced by the change in momentum.	CO 5	R1: 2.4
6	Determine the efficiencyand draw theperformance curves ofcentrifugal pump.	CO 6	R3: 4.5
7	Determine the efficiencyand draw theperformance curves of reciprocating pump.	CO 6	R3: 4.6
8	Determine the performance characteristics of pelton wheel under constant head.	CO 6	R2: 5.1
9	Determine the performance characteristics of Francis turbine.	CO 6	R2: 5.2
10	Determine the rate of flow through weir.	CO 7	R1: 7.1
11	Determine the rate of flow through Nothches.	CO 7	R1:7.2
12	Determine the rate of flow through a Orifice meter	CO 7	R1:7.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Demonstration of twin vortex formation and calculation of vortex size for different geometries.

2	**Open channel:** Demonstration of streamline at different angle of attack and calculation of separation point for different Reynolds number.
3	**Capillary action:** By modeling capillary action using two cups of water and a paper towel, you'll gain a better understanding of the importance of this process in trees.
4	**Buoyancy** Calculation of meta center and displacement volume for various geometries and materials.
5	**Flow through pipes:** Encourage students to design and analyze flow through pipes using ANSYS

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Mr. P Ravinder, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Course Title	**ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY**				
Course Code	AHSC04				
Program	B.Tech				
Semester	II	AI & ML			
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Dr. M.Sailaja, Associate Professor				

I COURSE OVERVIEW:

This lab course is designed to introduce the students to create wide exposure on language learning techniques regarding the basic elements of Listening, Speaking, Reading and Writing. In this lab the students are trained in communicative English language skills, phonetics, word accent, word stress, rhythm and intonation, oral presentations, extempore and Prepared-seminars, group-discussions, presenting techniques of writing, participating role plays, telephonic etiquettes, asking and giving directions, information transfer , debates, description of persons, places, objects etc; . The lab encourages the students to work in a group, engage in peer-reviews and inculcate team spirit through various exercises on grammar, vocabulary, and pronunciation games etc. Students will make use of all these language skills in academic, professional and real time situations.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
English Language and Communication Skills Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Sofware based
20 %	To test the perfection of primary tonic stress accent, pre-tonic secondary stress accent and post-tonic secondary stress accent.
20 %	To test the performance to achieve neutralization of accent.
20 %	To test the awareness while pronouncing gemination, elision and assimilation.
20 %	To test the presentation skills in the ICS laboratory.
20 %	To test the subject knowledge through viva.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Sofware based**

Objective	Analysis	Design	Conclusion	Viva	Total
4	4	4	4	4	20

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

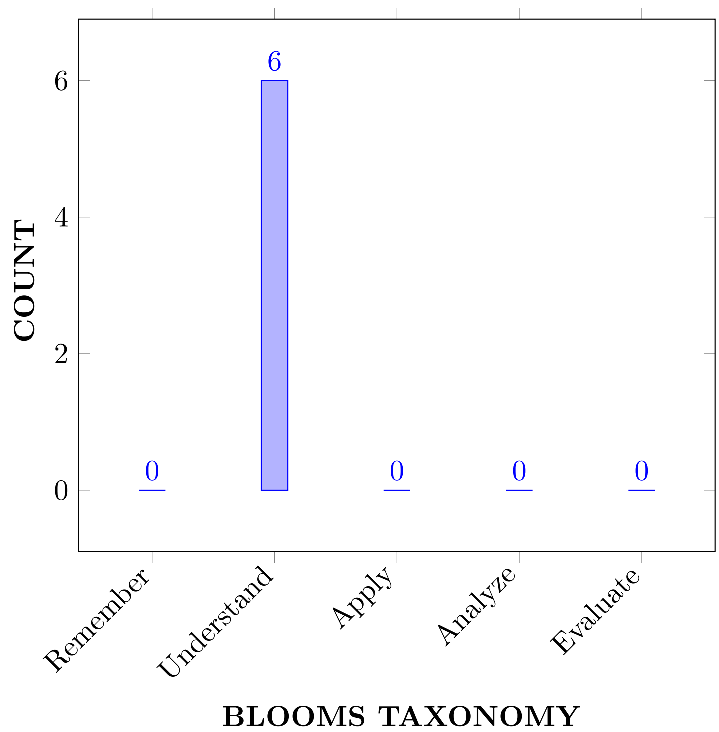
I	Facilitate computer-assisted multi-media instructions to make possible individualized and independent language learning.
II	The critical aspect of speaking and reading for interpreting in-depth meaning of the sentences.
III	Use language appropriately for social interactions such as public speaking, group discussions and interviews.
IV	Habituate using English speech sounds, word accent, intonation and rhythm.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Discuss** the prime necessities of listening skill for improving pronunciation in academic and non-academic purposes.	Understand
CO 2	**Summarize** the knowledge of English phonetics for speaking accepted language and describe the procedure of phonemic transcriptions and intonation patterns.	Understand
CO 3	**Express** about necessity of stressed and unstressed syllables in a word with appropriate length and clarity.	Understand
CO 4	**Explain** how writing skill fulfill the academic and non-academic requirements of various written communicative functions.	Understand
CO 5	**Generalize** appropriate concepts and methods from a variety of disciplines to solve problems effectively and creatively.	Understand
CO 6	**Classify** the roles of collaboration, risk-taking, multi-disciplinary awareness, and the imagination in achieving creative responses to problems.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Day-to-day evaluation / CIE/SEE
PO 10	**Communicate:** effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (Communication).	5	Day-to-day evaluation / CIE/SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 10	Discuss the heeds of functional **grammar** and **punctuation** tools in **speaking** and **writing** by generating the **clarity** of an audio text.	5
CO 2	PO 9	Define the meaning of **individual work** and **team work** and also participate effectively to develop **leadership** qualities among the **diverse teams** in **multidisciplinary** settings.	5

CO 3	PO 10	Describe the **clarity** of **grammatical** usage and the obligation of **punctuation** marks in **speaking** and **writing**.	5
CO 4	PO 10	Choose suitable **grammatical** structures and **punctuation** marks at **speaking** and **writing** areas maintaining **clarity** at professional platform.	5
CO 5	PO 10	Interpret the **grammatical** knowledge and **punctuation** marks systematically towards providing the **clarity** in **speaking** and **writing**.	5
CO 6	PO 10	Demonstrate the role of **grammar** and **punctuation** marks understanding the meaning between the sentences as well as paragraphs in **speaking** or **writing** for a **clarity**.	5

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO'S
	PO 9	PO 10	-	PSO
CO 1	-	5	-	-
CO 2	3	-	-	-
CO 3	-	5	-	-
CO 4	-	5	-	-
CO 5	-	5	-	-
CO 6	-	5	-	

XII ASSESSMENT METHODOLOGY DIRECT:

Laboratory Practices	PO 9, PO 10	Student Viva	PO 9, PO 10	Certification	-
Assignments	-	-	-	-	

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**INTRODUCTION ABOUT ELCS LAB..**
	Introducing Self and Introducing Others – feedback.
WEEK II	**INTRODUCTION TO PHONETICS AND PRACTICING CONSONANTS**
	Describing a person or place or a thing using relevant adjectives – feedback.
WEEK III	**PRACTICING VOWEL SOUNDS.**
	JAM Sessions using public address system.
WEEK IV	**STRUCTURE OF SYLLABLES.**
	Giving directions with help of using appropriate phrases – activities.
WEEK V	**WORD ACCENT AND STRESS SHIFTS. – PRACTICE EXERCISES.**
	Starting a conversation, developing and closing appropriately using fixed expressions..
WEEK VI	**PAST TENSE AND PLURAL MARKERS.**
	Role Play activities.
WEEK VII	**WEAK FORMS AND STRONG FORMS.**
	Oral Presentation..
WEEK VIII	**INTRODUCTION TO INTONATION- USES OF INTONATION - TYPES OF INTONATION- PRACTICE EXERCISES.**
	Expresions In Various Situations.
WEEK IX	**NEUTRALIZATION OF MOTHER TONGUE INFLUENCE (MTI).**
	Sharing Summaries Or Reviews On The Topics Of Students' Choice.
WEEK X	**COMMON ERRORS IN PRONUNCIATION AND PRONUNCIATION PRACTICE THROUGH TONGUE TWISTERS.**
	Interpretation Of Proverbs And Idioms.
WEEK XI	**LISENING COMPREHENSION.**
	Etiquettes.

WEEK XII	**TECHNIQUES AND METHODS TO WRITE SUMMARIES AND REVIEWS OF VIDEOS.**
	Writing Messages, Leaflets And Notices Etc.
WEEK XIII	**COMMON ERRORS.**
	Resume Writing.
WEEK XIV	**INTRODUCTION TO WORD DICTIONARY.**
	Group Discussions – Video Recording – Feedback.
WEEK XV	**INTRODUCTION TO CONVERSATION SKILLS.**
	Mock Interviews.

TEXTBOOKS

1. ENGLISH LANGUAGE AND COMMUNICATION SKILLS: LAB MANUAL

REFERENCE BOOKS:

1. . Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles and Practices", Oxford University Press, New Delhi, 3rd Edition, 2015.

2. Rhirdion, Daniel, "Technical Communication", Cengage Learning, New Delhi, 1st Edition, 2009.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Introduction About Elcs Lab, Introducing Self And Introducing Others – Feedback.	CO 2	R1: 1.2
2	Introduction To Phonetics And Practicing Consonants, Describing A Person Or Place Or A Thing Using Relevant Adjectives – Feedback.	CO 2	R2: 25-30
3	Practicing Vowel Sounds,Jam Sessions Using Public Address System.	CO 2	R1: 28-29,49-54
4	Structure Of Syllables, Giving Directions With Help Of Using Appropriate Phrases – Activities.	CO 3	R1: 23-38
5	Word Accent And Stress Shifts. – Practice Exercises, Starting A Conversation, Developing And Closing Appropriately Using Fixed Expressions.	CO 3	R1: 2.4
6	Past Tense And Plural Markers,	CO 2	R3: 4.5
7	Weak Forms And Strong Forms,Oral Presentation.	CO 2	R3: 4.6
8	Introduction To Intonation- Uses Of Intonation - Types Of Intonation- Practice Exercises, Expresions In Various Situations.	CO 2	R2: 39-42
9	Neutralization Of Mother Tongue Influence (Mti), Sharing Summaries Or Reviews On The Topics Of Students' Choice.	CO 2	R2: 5.2
10	Common Errors In Pronunciation And Pronunciation Practice Through Tongue Twisters, Interpretation Of Proverbs And Idioms.	CO 2	R1:42-43
11	Lisening Comprehension, Etiquettes	CO 5	R1:44-48

12	Techniques And Methods To Write Summaries And Reviews Of Videos,Writing Messages, Leaflets And Notices Etc.	CO 4	R1:107-110
13	Common Errors, Resume Writing.	CO 4	R1:7.3
14	Introduction To Word Dictionary,Group Discussions – Video Recording – Feedback.	CO 5	R1:7.3
15	Introduction To Conversation Skills,Mock Interviews.	CO 6	R1: 54-58

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	**Design Oriented Experiments.**
1	**Effective listening skills can be used in professional and personal platforms in future.**
2	**By learning LSRW skills, students can enhance desired language skills to fulfill their needs.**
3	**Practicing presentation skills will boost confidence at work place.**
4	**The overall experiments of the laboratory will lead to be an effective communicator.**
5	**The Students will develop critical comprehensive skills to solve the career related problems in future.**

Signature of Course Coordinator **HOD**
Dr. M.Sailaja, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Course Title	**PHYSICS LABORATORY**				
Course Code	AHSC05				
Program	B.Tech				
Semester	II	AI & ML			
Course Type	FOUNDATION				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. K Saibaba, Assistant Professor				

I COURSE OVERVIEW:

This lab course provides hands on experience in a number of experimental techniques and developscom-petenceintheinstrumentationtypicallyusedinphysics.This also develops student's expertise in applying physical concepts to practical problem and in learning about experimental techniques with advanced equipments. This laboratory includes experiments involving electromagnetism and optoelectronics.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	Basic principles of physics	1.5

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Physics laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day-to-day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

B. Programming Based

Purpose	**Algorithm**	**Program**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

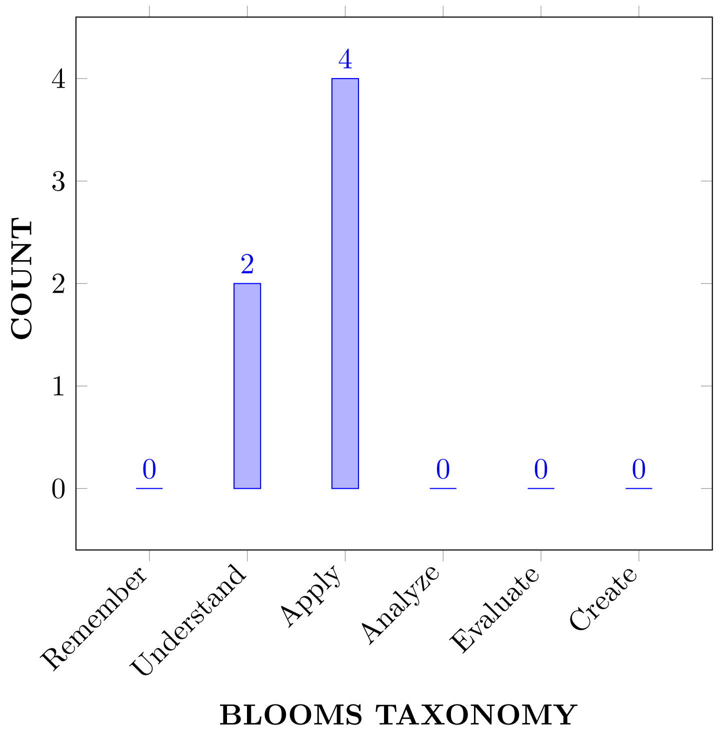
I	To familiarize with the lab facilities, equipment, standard operating procedures.
II	About the different kinds of functional electric and magnetic materials which paves a way for them to use in various technical and engineering applications.
III	The analytical techniques and graphical analysis to study the experimental data for optoelectronic devices.
IV	The applications of variation in the intensity of light due to natural phenomena like interference and diffraction.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the type of semiconductor using the principle of Hall Effect and also determine the energy gap of a semiconductor diode.	Apply
CO 2	**Illustrate** principle, working and application of wave propagation and compare results with theoretical harmonics and overtones.	Understand
CO 3	**Investigate** the energy losses associated with a given Ferro magnetic material and also magnetic field induction produced at various points along the axis of current carrying coil.	Apply
CO 4	**Examine** launching of light through optical fiber from the concept of light gathering capacity of numerical aperture.	Understand
CO 5	**Utilize** ththe phenomena of interference and diffraction for the determination of various parameters like radius of curvature of convex lens, wavelength of laser light and width of single slit.	Apply
CO 6	**Investigate** V-I/L-I characteristics of various optoelectronic devices like Light Emitting Diode, Photodiode to understand their basic principle of functioning as well as to infer the value of Planck's constant.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Laboratory experiments, internal and external lab examinations.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Laboratory experiments, internal and external lab examinations.
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Laboratory experiments, internal and external lab examinations.

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas		

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Identify basic principle of Hall effect and make use of mathematical expression for Hall coefficient to deduce the type of semiconductor.	2
	PO 2	Understand the given problem statement of identification of type of semiconductor and formulate Hall coefficient from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 1	Determine the energy gap of a semiconductor diode by making use of graphical analysis of current versus temperature curve.	2

CO 2	PO 1	Recall the theory of propagation of longitudinal and transverse waves and make use of number of loops formation in string to determine frequency of an electronically maintained tuning fork.	2
	PO 2	Understand the given problem statement of stationary wave propagation and formulate harmonics and overtones of fundamental frequency from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
CO 3	PO 1	Explain the variation of magnetic field at various points along the axis of current carrying coil and make use of mathematical expression of Tangent's law using Stewart Gee's apparatus.	2
	PO 2	Understand the given problem statement of current loop and formulate magnetic field induction at various points along the axis of current loop from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 1	Investigate the energy losses associated with a given ferromagnetic material and make use of graphical representation of hysteresis loop exhibited by magnetic material.	2
	PO 2	Understand the given problem statement of energy losses associated with a given ferromagnetic material and formulate hysteresis loop from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 4	Apply simulation tool to get hysteresis curve of a ferromagnetic material and understand energy losses associated with material.	1
	PSO 3	Make use of modern simulation tool to get information about energy losses associated with a ferromagnetic material.	1
CO 4	PO 1	Interpret launching of light through optical fiber and make use of mathematical expression for analyzing light gathering capacity through numerical aperture.	2
	PO 4	Make use of optical fiber trainer kit and understand conversion of electrical to light energy..	1
CO 5	PO 1	Explain the concept of interference in Newton's rings and make use of it to determine the radius of curvature of convex lens.	2
	PO 4	Make use of microscope to get Newton's rings and understand the phenomenon of interference in reflected light.	1
	PO 1	Recollect the phenomena of diffraction from N-slits and make use of it for the determination of wavelength of a given laser.	1

	PO 1	Understand the phenomenon of single slit diffraction and make use of it to determine the slit width by using laser light as monochromatic source.	1
CO 6	PO 1	Explain the V-I characteristics of light emitting diode and infer the value of planck's constant by plotting temperature versus current curve.	2
	PO 1	Understand the phenomenon of recombination of electron-hole pair and determine the value of threshold voltage of a given LED.	2
	PO 1	Illustrate the variation of photo current with light intensity in a photo diode.	1

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO'S
	PO 1	PO 2	PO 4	PSO 3
CO 1	3	2	-	-
CO 2	3	2	1	-
CO 3	3	-	-	1
CO 4	3	2	1	-
CO 5	3	-	1	-
CO 6	3	2	1	-

3 = High; 2 = Medium; 1 = Low

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**HAL LEFFECT (LORENTZFORCE)**
	Determination of charge carrier density.
WEEK 2	**MELDE'S EXPERIMENT**
	Determination of frequency of a given tuning fork
WEEK 3	**STEWART GEE'S APPARATUS**
	Magnetic field along the axis of current carrying coil – Stewart and Gee's method.
WEEK 4	**B-H CURVE WITH CRO**
	To determine the value of retentivity and coercivity of a given magnetic material.
WEEK 5	**ENERGY GAP OF A SEMICONDUCTOR DIODE**
	Determination of energy gap of a semiconductor diode.
WEEK 6	**PHOTO DIODE**
	Studying V-I characteristics of Photo Diode.
WEEK 7	**OPTICAL FIBER**
	Evaluation of numerical aperture of a given optical fiber.
WEEK 8	**WAVELENGTH OF LASER LIGHT**
	Determination of wavelength of a given laser light using diffraction grating.
WEEK 9	**PLANK'S CONSTANT**
	Determination of Plank's constant using LED.
WEEK 10	**LIGHT EMITTING DIODE**
	Studying V-I Characteristics of LED.
WEEK 11	**NEWTONS RINGS**
	Determination of radius of curvature of a given plano - convex lens.
WEEK 12	**SINGLE SLIT DIFFRACTION**
	Determination of width of a given single slit.

TEXTBOOKS

1. 1 CL Arora, “Practical Physics”, S Chand and Co.,New Delhi, 3rd Edition,2012.

2. 2 Vijay Kumar, Dr. T. Radha krishna, “Practical Physics for Engineering Students”, S M Enterprises, 2nd Edition, 2014.

REFERENCE BOOKS:

1. 1 CF Coombs,”Basic Electronic Instrument Handbook”, McGraw - HillBookCo.,1972.

2. 2 CH Bernardand CD Epp, John Wiley and Sons, ” Laboratory Experiments in College Physics” Inc.,NewYork,1995.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Determination of charge carrier density.	CO 1	T1:13.5
2	Determination of frequency of a given tuning fork.	CO 2	T1:13.5
3	Determination of Magnetic field along the axis of current carrying coil – Stewart and Gee's method.	CO 3, CO 4	TT1:14.7
4	Determination of the energy loss per unit volume of a given magnetic material per cycle by tracing the Hysteresis loop.	CO 3	T1:15.7
5	Determination of energy gap of a semiconductor diode.	CO 1	T1:16.8
6	Studying V-I Characteristics of Photo Diode.	CO 6	T1:16.9
7	Evaluation of numerical aperture of a given optical fiber.	CO 4	T1:17.9
8	Determination of wavelength of a given laser light using diffraction grating.	CO 5	T1:18.10
9	Determination of Plank's constant using LED.	CO 6	T1:19.10
10	Studying V-I characteristics of LED	CO 6	T1:19.9
11	Determination of radius of curvature of a given Plano-convex lens.	CO 5	T1:23.10
12	Determination of width of a given single slit.	CO 5	T1:23.10

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	To determine the wavelength of different colored light using white light source by Newton's ring method
2	To study the bending losses and transmission losses of an optical Fiber
3	To observe the dispersion of prism by using spectrometer.
4	Study the characteristics of Laser diode.
5	To illustrate the interference pattern produced from the air wedge.
6	To determine the voltage current characteristics of solar cell

Signature of Course Coordinator
Mr.K Saibaba, Assistant Professor

HOD,CSE (AI & ML)

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI & ML)**				
Course Title	**ANALOG AND DIGITAL ELECTRONICS**				
Course Code	AECC08				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. B Ravi Kumar, Associate Professor				

I COURSE OVERVIEW:

This course provides the basic knowledge over the construction and functionality of the basic electronic devices such as diodes and transistors. It also provides the information about the uncontrollable and controllable electronic switches and the flow of current through these switches in different biasing conditions and also will make them to learn the basic theory of switching circuits and their applications in specified relationship between signals at the input and output terminals. They will be able to design combinational and sequential circuits detail. Starting from a problem statement they will learn to design circuits of logic gates that have a.They will learn to design counters, adders, sequence detectors.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB13	II	Semiconductor Physics

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital Communications	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
50%	Understand
25%	Apply
15%	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz \Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz \AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI COURSE OBJECTIVES:

The students will try to learn:

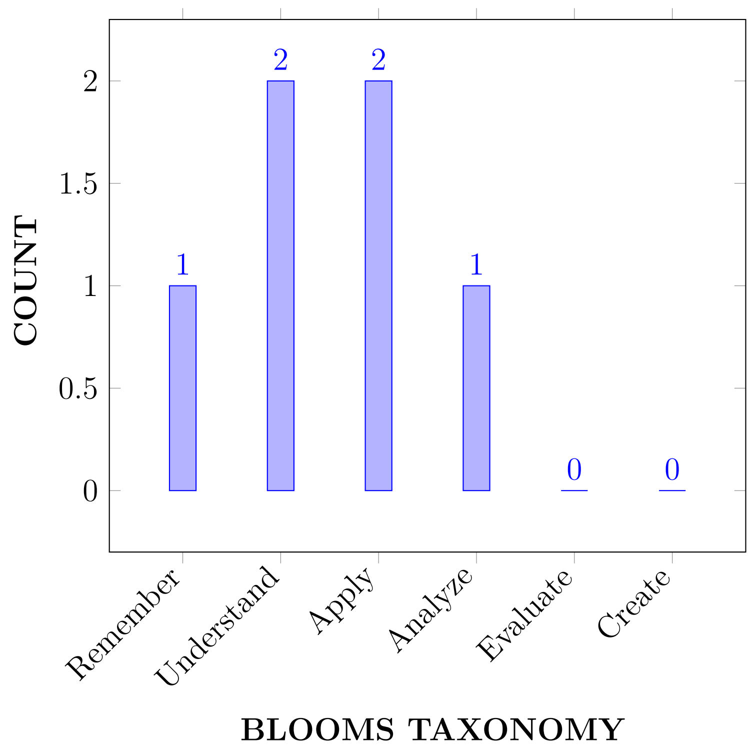
I	The Fundamental knowledge of the operational principles and characteristics of semiconductor devices and their applications.
II	The basic concept of number systems, boolean algebra and optimized implementation of combinational and sequential circuits.
III	The perceive subsequent studies in the area of microprocessors, microcontrollers, VLSI design and embedded systems effectively use of fundamentals of digital electronics.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the volt-ampere characteristics of semiconductor devices for finding cut-in voltage, resistance and capacitance.	Remember
CO 2	**Explain** half wave and full wave rectifier circuits with filter and without filters for conversion of alternating current in to direct current.	Understand
CO 3	**Analyse** the input and output characteristics of transistor configurations and small signal h-parameter models for determining the input - output resistances, current gain and voltage gain	Apply
CO 4	**Identify** the functionality of logic gates, parity code and hamming code techniques for error detection and correction of single bit in digital systems.	Understand
CO 5	**Construct** the combinational logic circuits using appropriate logic gates .	Apply
CO 6	**Implement** the synchronous and asynchronous counters for memory storing applications.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/Quiz /AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE/CIE/Quiz /AAT
PO 3	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	SEE/CIE/Quiz /AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, WebDevelopment, Gaming, Augmented Reality /Virtual Reality (AR/VR).	3	Lectures and assignments.
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	Lectures and assignments.
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lectures and assignments.

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Recall(knowledge)** the semiconductor device properties **(knowledge)** for understanding conduction, Fermi-levels, barrier potentials through energy band diagrams, diffusion and drift currents in the device characteristics by applying the principles of **science**	3

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
	PO 2	**Understand** the given **problem statement** and **formulate** the static and dynamic resistance from the volt-ampere characteristics of the semiconductor devices using **first principles of mathematics, natural sciences, and engineering sciences**	4
	PO 10	Understand **problem statement** and solve it for dynamic resistance then **present it in the project**.	2
CO 2	PO 1	**Apply (knowledge)** the given the diode application **problem statement** and finding the **solution implementation** of rectifier circuits	3
	PO 2	**Formulate** and **analyze (Problem analysis) complex Engineering problems** and apply best rectifier of **engineering mathematics, design** and the results in terms of computational complexity.	6
	PO 10	Understand **problem statement** and solve it using ripple factor and effieciency then **present it in the project**.	2
CO 3	PO 1	**Apply** the **knowledge of mathematics, science, Engineering fundamentals** to understandtransistor configurations	3
	PO 2	**Identify** the given **problem statement** and formulate the required steps and **implement** (complex) amplifier circuits from the h-parameter model **information and data. Validate** one transistor design with other design in reaching substantiated conclusions by the **interpretation of results.**	6
	PO 3	**Design** ce configuration for determining voltage gain ,current gain input impedance and output impedance by applying the principles of **mathematics, science to the solutions of complex engineering problems and design system components.**	5
	PO 10	**Design** transistor configuration by applying h-parameters and the principles of of complex engineering problems and design system components.**applied in journals**	2
	PSO 1	**Apply** h- parameter model to analyze the transistor characheristics and presente it in concept videos	1
CO 4	PO 1	Basic **knowledge** of **science and mathematics** is needed to understand arrore detection and correction and then **apply** design hamming code.	3
	PO 2	**Identify** the probem **statement** of multigate realizations with **data** specification. **Implement** of boolean functions and **interpretation** of results.	4
	PO 10	**Design** solutions for logic circuits and **presented well in concept video**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	Understand (knowledge) concept of boolean algebra and logic gates from **Engineering and Science of mathematical principles.**	3
	PO 2	**Identify** the problem **statement** of combinational logic circuitsr provided with **data** specification. **Make use of**k-map and truth table concepts in the **design of system components** combinational circuits to establish innovative solutions **for complex engineering problems**	6
	PO 3	**Design** the problem of combinational logic circuitsr provided with **data** specification. **Make use of**k-map and truth table concepts in the **design of system components** combinational circuits to establish innovative solutions **for complex engineering problems**	6
	PO 10	**Identify** the problem **statement** of combinational logic designs provided with **data** specification.	2
	PSO 1	Understand the boolean algebra and - map **apply** combinational design stepsand r research based learning	1
CO 6	PO 1	**Understand (knowledge)** concept of flipflops and sequential log circuits apply **Engineering and Science of mathematical principles.**	3
	PO 2	**Identify** the **problem statement** of sequential circuits **implementing counter**(analyze complex engineering problems) **on digitalcircuits(engineering sciences)**. conclusions by the **interpretation of results.**	6
	PO 3	**Design** the problem of seqential logic circuitsr provided with **data** specification. **Make use of** truth table and excitation table concepts in the **design of system components** seqential circuits to establish innovative solutions **for complex engineering problems**	6
	PO 10	**Identify** the **problem statement** of seqential circuits and **implementing** for memory applications .	2
	PSO 1	Understand the seqential circuits and **apply** sequential design steps and used in research based learning	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	3	4	-	-	-	-	-	-	-	2	-		-	-	-
CO 2	3	6	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	6	5	-	-	-	-	-	-	2	-	-	1	-	-
CO 4	3	4	-	-	-	-	-	-	-	2	-		-	-	-
CO 5	3	6	6	-	-	-	-	-	-	2	-	-	1	-	-
CO 6	3	6	6	-	-	-	-	-	-	2	-		1	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	100	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	60	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	60	50	-	-	-	-	-	-	40	-	-	50	-	-
CO 4	100	40	-	-	-	-	-	-	-	40	-		-	-	-
CO 5	100	60	60	-	-	-	-	-	-	40	-	-	50	-	-
CO 6	100	60	60	-	-	-	-	-	-	40	-	-	50	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -5 $< C \leq 40\%$ – Low/ Slight
2 - 40 % $< C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	3	2	-	-	-	-	-	-	2	-	-	2	-	-
CO 4	3	2	-	-	-	-	-	-	-	2	-		-	-	-
CO 5	3	3	3	-	-	-	-	-	-	2	-	-	2	-	-

CO 6	3	3	3	-	-	-	-	-	-	2	-	-	2	-	-
TOTAL	18	16	8	-	-	-	-	-	-	12	-	-	6	-	-
AVERAGE	**3.00**	**2.67**	**2.67**	-	-	-	-	-	-	**2**	-	-	**2**	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of mini projects by experts		

XVIII SYLLABUS:

MODULE I	**DIODE AND APPLICATIONS**
	Diode - Static and Dynamic resistances, Equivalent circuit, Load line analysis, Diffusion and Transition Capacitances, Diode Applications: Switch-Switching times. Rectifier - Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Rectifiers with Capacitive Filter.
MODULE II	**BIPOLAR JUNCTION TRANSISTOR (BJT)**
	Principle of Operation and characteristics - Common Emitter, Common Base, Common Collector Configurations, Operating point, DC and AC load lines, Transistor Hybrid parameter model, Determination of h-parameters from transistor characteristics, Conversion of h-parameters.
MODULE III	**NUMBER SYSTEMS**
	Number systems, Complements of Numbers, Codes- Weighted and Non-weighted codes and its Properties, Parity check code and Hamming code. Boolean Algebra: Basic Theorems and Properties, Switching Functions-Canonical and Standard Form, Algebraic Simplification, Digital Logic Gates, EX-OR gates, Universal Gates, Multilevel NAND/NOR realizations.
MODULE IV	**MINIMIZATION OF BOOLEAN FUNCTIONS**
	Karnaugh Map Method - Up to five Variables, Don't Care Map Entries, Tabular Method, Combinational Logic Circuits: Adders, Subtractors, comparators, Multiplexers, Demultiplexers, Encoders, Decoders and Code converters, Hazards and Hazard Free Relations
MODULE V	**SEQUENTIAL CIRCUITS FUNDAMENTALS**

	Basic Architectural Distinctions between Combinational and Sequential circuits, SR Latch, Flip Flops: SR, JK, JK Master Slave, D and T Type Flip Flops, Excitation Table of all Flip Flops, Timing and Triggering Consideration, Conversion from one type of Flip-Flop to another. Registers and Counters: Shift Registers – Left, Right and Bidirectional Shift Registers, Applications of Shift Registers - Design and Operation of Ring and Twisted Ring Counter, Operation of Asynchronous and Synchronous Counters. .

TEXTBOOKS

1. Electronic Devices and Circuits "Jacob Millman", McGraw Hill Education, 2017
2. Electronic Devices and Circuits theory "Robert L. Boylestead, Louis Nashelsky",11th Edition, Pearson, 2009.
3. Switching and Finite Automata Theory, "Zvi Kohavi and Niraj K. Jha, 3rd Edition", Cambridge, 2010.
4. Modern Digital Electronics, "R. P. Jain, 3rd Edition", Tata McGraw-Hill, 2007.

REFERENCE BOOKS:

1. 1. Pulse, Digital and Switching Waveforms, "J. Millman, H. Taub and Mothiki S. Prakash Rao", 2 Ed., McGraw Hill, 2008.
2. 2. Electronic Devices and Circuits, "S. Salivahanan, N.Suresh Kumar, A Vallvaraj, 2nd Edition", TMH.
3. 3. Digital Design, "Morris Mano", PHI, 4th Edition,2006
4. 4. Introduction to Switching Theory and Logic Design, "Fredriac J. Hill, Gerald R. Peterson", 3rd Ed, John Wiley and Sons Inc.

COURSE WEB PAGE:

1. http://www.ebooks directory.com
2. http://Campus guides.lib.utah.edu

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	Course Outcomes	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
2	Introduction to semiconductors, Diode - Static and Dynamic resistances	CO 1	T1:2.1-2.3
3	Equivalent circuit, Load line analysis.	CO 1	T1:2.4,7.5
5	Diffusion and Transition Capacitances, Diode Applications, Switch-Switching times	CO 1	T1:2.7,7.3
8	Design Rectifier - Half Wave Rectifier and problems	CO 1	T1:2.8
10	Design Full Wave Rectifier and problems	CO 2	T1:3.2 R1:3.1-3.2
11	Design Bridge Rectifier, Rectifiers with Capacitive Filter	CO 2	T1:4.2
14	Understand the concepts of Transistor operation	CO 3	T1:8.1 R2:4.5
15	Characteristics of CB	CO 3	T1:8.3-8.7
18	Characteristics of CE	CO 4	T1:8.7-8.9
19	Characteristics of CC	CO 4	T1:10.2.1-2.3
20	Operating point, DC and AC load line Analysis and problems	CO 4	T1:10.2.4 R2:7.6
21	Transistor Hybrid parameter model, Determination of h-parameters from transistor characteristics, .	CO 4	T1:11.1-11.5
22	Conversion of h-parameters	CO 4	T1:11.4
23	Understand the need for digital systems, review of number systems, number base conversion	CO 5	T1:11.9
24	Complements of numbers, Weighted codes and Non-weighted codes.	CO 4	T1:9.4-9.6
25	Error detecting and correcting codes, Digital Logic Gates	CO 5	T1:9.7-9.10
32	Basic Theorems and Properties, Algebraic Simplification,	CO 4	T1:12.1-12.3
33	Canonical and Standard Form	CO 4	T1:12.3,7.3
34	Universal Gates, Multilevel NAND/NOR realizations.	CO 4	T1:12.4

37	Identify basic building blocks of digital systems and Minimization using three variable; four variable; five variable K-Maps; Don‘t Care Conditions.	CO 6	T1:12.3-12.5
38	Understand Tabular Method	CO 6	T1:12.6
39	Design Combinational Logic Circuits adders, subtractors.	CO 6	T1:12.7 R1:3.1
40	Design different combinational logic circuits comparators Multiplexers, Demultiplexer.	CO 4	T1:7.2
41	Demonstrate the Encoders, Decoders.	CO 4	T1:12.8 R2:4.5
42	Code converters, Hazards and Hazard Free Relations	CO 5	T1:12.9-12.10
43	Combinational and sequential circuits, the binary cell, the Fundamentals of sequential machine operation, SR-Latch	CO 5	T1:12.11-12.12
44	Flip Flops: SR, JK, JK Master Slave, D	CO 5	T1:12.13-12.14
45	T Type Flip Flops. Timing and Triggering	CO 5	T1:12.15 R2:7.6
46	Excitation tables of Flip-flops,	CO 5	T1:12.16-12.17
47	Conversion from one type of Flip-Flop to another	CO 5	T1:13.1 R2:8.1
48	Draw and explain about Shift Registers	CO 6	T1:13.2 R2:8.2
49	Implement snchounous counter:binary counter	CO 6	T1:13.3 R2:8.3
50	Implement snchounous counter:up down counter	CO 6	T1:13.4 R2:8.4
51	Implement snchounous counterr	CO 6	T1:13.5 R2:8.5
52	Implement snchounous counter	CO 6	T1:13.6 R2:8.6
53	Asynchronous Counters using flip flops	CO 6	T1:14.1 R3:7.1
54	Asynchronous Counters using flip flops :ring counter	CO 6	T1:14.2 R3:7.2
55	Asynchronous Counters using flip flops : johnson counter	CO 6	T1:14.3 R3:7.3
56	Asynchronous Counters using flip flops	CO 6, CO 6	T1:14.4 R3:7.4
PROBLEM SOLVING/ CASE STUDIES			
6	Dynamic resistance	CO 1	T2:1.12
7	Diode current equation	CO 1	T1:2.2
9	Half wave and full wave rectifier	CO 1	T2:1.12
12	Transistor configurations: CE, CB and CC	CO 2	T1:3.2
13	H-parameter model for transistor configurations	CO 2	T1:3.2
16	Conversion of h-parameters	CO 3	T1: 9.2-9.3
17	Number systems	CO 3	T1: 9.2-9.3
26	Weighted and non weighted codes	CO 4	T1: 7.2
27	Boolean algebra	CO 4	T1: 7.2
28	Logics gates and multilevel gates	CO 4	T1: 7.2
29	minimization of boolean function using K-map	CO 5	T1: 8.1
30	Combinational circuits	CO 5	T1: 8.1

31	FlipFlops	CO 5	T1: 8.1
35	Conversion between flipflop	CO 6	T1: 10.3
36	Snchrounous counter	CO 6	T1: 10.3
57	ASnchrounous counter	CO 6	T1: 10.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	Dynamic resistance	CO1	T2:1.12
59	Cutin voltage	CO1	T1:7.2, T1:8.1
60	Rectifier	CO 6	T1:10.2,T1:10.3
61	H- parameter model	CO 5,CO 5	T1:11.6
62	Voltage gain, current gain input resitance and output resitance	CO 6	T1:9.4-9.6
DISCUSSION OF QUESTION BANK			
63	number system	CO1,CO2	T2:1.12, T1:3.2
64	logic gates	CO 2	T1: 9.2-9.3
65	hamming code	CO3,CO4	T1:7.2, T1:8.1
66	combinational circuits	CO 5	T1:10.2,T1:10.3
67	latch and flipflops	CO 5,CO 5	T1: 11.6

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr. B Ravi Kumar, Associate professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING(AI & ML)				
Course Title	DATA STRUCTURES				
Course Code	ACSC08				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	UG.20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	3	1.5
Course Coordinator	Dr B Padmaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming

II COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Structures	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	whiteboard		Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
60%	Understand
20%	Apply
10%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz \Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz \AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course

is given in table.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

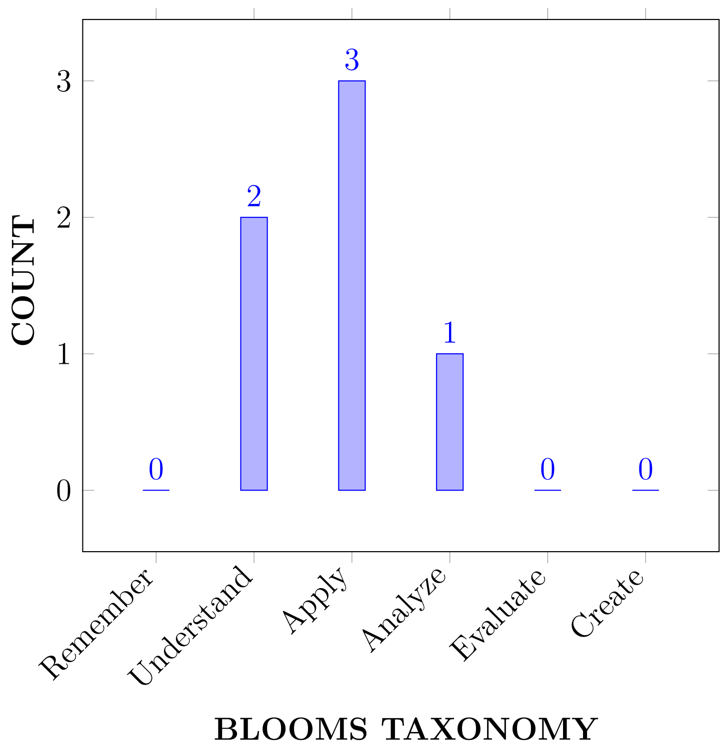
I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching.
III	The fundamentals of how to store, retrieve, and process data efficiently
IV	To provide practice by specifying and implementing these data structures and algorithms in Python.
V	Understand essential for future programming and software engineering courses.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the complexity of algorithm using the asymptotic notations.	Understand
CO 2	**Select** appropriate searching and sorting technique for a given problem.	Apply
CO 3	**Construct** programs on performing operations on linear and nonlinear data structures for organization of a data	Apply
CO 4	**Make use of** linear data structures and nonlinear data structures solving real time applications.	Apply
CO 5	**Describe** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	Understand
CO 6	**Compare** various types of data structures ; in terms of implementation, operations and performance.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIA/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIA/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	CIA/SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	CIA/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	CIA/SEE/Open ended Experiments
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Tech Talk/Concept Videos/Open ended Experiments
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Tech Talk/Concept Videos/Open ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, WebDevelopment, Gaming, Augmented Reality /Virtual Reality (AR/VR).	3	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems	2	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIA/ SEE/ Tech Talk/ Concept Videos

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	✓
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 5	✓	-	✓	-	✓	-	-	-	-	✓	-	-	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	**Understand** (knowledge) the concept of conventional digital communication system and (understand) various types of pulse analog modulation techniques for signals analysis by applying the principles of **mathematics, science,** and **engineering fundamentals**.	3
	PO 2	**Problem Analysis** on different types of algorithms to analyze space and time complexities.	4
	PO 3	**Design the Solutions** for finding space and time complexities of a complex algorithm and representing it by asymptotic notations	2
	PO 10	**Subject matter and speaking style** assessed in explanation of various algorithms, algorithm complexity.	2
	PSO1	**Design and analyze** complex algorithms and specify its space and time complexities and representing it by asymptotic notations for faster processing of data.	3
	PSO3	**Make use of modern** computer tools for finding space and time complexities of a complex algorithm	1
CO 2	PO 1	**Make use** of broad knowledge of searching and sorting techniques for an efficient search from a data structure and optimize the efficiency of other algorithms by applying the knowledge of mathematics, science, Engineering fundamentals.	1
	PO 2	**Problem Analysis** on different types of search sort algorithms to analyze space and time complexities.	5
	PO 3	**Design/Development of Solutions** using appropriate searching and sorting techniques for designing a solution for complex Engineering problems.	2

	PO 5	**Implementation of**different sorting and searching techniques for given problem with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of searching and sorting along with efficiency of searching and sorting techniques in terms of space and time complexity	2
	PO 12	**Keeping current in CSE and advanced engineering concepts** of various searching , sorting and respective time and space complexity by tech talk, concept videos and open ended experiments.	3
	PSO1	**Understand**complex problems and analyzing it and apply appropriate sorting and searching techniques for data processing.	4
	PSO2	**Applying**various selecting and sorting techniques while designing and developing information retrieval systems and its applications	2
	PSO3	**Make use of** various selecting and sorting techniques and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 3	PO 1	**Make use of** linear and nonlinear data structures to organize the data in a particular way so to use them in the most effective way by applying the basic knowledge of mathematics, science, engineering fundamentals	2
	PO 2	**Problem analysis:** Organizing the given data in particular way by performing the operations on linear and nonlinear data structures to use the data in the most effective way.	7
	PO 3	**Recognize the** need of linear and nonlinear data structures such as linked list, array, stack and queue by Designing solutions for complex Engineering.	5
	PO 4	**Conduct Investigations** Conduct Investigations of Complex Problems: Ability to apply operations on linear and nonlinear data structures in order to organize the given data in a particular way	4
	PO 5	**Implementation of** Implementation of different operations on linear and nonlinear data structures for given problem with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of linear and nonlinear data structures like linked lists, stacks and queues	2
	PO 12	**Keeping current in** CSE and advanced engineering concepts of linear and nonlinear data structures like linked lists, stacks and queues by tech talk, concept videos and open-ended experiments	3

	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for Developing the solution.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	2
	PSO3	**Make use of** various linear or nonlinear data structures and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 4	PO 1	**Make use of** linear and nonlinear data structures for solving real time applications by applying the basic knowledge of mathematics, science, engineering fundamentals	3
	PO 2	**Problem analysis:**Solving real time applications by performing the operations on linear or nonlinear data structures.	7
	PO 3	**Recognize the** need of linear and nonlinear data structures such as linked list, array, stack and queue for Designing real time applications.	2
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Implementation of** different operations on linear and nonlinear data structures for solving real time applications with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of linear and nonlinear data structures like linked lists, stacks, queues, trees and graphs	2
	PO 12	**Keeping current** in CSE and advanced engineering concepts of linear and nonlinear data structures like linked lists, stacks, queues, trees and graphs by tech talk, concept videos and open-ended experiments for solving real time applications.	3
	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for solving real time applications.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	1
	PSO3	**Make use of** various linear or nonlinear data structures and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1

CO 5	PO 1	**Understand** the knowledge of hashing techniques and collision resolution methods and implementing for specified problem domain using knowledge of mathematics, science and engineering fundamentals	1
	PO 3	**Design the Solution** for efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	2
	PO 5	**Implementation of** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of Hashing, Collision techniques	2
	PSO1	**Understand** complex problems and analyzing it and apply appropriate hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	4
	PSO2	**Applying** various hashing techniques and collision resolution methods while designing and developing information retrieval systems and its applications	1
	PSO3	**Build** sufficient knowledge hashing techniques and collision resolution methods so that new product can be developed, which leads to become successful entrepreneur in the present market.	1
CO 6	PO 1	**Understand** various types of data structures in terms of implementations and choose appropriate data structure for specified problem domain using knowledge of mathematics, science and engineering fundamentals	3
	PO 2	**Problem Analysis:** Recognize the importance of suitable data structures in checking the efficiency of algorithms used for complex engineering problems.	7
	PO 3	**Design the Solution** complex problems or efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	5
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Understand** the Implementation of various types of data structures with the help of computer software	1
	PO 10	**Subject matter and speaking** style assessed in explanation of Implementation of various types of data structures.	2
	PO 12	**Keeping current in CSE** and advanced engineering concepts of Implementation of various types of data structures by tech talk, concept videos and open ended experiments	3

	PSO 1	**Understand** complex problems and analyzing it and apply Implementation of various types of data structures.	5
	PSO 2	**Applying** Implementation of various types of data structures while designing and developing information retrieval systems and its applications	1
	PSO 3	**Build** sufficient knowledge Implementation of various types of data structures so that new product can be developed, which leads to become successful entrepreneur in the present market.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	6	2	2
CO 1	1	4	2	-	-	-	-	-	-	2	-	-	3	-	1
CO 2	1	5	2	-	1	-	-	-	-	2	-	3	4	2	1
CO 3	2	7	5	4	1	-	-	-	-	2	-	3	5	2	1
CO 4	3	7	2	4	1	-	-	-	-	2	-	3	5	1	1
CO 5	1	-	2	-	1	-	-	-	-	2	-	-	4	1	1
CO 6	3	7	5	4	1	-	-	-	-	2	-	3	5	1	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	2	2	2
CO 1	33.3	40	20	-	-	-	-	-	-	40	-	-	50	-	50
CO 2	33.3	50	20	-	100	-	-	-	-	40	-	25	66.6	100	50
CO 3	66.6	70	50	36.3	100	-	-	-	-	40	-	25	83.3	100	50
CO 4	100	70	20	36.3	100	-	-	-	-	40	-	-	66.6	50	50
CO 5	33.3	-	20	-	100	-	-	-	-	40	-	-	66.6	50	50
CO 6	100	70	50	36.3	100	-	-	-	-	40	-	25	83.3	50	50

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE	PROGRAM OUTCOMES												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1	1	1	-	-	-	-	-	-	1	-	-	2	-	2
CO 2	1	2	1	-	3	-	-	-	-	1	-	1	3	3	2
CO 3	3	3	2	1	3	-	-	-	-	1	-	1	3	3	2
CO 4	3	3	1	1	3	-	-	-	-	1	-	1	3	2	2
CO 5	1	-	1	-	3	-	-	-	-	1	-	-	3	2	2
CO 6	3	3	2	1	3	-	-	-	-	1	-	1	3	2	2
TOTAL	**12**	**12**	**8**	**3**	**15**	**-**	**-**	**-**	**-**	**6**	**-**	**4**	**17**	**12**	**12**
AVERAGE	**2.0**	**2.4**	**1.3**	**1.0**	**3.0**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**2.8**	**2.4**	**2.0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Seminars	-	Student Viva	-	Certification	-
Laboratory Practices	-	5 Minutes Video	-	Open Ended Experiments	-
Term Paper	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING**
	Basic concepts: Introduction to data structures, classification of data structures, operations on data structures; Algorithms Specification ,Recursive algorithms ,Data Abstraction, Performance analysis-time complexity and space complexity, Asymptotic Notation-Big O ,Omega and Theta notations. Introduction to Linear and Non Linear data structures, Searching techniques: Linear search, Binary search; Sorting techniques: Bubble, Selection, Insertion, Quick and Merge Sort and comparison of sorting algorithms
MODULE II	**LINEAR DATA STRUCTURES**
	Stacks: Stack ADT, definition and operations, Implementations of stacks using array, applications of stacks, Arithmetic expression conversion and evaluation; Queues: Primitive operations; Implementation of queues using Arrays, applications of linear queue, circular queue and double ended queue (deque).
MODULE III	**LINKED LISTS**
	Linked lists: Introduction, singly linked list, representation of a linked list in memory, operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation. Types of linked lists: Circular linked lists, doubly linked lists; Linked list representation and operations of Stack, linked list representation and operations of queue
MODULE IV	**NON LINEAR DATA STRUCTURES**
	Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, application of trees; Graphs: Basic concept, graph terminology, Graph representations-Adjacency matrix, Adjacency lists, graph implementation, Graph traversals-BFS,DFS, Application of graphs, Minimum spanning trees-Prims and Kruskal algorithms
MODULE V	**BINARY TREES AND HASHING**
	Binary search trees: Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M-Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.

TEXTBOOKS

1. Rance D. Necaise, Data Structures and Algorithms using Python, Wiley Student Edition.

2. Benjamin Baka, David Julian, Python Data Structures and Algorithms, Packt Publishers, 2017.

REFERENCE BOOKS:

1. S. Lipschutz, Data Structures , Tata McGraw Hill Education, 1st Edition, 2008.
2. D. Samanta, Classic Data Structures, PHI Learning, 2nd Edition, 2004.

WEB REFERENCES:

1. http://www.tutorialspoint.com/data-structures-algorithms
2. https://www.geeksforgeeks.org/data-structures/
3. https://www.studytonight.com/data-structures/
4. https://www.coursera.org/specializations/data-structures-algorithms

COURSE WEB PAGE:

1. https://www.iare.ac.in/?q=courses/computer-science-and-engineering-autonomous/datastructures

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://www.iare.ac.in/?q=courses/computer-science-and-engineering-autonomous/datastructures
	CONTENT DELIVERY (THEORY)		
1	Basic concepts: Introduction to Data Structures	CO 3	T1:1.1.3 R2 : 1.2
2	Classification of data structures	CO 3	T1:1.1.3 R2 : 1.4
3	Operations on data Structures	CO 3	T1:1.2
4	Recursive algorithm, Performance Analysis	CO 1	T1:1.2 T1:5.1
5	Searching techniques: Linear search and binary search	CO 2, CO 6	T1:5.1
6	Searching techniques: Fibonacci search and comparison	CO 2, CO 6	T1:5.1
8	Sorting techniques: Bubble sort, selection sort and companding	CO 2 CO 6	R1:14.5

9	Sorting techniques: Insertion sort, Quick sort	CO 2, CO 6,	T1:5.2 R2 : 10.2
10	Merge sort ,comparison of sorting algorithms	CO 4, CO 6	T1:5.2 R2 : 10.2
13	Stacks: Primitive operations, implementation of stacks using Arrays	CO 3, CO 4	T1:7.1
14	Applications of stacks arithmetic expression conversion and evaluation	CO 4, CO 6	T1:7.2
16	Queues: Primitive operations; Implementation of queues using Array	CO 3, CO 4	T1:8.1
17	Applications of linear queue, circular queue	CO 3, CO 4	T1:8.4
18	Double ended queue (deque)l	CO 3, CO 4	R2 : 5.4
19	Linked lists: Introduction, singly linked list, representation of a linked list in memory	CO 3, CO 4	T1:9.1
20	Operations on a single linked list :creation, insertion and deletion	CO 3, CO 4	T1:9.2
21	Applications of linked lists	CO 4,	T1:9.3
22	Operations on a double linked lists :creation, insertion and deletion	CO 3, CO 4	T1:9.4
23	Operations on a double linked lists : deletion ,traversal.	CO 3, CO 4	T1:9.4
24	single linked list :polynomial expression	CO 3, CO 4	T1:9.3
25	single linked list :Sparse matrix manipulation.	CO 3, CO 4	T1:9.3
26	Operations on a Circular linked lists: creation, insertion and deletion	CO 3, CO 4	T1:9
30	Operations on a Circular linked lists: deletion, traversal	CO 3, CO 4	T1:9
31	Linked list representation and operations of Stack	CO 3, CO 4	T1:9.7
32	Linked list representation and operations of queue	CO 3, CO 4	T1:9.8
37	Trees: Basic concept, Tree terminology	CO 3	T1:13.1

CONTENT DELIVERY (THEORY)			
38	Binary tree :Binary Tree properties	CO 3, CO 4	T1:13.1
39	Binary tree representation using array	CO 3, CO 4	T1:13.2
40	Binary tree representation using linked list	CO 3, CO 4	T1:13.2
41	Binary tree traversal, binary tree variants	CO 3, CO 4	T1:13.2
42	Application of trees	CO 4	T1:13.2.3
44	Graphs: Basic concept, graph terminology	CO 3	R2 : 8.2
45	Types of graphs, Representation of graph	CO 3	R2 : 8.2
46	Graph traversals :DFS and BFS, Application of graphs	CO 3	T2:6.2
48	Minimum Spanning Trees-Prims and Kruskal algorithms	CO 4	T1:6.1 T2:5.6
50	Binary search trees, properties	CO 3	T1:13.2.3
51	Binary search trees operations	CO 3	T1:13.2.3
52	AVL trees	CO 3	T1:14.3
53	M- Way search trees, B trees	CO 3	T1:14.3
54	Hashing, Collision	CO 5	R2 : 6.4
7	Problems on linear search, binary search and Fibonacci search.	CO 2	T1:5.1
11	Problems on bubble sort, selection and insertion sort	CO 3, CO 4	T1:5.2 R2 : 10.2
12	Problems on quick and merge sort	CO 3, CO 4	T1:5.2 R2 : 10.2
15	Problems on Arithmetic expression conversion and evaluation	CO 3, CO 4	T1:7.2
27	Problems on single linked list to add, delete element	CO 3, CO 4	T1:9.8
28	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.8
33	Problems on circular linked list to add, delete element	CO 3, CO 4	T1:9.4
34	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.3
35	Problems on stack using linked list	CO 3, CO 4	T1:9.7
36	Problems on queue using linked list	CO 3, CO 4	T1:9.8
43	Problems on Binary tree :creation ,insertion and deletion of a node	CO 3, CO 4	T1:13.2
47	Problems on Graph Traversal: DFS and BFS	CO 3, CO 4	T2:6.2

49	Problems on MST: Prim's and Kruskal's	CO 3, CO 4	T1:6.1 T2:5.6
55	Problems on Binary search tree	CO 4	T1:14.3
56	Problems oh hashing	CO 5	R2 : 6.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Definitions on Data Structures, searching and sorting	CO 1,CO2,CO 3	T1:1 R1:14
58	Definitions on Linear Data Structures	CO 3	T1:7,.T1:8
59	Definitions on Linked Lists	CO 3	T1:9
60	Definitions on Non Linear data Structures	CO 3	T1:7.5
61	Definitions on Binary Trees and Hashing	CO 3 CO 5	T1:14
DISCUSSION ON QUESTION BANK			
62	Module I	CO 1, CO2,CO6	T1:1 R1:14
63	Module II	CO 3,CO 4,CO 6	T1:9
64	Module III	CO 3,CO 4,CO 6	T1:2.5
65	Module IV	CO 3,CO 4,CO 6	T1: 4.1
66	Module V	CO 3,CO 5,CO 6	T1: 5.1

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr. B Padmaja, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**OPERATING SYSTEMS**				
Course Code	ACSC12				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms. S Aswani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC04	II	Programming for Problem Solving using C
B.Tech	ACSC07	III	Computer Organization and Architecture

II COURSE OVERVIEW:

This course emphasizes on basic knowledge of various types of operating systems, effective resource utilization by using systems and applications software. It is designed to provide in-depth critique on the problems of resource management, scheduling, concurrency, synchronization, memory management, file management, protection and security of used system. Learned knowledge will be implemented in design and development of hybrid operating systems, command control systems, and in real time environments.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Operating Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
45 %	Understand
18 %	Apply
27 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

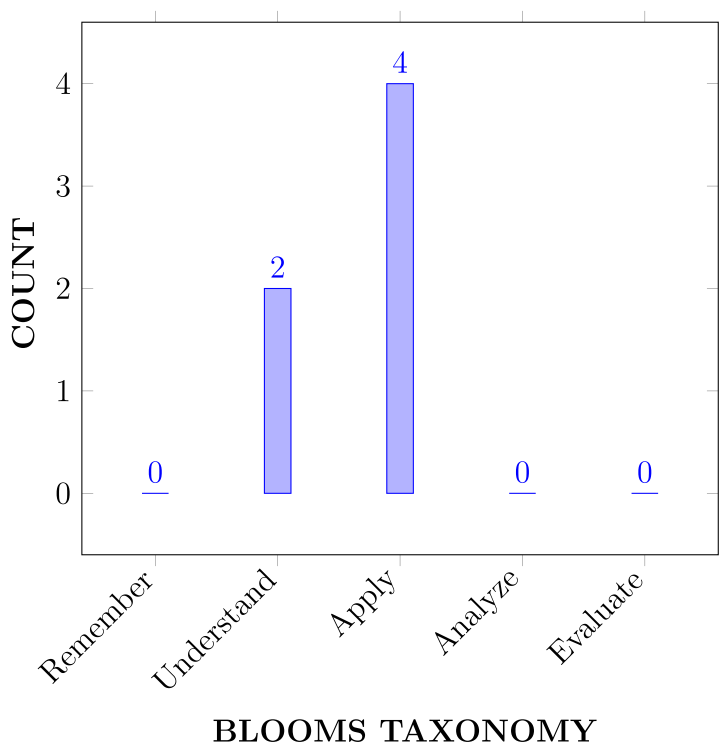
I	The principles of operating systems, services and functionalities with its evolution.
II	The structures, functions and components of modern operating systems
III	The conventional hardware at different OS abstraction levels.
IV	The essential skills to examine issues and methods employed in design of operating systems with identification of various functionalities.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** different architectures used in design of modern operating systems.	Understand
CO 2	**Solve** problems related to process scheduling, synchronization and deadlock handling in uni and multi-processing systems.	Apply
CO 3	**Choose** memory allocation algorithms for effective utilization of resources.	Apply
CO 4	**Select** various page replacement algorithms applied for allocation of frames.	Apply
CO 5	**Make use of** different file allocation and disk scheduling algorithms applied for efficient utilization of storage.	Apply
CO 6	**Outline** mechanisms used in protection of resources in real time environment	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE / CIE / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE / CIE / AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	2	SEE/AAT
PSO 2	Focus on improving software reliability, network security / information retrieval systems.	3	SEE/AAT
PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	3	SEE/AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	✓	✓	-	✓
CO 2	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	-
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand the structure and evolution of operating system by understanding fundamentals of Computer engineering specialization and mathematical and scientific principles.	3
	PO 10	Communicate effectively on evolution of operating systems including deep subject knowledge.	1
	PO 12	By understanding different operating system architectures, one can personally continue understanding of different operating systems developed by the companies to stay up with new technology and for personal development.	2
	PSO 1	Identify the need, key issues and applications of the operating system in various real time environments.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 3	By understanding different operating system architectures, one can acquire knowledge on advanced operating systems for engineering practice and higher education and even can extend the knowledge to become an entrepreneur.	2
CO 2	PO 1	Understand the concept of Process, process scheduling, issues and their solutions related to process synchronization by using mathematical principles, fundamental of Computer engineering specialization and scientific principles.	3
	PO 2	Identify synchronization problem and understand the problem statement of classical synchronization problems collect the data needed for solving the problem then analyze different models of solutions for classical synchronization problems by semaphores and monitors and interpret the solutions	6
	PO 3	Define the process synchronization problem, understand the user needs then identify the resources required next manage the design process using banker's algorithm and evaluate outcomes.	4
	PO 4	By having the knowledge of characteristics of process and understanding the context in classical synchronization problems and the solutions provided using the technical constructs like semaphores and monitors with their working strategies, these can be applied for understanding of other synchronization problems.	5
	PO 10	Communicate effectively on process communication using process communication techniques and explaining each technique.	2
	PO 12	By understanding process management, one can personally continue understanding internal functioning of operating systems developed by the companies to stay up with new technology and for personal development.	2
	PSO 1	Identify the need for process scheduling and apply appropriate algorithms for scheduling of process arriving at various time intervals.	4
	PSO 2	By acquiring knowledge of process management one can design software applications with reliability and applications with fast information retrieval.	2
CO 3	PO 1	Describe the need and various techniques for memory management by understanding the limits of contiguous memory allocation through applying mathematical principles, fundamental of Computer engineering specialization and scientific principles	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Identify problem of memory management and understand the problem statement of contiguous memory management then analyze different models of non-contiguous memory management.	3
	PO 3	Define the problem related to contiguous memory management, understand the user needs then identify the memory requirements of each process next manage the design process by using non-contiguous memory management techniques and evaluate outcomes.	4
	PO 10	Communicate effectively on memory management techniques with clarity on contiguous and varied strategies and explaining each technique with appropriate terminology.	2
'	PSO 1	Identify the need of efficient utilization of main memory and apply various contiguous and non-contiguous memory allocation techniques of memory management.	4
CO 4	PO 1	Understand the concept of virtual memory and various algorithms for effective usage of memory by applying the knowledge of computer engineering fundamentals, mathematical and scientific principles.	3
	PO 2	Identify the need for page replacement, understand the problem statement of allocation of pages to frames, then collect the data related to available pages and frames then analyze various models for solving problem based on the given sequence of pages and interpret their results accordingly.	6
	PO 3	Define the problem of mapping of large virtual memory to the existing physical memory, understand the user needs then manage the design process using page replacement algorithms and evaluate outcomes by identifying the number of page faults incurred.	4
	PO 4	By understanding characteristics of process, understanding the context in virtual memory management using demand paging and segmentation, this knowledge can be applied for virtualizing engineering process.	4
	PO 10	Communicate on utilization of main memory using pictorial representation of demand paging and segmentation and explaining them in detail.	2
	PSO 1	Identify the need of separation of logical memory from physical memory and apply appropriate algorithms for allocating given sequence of pages to frames.	4
CO 5	PO 1	Understand the concept of file system and analyze various file allocation methods by using the knowledge of computer engineering fundamentals, mathematical and scientific principles.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Identify the need for disk scheduling, understand the problem statement of disk scheduling, then collect the data related to location of data to be accessed in the disk structure then analyze different scheduling algorithm models used for solving problems related to finding total head movements and interpret their results.	6
	PO 3	Define the problem of file allocation to disk block, understand the user needs then identify the free disk space available next manage the design process by using appropriate file allocation methods.	4
	PO 10	Communicate on effective utilization of mass storage structures clearly using pictorial representation of disk structure.	2
	PO 12	By understanding mass storage structure, one can personally continue understanding of different storage devices developed by the companies to stay up with new technology.	2
	PSO 1	Identify the need of scheduling the service of disk I/O requests and apply appropriate algorithms for processing I/O requests.	4
CO 6	PO 1	Explain the importance of protection of objects and the protection provided for them by using domain concept in terms of access matrix implementation by applying knowledge of computer science fundamentals.	1
	PO 10	Communicate on protection of computer system components using protection strategies in detail.	1
	PO 12	By understanding the concept of protection, one can study and analyze various protection mechanisms developed recently for personal development.	2
	PSO 1	Identify the need of protection provided to the hardware and software components of the computer system and analyze the techniques provided for their protection.	1
	PSO 2	By acquiring knowledge of protection one can design software applications with high security and reliability.	1
	PSO 3	By understanding the concept of protection, one can acquire knowledge on advanced protection mechanisms for engineering practice and higher education and even can extend the knowledge to become an entrepreneur.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	2	1	-	2
CO 2	3	6	4	5	-	-	-	-	-	2	-	2	4	2	-
CO 3	3	3	4	-	-	-	-	-	-	2	-	-	4	-	-
CO 4	3	6	4	4	-	-	-	-	-	2	-	-	4	-	-
CO 5	3	6	4	-	-	-	-	-	-	2	-	2	4	-	-
CO 6	1	-	-	-	-	-	-	-	-	1	-	2	1	1	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	20	-	25	17		100
CO 2	100	60	40	45	-	-	-	-	-	40	-	25	67	100	-
CO 3	100	30	40	-	-	-	-	-	-	40	-	-	67	-	-
CO 4	100	60	40	36	-	-	-	-	-	40	-	-	67	-	-
CO 5	100	60	40	-	-	-	-	-	-	40	-	25	67	-	-
CO 6	33	-	-	-	-	-	-	-	-	20	-	25	17	50	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	1	1	-	3
CO 2	3	3	2	2	-	-	-	-	-	2	-	1	3	3	-
CO 3	3	1	2	-	-	-	-	-	-	2	-	-	3	-	-
CO 4	3	3	2	2	-	-	-	-	-	2	-	-	3	-	-
CO 5	3	3	2	-	-	-	-	-	-	2	-	1	3	-	-
CO 6	1	-	-	-	-	-	-	-	-	1	-	1	1	2	3
TOTAL	16	10	8	4	-	-	-	-	-	10	-	4	14	5	6
AVERAGE	2.7	2.5	2	2	-	-	-	-	-	1.7	-	1	2.3	2.5	3

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Operating systems objectives and functions: Computer system architecture, operating systems structure, operating systems operations; Evolution of operating systems: Simple batch, multi programmed, time shared, personal computer, parallel distributed systems, real time systems, special purpose systems, operating system services, user operating systems interface; Systems calls: Types of systems calls, system programs, protection and security, operating system design and implementation, operating systems structure, virtual machines.
MODULE II	**PROCESS AND CPU SCHEDULING, PROCESS COORDINATION**
	Process concepts: The process, process state, process control block, threads; Process scheduling: Scheduling queues, schedulers, context switch, preemptive scheduling, dispatcher, scheduling criteria, scheduling algorithms, multiple processor scheduling; Real time scheduling; Thread scheduling; Case studies Linux windows; Process synchronization, the critical section problem; Peterson‘s solution, synchronization hardware, semaphores and classic problems of synchronization, monitors.
MODULE III	**MEMORY MANAGEMENT AND VIRTUAL MEMORY**
	Logical and physical address space: Swapping, contiguous memory allocation, paging, structure of page table. Segmentation: Segmentation with paging, virtual memory, demand paging; Performance of demand paging: Page replacement, page replacement algorithms, allocation of frames, thrashing
MODULE IV	**FILE SYSTEM INTERFACE, MASS-STORAGE STRUCTURE**
	The concept of a file, access methods, directory structure, file system mounting, file sharing, protection, file system structure, file system implementation, allocation methods, free space management, directory implementation, efficiency and performance; Overview of mass storage structure: Disk structure, disk attachment, disk scheduling, disk management, swap space management; Dynamic memory allocation: Basic concepts; Library functions.

MODULE V	DEADLOCKS, PROTECTION
	System model: Deadlock characterization, methods of handling deadlocks, deadlock prevention, dead lock avoidance, dead lock detection and recovery form deadlock system protection, goals of protection, principles of protection, domain of protection, access matrix, implementation of access matrix, access control, revocation of access rights, capability based systems, language based protection.

TEXTBOOKS

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, —Operating System Principles‖, Wiley Student Edition, 8th Edition, 2010.

2. . William Stallings, —Operating System- Internals and Design Principles‖, Pearson Education, 6th Edition, 2002.

REFERENCE BOOKS:

1. Andrew S Tanenbaum, —Modern Operating Systems‖, PHI, 3rd Edition, 2007.

2. D. M. Dhamdhere, —Operating Systems a Concept based Approach, Tata McGraw-Hill, 2nd Edition, 2006.

WEB REFERENCES:

1. www.smartzworld.com/notes/operatingsystems

2. www.scoopworld.in

3. www.sxecw.edu.in

4. www.technofest2u.blogspot.com

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
	CONTENT DELIVERY (THEORY)		
2	Computer system architecture, operating systems structure	CO 1	T1:1.1-1.4
3	operating systems operations	CO 1	T1:1.5
4	Evolution of operating systems: Simple batch, multi programmed, time shared, personal computer	CO 1	T2:2.2
5	parallel distributed systems, real time systems, special purpose systems,	CO 1	T2:2.2
6	operating system services, user operating systems interface	CO 1	T2:2.1-2.2

7	Systems calls: Types of systems calls, system programs	CO 1	T2:2.3-2.5
8	protection and security, operating system design and implementation	CO 1	T1:2.6
9	operating systems structure, virtual machines.	CO 1	T1:2.7-2.8
10	Process concepts: The process, process state	CO 2	T1:3.1-3.2
11	process control block, threads;	CO 2	T1:3.2-3.4
12	Process scheduling: Scheduling queues, schedulers, context switch	CO 2	T1:5.2
13	preemptive scheduling, dispatcher, scheduling criteria	CO 2	T1:5.3
14	scheduling algorithms	CO 2	T1:5.3
15	multiple processor scheduling	CO 2	T1:5.3
17	Real time scheduling; Thread scheduling;	CO 2	T1:5.4-5.5
18	Case studies Linux windows	CO 2	T1:5.6, 21.4
19	Process synchronization, the critical section problem	CO 2	T1:6.1
20	Peterson‘s solution	CO 2	T1:6.2-6.3
21	synchronization hardware	CO 2	T1:6.4
22	semaphores	CO 2	T1:6.5
23	classic problems of synchronization, monitors.	CO 2	T1:6.6-6.7
24	Logical and physical address space: Swapping, contiguous memory allocation	CO 3	T1:8.1
26	paging, structure of page table	CO 3	T1:8.2
27	Segmentation: Segmentation with paging	CO 3	T1:8.3
29	virtual memory, demand paging	CO 3	T1:8.4-8.5
30	Performance of demand paging	CO 3	T1:8.6
31	Page replacement, page replacement algorithms,	CO 4	T1:8.6
33	allocation of frames	CO 4	T1:9.5
34	Thrashing	CO 4	T1:9.6
35	The concept of a file, access methods	CO 4	T1:10.1-10.2
36	directory structure	CO 4	T1:10.3
37	file system mounting	CO 4	T1:10.5
38	file sharing, protection	CO 4	T1:10.6
39	file system structure	CO 4	T1:10.6
40	file system implementation	CO 4	T1:11.3
41	allocation methods	CO 4	T1:11.4
43	free space management	CO 4	T1:11.5
44	directory implementation, efficiency and performance	CO 4	T1:11.6

45	Overview of mass storage structure: Disk structure, disk attachment	CO 5	T1:12.1-12.3
46	disk scheduling, disk management, swap space management	CO 5	T1:12.4-12.6
48	Dynamic memory allocation: Basic concepts; Library functions.	CO 5	T1:12.7-12.8
49	System model: Deadlock characterization, methods of handling deadlocks	CO 2	T1:7.1-7.2
50	deadlock prevention	CO 2	T1:8.1
51	deadlock avoidance	CO 2	T1:8.2
52	dead lock detection and recovery form deadlock system protection	CO 2	T1:8.3
55	goals of protection, principles of protection, domain of protection	CO 6	T2:27.8
56	access matrix, implementation of access matrix, access control, revocation of access rights	CO 6	T2:27.9
57	capability based systems, language based protection	CO 6	T1:8.2-8.3
PROBLEM SOLVING/ CASE STUDIES			
16	Problems on CPU scheduling algorithms	CO 2	T1:5.3-5.3
25	Problems on contiguous memory allocation	CO 3	T1:8.1-8.3
28	Problems on paging and segmentation	CO 3	T1:8.4-8.6 T1:9.1-9.2
32	Problems on page replacement algorithms	CO 4	T1:9.4-9.6
42	Problems on file allocation methods	CO 5	T1:11.3-11.6
47	Problems on disk scheduling	CO 5	T1:12.1-12.6
53	Problems on deadlock avoidance	CO 2	T1:8.1-8.3
54	Problems on recovery from deadlocks	CO 2	T1:8.1-8.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	Definitions on operating systems fundamentals	CO 1	T1:1.2
59	Definitions on process, CPU scheduling and process coordination	CO 2	T1:1.5
60	Definitions on memory management and virtual memory	CO 3, CO 4	T1:8,9
61	Definitions on file system interface and mass storage structure	CO 5	T1:10,11
62	Definitions on deadlocks and protection	CO 2, CO 6	T1:9.1

DISCUSSION OF QUESTION BANK			
1	Introduction	CO 1	T1:1.2
2	Process and CPU Scheduling, Process Coordination	CO 2	T1:1.5
3	Memory Management and Virtual Memory	CO 3,4	T1:8,9
4	File System Interface, Mass Storage Structure	CO 5	T1:10,11
5	Deadlocks, Protection	CO 2,6	T1: 9.1

Signature of Course Coordinator **HOD, CSE (AI & ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">COMPUTER SCIENCE AND ENGINEERING (AI & ML)</td></tr>
<tr><td>Course Title</td><td colspan="5">COMPUTER ORGANIZATION AND ARCHITECTURE</td></tr>
<tr><td>Course Code</td><td colspan="5">ACS004</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>1</td><td>4</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. P Chandana, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSOO4	II	PROGRAMING FOR PROBLEM SOLVING

II COURSE OVERVIEW:

This course introduces the principles of basic computer organization, CPU organization, and the basic architecture concepts. The course emphasizes performance and cost analysis, instruction set design, register transfer languages, arithmetic, logic and shift micro-operations, pipelining, memory technology, memory hierarchy, virtual memory management, and I/O organization of computer, parallel processing and inter process communication and synchronization.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Organization and Architecture	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

<table>
<tr><td>✓</td><td>Power Point Presentations</td><td>✓</td><td>Chalk & Talk</td><td>✓</td><td>Assignments</td><td>x</td><td>MOOC</td></tr>
<tr><td>x</td><td>Open Ended Experiments</td><td>✓</td><td>Seminars</td><td>x</td><td>Mini Project</td><td>✓</td><td>Videos</td></tr>
<tr><td>x</td><td colspan="7">Others</td></tr>
</table>

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
45 %	Understand
18 %	Apply
27 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

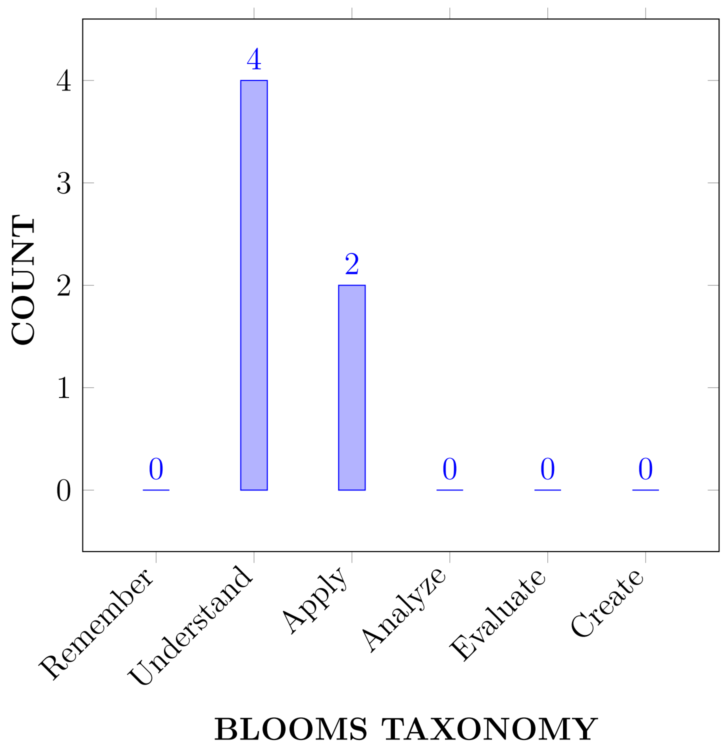
I	Understand the organization and architecture of computer systems and electronic computers.
II	Study the assembly language program execution, instruction format and instruction cycle.
III	Design a simple computer using hardwired and micro-programmed control methods.
IV	Study the basic components of computer systems besides the computer arithmetic .
V	Understand input-output organization, memory organization and management, and pipelining.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** interaction of components in a computer system with functional units and levels of programming languages.	Understand
CO 2	**Demonstrate** the implementation of micro-operations with the help of register transfer language and electronic circuits.	Understand
CO 3	**Identify** appropriate addressing modes for specifying the location of an operand.	Apply
CO 4	**Make use of** number system for data representation and binary arithmetic in digital computers.	Apply
CO 5	**Interpret** the design of hardwired and micro-programmed control unit for execution of micro programs.	Understand
CO 6	**Summarize** the concepts of pipelining and interprocess communication for advanced processor design.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE / CIE / AAT
PO 4	**Conduct investigations of complex problems:**Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE / CIE / AAT
PO 5	**Modern tool usage:**Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineeringactivities with an understanding of the limitations.	3	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	SEE / CIE / AAT
PO 12	**Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	CIE/Quiz/ AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	-	-		✓	✓	-
CO 2	✓	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	-	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 5	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	✓
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	✓	✓	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Explain the various functional units of Computer with computer science principles.	1
	PO 2	Explore the types of programming languages for problem identification and to formulate computer science and Engineering Problems.	2
	PO 3	Evaluate the instruction set architecture based on the cost drivers, integration, manage design process and understand customer needs..	4
	PSO 1	Understand levels of programming languages related to Software.	1
	PSO 2	Develop micro programs using instruction set architecture with a major focus on improving software reliability and information retrieval systems.	1

CO 2	PO1	Explore taxonomy of microoperations and RTL for micro program development by using the mathematical and computer science principles.	2
	PSO 1	Understand the notations of RTL related to Software.	4
	PSO 2	Develop assembly language programs with a major focus on improving software reliability and information retrieval systems.	3
CO 3	PO 1	Select appropriate addressing mode for finding effective address of operand using mathematical and computer science principles	2
	PO 2	Choose appropriate addressing mode for information and data collected from various sources memory locations or registers and perform microoperations and validation the results for interpretation	1
	PO 3	Classify the addressing modes in terms of defining various problems and understanding appropriate codes of practice.	3
	PO 4	Utilize Instruction set architecture of processors for designing assembly language programs through laboratory skills and technical literature.	2
	PO 10	Make use of variety of addressing modes to fetch operands for the development of assembly language program with clarity and semantics or grammar of the assembly language.	2
	PSO 1	Develop applications for specific problems by including huge volume of data and related to Software.	1
CO 4	PO 1	Explain the concept of data representation by applying mathematical and computer science principles.	3
	PO 2	Understand the data representation and computer arithmetic for understanding of appropriate codes to formulate, solve problem, document and interpretation of results.	6
	PO 3	Identify the appropriate representation of data suitable for customer needs, investigation of a problem, identify and manage architecture design process.	4
	PO 4	Communicate effectively in orally and written by comprehend and write effective reports and design documentation with the engineering community by having major focus on clarity on content, Grammar/Punctuation, appropriate References, good Speaking style and depth in subject matter.	2
	PO 10	Recognize the need for advanced concepts in binary arithmetic and algorithms for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change	3
	PSO 1	Explain the technologies used to represent data and computer arithmetic related to Algorithms and architecture.	1

CO 5	PO 1	Design control unit by considering various issues and types risk assessment and analysis activity to identify and analyze root causes using computer science principles.	1
	PO 2	Design and develop hardwired and micro programmed control units with knowledge and uncertainty of commercial engineering process and management.	2
	PO 3	Design a control memory of system by investigating and defining various problems, understanding user needs.	3
	PO 4	Utilize micro instructions for designing assembly language programs through laboratory skills, technical literature, technical uncertainty and quality issues.	3
	PO 5	Experiment the design of control unit with Computer software or simulation packages.	2
	PO 10	Recognize the need for advanced concepts of control memory design and micro instructions based on micro architecture for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change.	4
	PSO 1	Explain the design issues of control memory and micro instruction format used to develop micro program related to Algorithms and architecture.	1
	PSO 3	Develop micro programs and support design of control memory by using modern computer software and simulation tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	1
CO 6	PO 1	Understand the concept of pipelining to improve performance of the system by applying mathematical principles and computer science methodologies.	2
	PO 10	Communicate in written form by comprehending and writing effective reports and design documentation advanced micro architectures with the engineering community by having major focus on clarity on content, Grammar/Punctuation, good Speaking style	2
	PO 12	Recognize the need for advanced concepts for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change.	4
	PSO 1	Develop MIMD architecture for optimizing the performance related to Algorithms, Software and Networking.	1
	PSO 3	Recognize importance of pipelining, inter process communication of advanced micro processors for creating innovative career paths, to be an entrepreneur and desire for higher studies.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	4	-	-	-	-	-	-	-	-	-	1	1	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO 3	2	2	1	3	-	-	-	-	-	2	-	2	1	-	-
CO 4	3	6	-	4	-	-	-	-	-	2	-	3	1	-	-
CO 5	1	2	3	3	-	-	-	-	-	2	-	4	1	-	1
CO 6	2	-	-	-	-	-	-	-	-	2	-	4	1	-	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.4	20	40	-	-	-	-	-	-	-	-	-	16.6	50	-
CO 2	66.6	-	-	-	-	-	-	-	-	-	-	-	16.6	100	-
CO 3	66.6	20	10	27.3	-	-	-	-	-	20	-	16.6	16.6	-	-
CO 4	100.0	60	-	36.4	-	-	-	-	-	20	-	25	16.6	-	-
CO 5	33.4	20	30	27.3	-	-	-	-	-	20	-	33.4	16.6	-	50
CO 6	66.6	-	-	-	-	-	-	-	-	20	-	33.4	66.7	-	50

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	2	-	-	-	-	-	-	-	-		1	-	3
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	1	-	3
CO 3	3	1	1	1	-	-	-	-	-	1	-	1	1	-	-
CO 4	3	3	-	1	-	-	-	-	-	1	-	1	3	-	-
CO 5	1	1	1	1	-	-	-	-	-	1	-	1	1	-	3
CO 6	3	-	-	-	-	-	-	-	-	1	-	1	1	-	3
TOTAL	14	6	4	3	-	-	-	-	-	4	-	4	8	-	12
AVERAGE	2.3	1.5	2.6	1	-	-	-	-	-	1	-	1	1.33	-	3

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Seminars	✓	Student Viva	-	Certification	-
Laboratory Practices	-	Student viva	-	Mini projects	-
Term Paper	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO COMPUTER ORGANIZATION**
	Basic computer organization, CPU organization, memory subsystem organization and interfacing, input or output subsystem organization and interfacing, a simple computer levels of programming languages, assembly language instructions, instruction set architecture design, a simple instruction set. .
MODULE II	**ORGANIZATION OF A COMPUTER**
	Register transfer: Register transfer language, register transfer, bus and memory transfers, arithmetic micro operations, logic micro-operations, shift micro-operations; Control unit: Control memory, address sequencing, micro program example, and design of control unit.
MODULE III	**CPU AND COMPUTER ARITHMETIC**
	CPU design: Instruction cycle, data representation, memory reference instructions, input-output, and interrupt, addressing modes, data transfer and manipulation, program control. Computer arithmetic: Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit.
MODULE IV	**INPUT-OUTPUT ORGANIZATION AND MEMORY ORGANIZATION**
	Memory organization: Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory; Input or output organization: Input or output Interface, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access.
MODULE V	**MULTIPROCESSORS**
	Pipeline: Parallel processing, pipelining-arithmetic pipeline, instruction pipeline; Multiprocessors: Characteristics of multiprocessors, inter connection structures, inter processor arbitration, inter processor communication and synchronization.

TEXTBOOKS

1. 1. M. Morris Mano, “Computer Systems Architecture”, Pearson, 3 rd Edition, 2015.
2. 2.John D. Carpinelli, “Computer Systems Organization and Architecture”, Pearson, 1 st Edition, 2001.
3. 3. Patterson, Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Morgan Kaufmann, 5 th Edition, 2013.

REFERENCE BOOKS:

1. 1. John. P. Hayes, “Computer System Architecture”, McGraw-Hill, 3 rd Edition, 1998.
2. 2. Carl Hamacher, Zvonko G Vranesic, Safwat G Zaky, “Computer Organization”, McGraw-Hill, 5 th Edition, 2002.
3. 3. William Stallings, “Computer Organization and Architecture”, Pearson Edition, 8 th Edition, 2010

WEB REFERENCES:

1. http://www.web.stanford.edu/class/cs103x

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details & course_id=528

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
OBE DISCUSSION			
1	In Outcome-Based Education (OBE), we discussed about course delivery assessment that are planned to achieve stated objectives and outcomes. We will focuses on measuring student performance i.e. outcomes at different levels. Course outcomes(CO),Program Outcomes(PO)and Program Specific Outcomes(PSO) and also mapping of CO’s to PO’s PSO’s and their attainments are discussed.		
CONTENT DELIVERY (THEORY)			
1-2	Outline the basic computer organization	CO1	T1: 4.1-4.2,T1: 4.1
2-3	Understand the CPU organization, memory subsystem organization and interfacing	CO 1	T1: 4.3-4.4
4-5	Analyze the input or output subsystem organization and interfacing	CO 1,CO6	T1: 3.1-3.2
5-6	Understand a simple computer levels of programming languages	CO 1	T2: 2.5-2.6,
7-8	Explain assembly language instructions	CO 2, CO 3	T1:1.5, 1.4.2,1.4.3
9	Determine the simple instruction set architecture	CO 2	T2: 7.4
10-11	Understand the register transfer language, register transfer.	CO 2	T2: 5.6-5.7
12	Analyze bus and memory transfers	CO 2	T1: 6.7-6.8
13-15	Explain the arithmetic micro-operations, logic micro-operations, shift micro-operations	CO 2	T2: 8.5-8.7
16	Understand the control memory	CO 5	T2: 8.6
17-18	Explain the instruction cycle	CO 2	T2: 10.1-10.5
19-20	Outline the data representation, memory reference instructions	CO 3	T2: 12.1
20-21	Analyze input-output, and interrupt, addressing modes	CO 3	T2: 11.2

22	Discuss the data transfer and manipulation, program control	CO 3	T2: 11.3-11.4
23-25	Determine the Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit	CO 4	T2: 11.5
26	Need of Input or output organization	CO5	R1: .3.1
27-29	Discuss the Input or output Interface	CO5	R1: 3.3-9.5
30-31	Understand the asynchronous data transfer, modes of transfer	CO5	T2: 9.4
32-33	Analyze the priority interrupt, direct memory access	CO5	T2:13.1
34	Understand the memory organization	CO5	T2:13.2
35-36	Discuss Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory	CO 5	T2: 13.3
37-38	Understand the Pipeline: Parallel processing, Instruction pipeline	CO6	T2: 13.
39	Characteristics of multiprocessors	CO6	T2: 13.1
40	Inter connection structures	CO6	T2: 13.2
41	Inter processor arbitration	CO 3,CO6	T2: 13.3
42	Inter processor communication and synchronization	CO 6	T2: 13.4
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on BCD conversions	CO1	T2:2.1
2	Problems on BCD conversions	CO1	T2:2.3
3	Problems on Addition and substraction	CO3	T2:2.3.1
4	Problems on Multiplication	CO3	T2:7.2,7.3
5	Problems on Booths multiplication	CO3	T2:10.3.1
6	Problems on Booths Algorithm	CO3	T2:13.3.2, 13.4.1
7	Problems on Division	CO3	T2:17.1.1, 17.1.3
8	Problems on Data presentation	CO3	T2:18.3.4, 18.3.4.1
9	Problems on Data presentation	CO3	T2:22.12, 19.1.2
10	Problems on Data presentation	CO3	T2:18.4, 18.4.3
11	Problems on floating point arithmetic operations	CO3	T2:19.2, 18.4.4
12	Problems on Decimal arithmatic unit	CO3	T2:23.1.1, 23.1.3
DISCUSSION ON DEFINITION AND TERMINOLOGY			
1	Define register transfer language,fixed point number,instruction format,data Processing instruction,data Processing instruction	CO 1	T2:18.3.4, 18.3.4.1
2	Define miscellaneous Instructions, addressing mode,micro operation.	CO 2	T2:22.12, 19.1.2
3	Define arithmetic micro operations,arithmetic micro operations,logical shift operation	CO 3	T2:18.4, 18.4.3

4	Define data bus,metropolitan area network,network topology,star topology,bus tropology	CO4, CO 5	T2:19.2, 18.4.4
5	define vecto,pipeline cycle time, arithmetic pipeline,optimal number of pipeline stages	CO 6	T2:23.1.1, 23.1.3
DISCUSSION ON QUESTION BANK			
1	Illustrate the input and output operations with a neat diagram.	CO 1	T2:18.3.4, 18.3.4.1
2	List the various instruction formats and illustrate with an example.	CO 2	T2:22.12, 19.1.2
3	Identify micro programexample and build a computer hardware configuration	CO3,CO4	T2:18.4, 18.4.3
4	Illustrate the belowaddressing modes withexamples a. Implied Modeb. Immediate Mode c. Autoincrement and Auto,decrement Mode d. Direct and Indirect Address Mode.	CO5	T2:19.2, 18.4.4
5	Define parallel processing and explain the flynn's classification of computer with suitable diagram	CO 6	T2:23.1.1, 23.1.3

Course Coordinator **HOD,CSE (AI & ML)**
Dr. P Chandana, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Course Title	**PROBABILISTIC MODELLING AND REASONING**				
Course Code	ACAC01				
Program	B.Tech				
Semester	III	AI & ML			
Course Type	Foundation				
Regulation	UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr Ch. Chaitanya, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC08	II	Probability and Statistics
B.Tech	AHSC02	I	Linear Algebra and Calculus

II COURSE OVERVIEW:

The aim of the course is to provide a firm grounding in probabilistic modelling and reasoning along with dimensionality reduction techniques, and to give a basis which will allow students to go on to develop their interests in more specific areas, such as data-intensive linguistics, automatic speech recognition, probabilistic expert systems, optimization of information etc. This course provides a study of probabilistic modelling, inference and learning in a logic-based setting. Principal component analysis and Gaussian approach are most commonly used unsupervised machine learning algorithms across a variety of applications: exploratory data analysis, dimensionality reduction, information compression, data de-noising etc. The Maximum likelihood estimation framework can be used as a basis for estimating the parameters of many different machine learning models. Bayes Theorem is a useful tool in applied machine learning. It provides a way of thinking about the relationship between data and a model.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Fluid Dynamics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
30 %	Understand
60 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

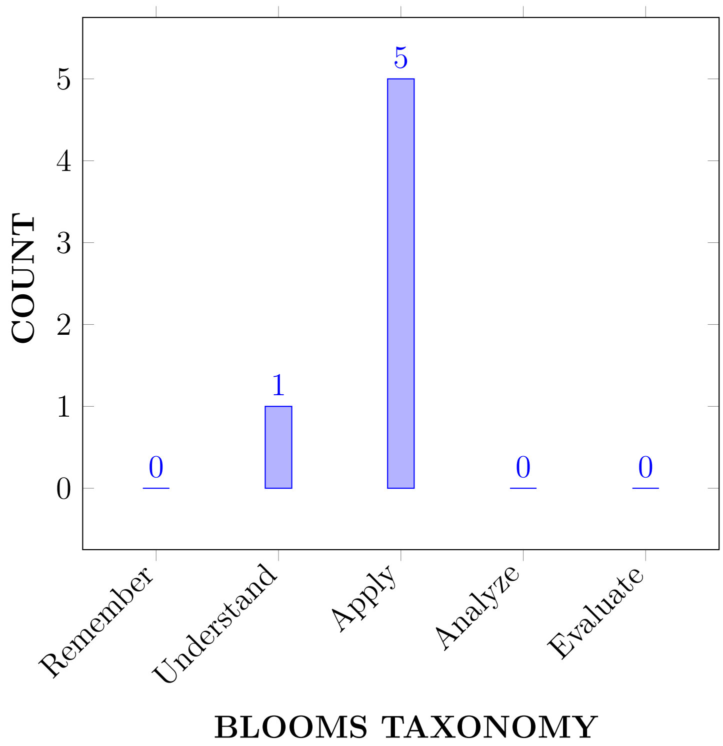
I	The Matrix decomposition mathematics and principal component analysis.
II	The Gaussian approach of dimensionality reduction of unsupervised data sets with the aids of probability distribution parameters.
III	The estimation statistics and decision-making techniques, algorithms which plays vital role in data mining.
IV	The Bayesian process of inference in probabilistic reasoning system.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Calculate** the singular value decomposition of a given matrix and principal components of a given covariance data matrix for reducing the dimensions.	Apply
CO 2	**Apply** moments, mean, variance, skewness and kurtosis of Gaussian distributions in the geometrical analysis of a data set which follows Gaussian distributions.	Apply
CO 3	**Make use of** decision theory and estimation statistics,EM algorithm in finding maximum likelihood parameters of a statistical model.	Apply
CO 4	**Interpret** the role of the log likelihood function and maximum likely hood estimate in determining the eatimates of Binomial, Poisson,Normal distribution parameters.	Under-stand
CO 5	**Make use of** Cramer-Rao Lower Bound in calculating minimum variance unbiased estimator.	Apply
CO 6	**Apply** Bayesian laws, methods and entropies in solving the inference problems and optimizing the information.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE,CIE, Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE ,CIE, AAT/QUIZ
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	SEE, CIE,Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	SEE, CIE, Quiz/AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	✓	-	-	-	-	-	-	-	-	-	✓	-
CO 2	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Calculate** the singular value decomposition of a given matrix for making decisions in complex engineering problems modelled by matrices by using **principles of mathematics and scientific methods**.	2
	PO 4	**Calculate** the singular value decomposition of a given matrix for the sake of Dimensionality reduction of the large amount of **technically uncertain** data sets with the help of **principal component modelling** and analysis and **matrix oriented quantitative calculations** along with the support of **necessary technical literature** in a **systematic approach**.	5
	PSO 2	**Calculate** the singular value decomposition of a given matrix by using eigenvalues and eigen vectors in the data mining problems involving **supervised, unsupervised learning** of the data sets and hence reducing the dimensions in AI problems.	2
CO 2	PO 1	**Apply** the mean and variance of Gaussian distribution in solving complex engineering problems under probabilistic conditions requiring reducing the dimensionality of a data set with the aid of **principles of mathematics and scientific methods**.	2
	PO 4	**Apply** the Gaussian distribution approach to **model and analyze** the **technical uncertainty** involved in the dimensionality reduction of data sets with the aids of **statistical quantitative measurements**along with the support of **necessary technical literature** in a **systematic approach**.	5
CO 3	PO 1	**Explain** the role of principal component analysis in solving complex engineering problems requiring dimensionality reduction by using **principles of mathematics and scientific methods**.	2

	PO 4	**Apply** EM algorithm in finding maximum likelihood parameters of a **technically uncertain statistical model** triggered in the process of reduction of dimensionality of large amounts of unsupervised data sets along with the support of **necessary technical literature** in a **systematic** and **quantitative** approach .	5
	PO 5	**Make Use of Python software package** in implementing the EM algorithm and hence analyze its role in finding maximum likelihood parameters of a statistical model in computer software relevant applications.	1
	PSO 2	**Explain** the role of principal component analysis in exploring **supervised, unsupervised learning** and hence reducing the dimensions in AI problems.	2
CO 4	PO 1	**Interpret** the maximum likely hood estimate of Binomial, Poisson distributions by using **principles of mathematics and scientific methods** in making decisions over statistical claims that arise in complex engineering problems which requires sampling inspections.	2
CO 5	PO 1	**Make use of** Cramer-Rao Lower Bound in calculating minimum variance unbiased estimator for complex engineering problem which requires dimensionality reduction of data sets with the support of **principles of mathematics and scientific methods**.	2
	PO 4	**Make use of** Cramer-Rao Lower Bound in **modelling**, analyzing the dimensionality reduction problems **modelled** by **technical uncertainity** and calculating minimum variance unbiased estimator with the help of **logarithmic and probability oriented quantitative measurements** along with the support of **necessary technical literature**in a **systematic approach**.	5
CO 6	PO 1	**Apply** Bayesian laws, methods and approach while handling complex engineering problems which involves inspection of large amount of unsupervised data with the help of **principles of mathematics and scientific methods**.	2
	PO 4	**Apply** Bayesian laws, methods and approach in **modelling**, analyzing the dimensionality reduction problems governed by **technical uncertainity**and finding the solution with the aids of **probabilistic oriented quantitative assessments**along with the support of **necessary technical literature** in a **systematic approach**.	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE	POS/ No. of Key Competencies Matched												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	1	2	2
CO 1	2	-	-	5	-	-	-	-	-	-	-	-	-	1	-
CO 2	2	-	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	5	1	-	-	-	-	-	-	-	-	1	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-		-
CO 5	2	-	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	5	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE	PROGRAM OUTCOMES												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	67	-	-	45	-	-	-	-	-	-	-	-	-	50	-
CO 2	67	-	-	45	-	-	-	-	-	-	-	-	-	-	-
CO 3	67	-	-	45	100	-	-	-	-	-	-	-	-	50	-
CO 4	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	67	-	-	45	-	-	-	-	-	-	-	-	-	-	-
CO 6	67	-	-	45	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5\% < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE	PROGRAM OUTCOMES												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO 2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	2	3	-	-	-	-	-	-	-	-	2	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	-	-	10	3		-	-	-	-	-	-	-	4	-

AVERAGE	3	-	-	2	3	-	-	-	-	-	-	-	-	2	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams		SEE Exams		Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 4	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**MATRIX DECOMPOSITION ALGORITHMS-DIMENSIONS REDUCTION**
	Principal Component Analysis- Population Principal Components, sample principal coefficients, covariance matrix of data set, Dimensionality reduction, Singular value decomposition, Gram Schmidt process
MODULE II	**CONTINUOUS DISTRIBUTIONS AND GAUSSIAN MODELS**
	Continuous distributions: normal distribution-MGF, cumulant generating function, skewness, kurtosis, exponential distribution-memory less property, Gaussian distribution.
MODULE III	**DECISION THEORY**
	Decision functions, basic concepts, the loss function, minimax, expected utility principle, point estimation and interval estimation, the Neyman-Pearson lemma as a decision theoretic result, mixture models the EM algorithm.
MODULE IV	**MAXIMUM LIKELIHOOD PARAMETER ESTIMATION**
	Maximum likelihood estimate - log-likelihood function-Binomial, Poisson, Cramer-Rao Lower Bound and applications, minimum variance unbiased estimator
MODULE V	**BAYESIAN METHODS FOR INFERENCE AND INFORMATION THEORY**
	Deriving the likelihood function, Bayes' rule, Statistical tests and Bayesian model comparison, Bit, Surprisal, Entropy, Source coding theorem, Joint entropy, Conditional entropy, Kullback-Leibler divergence.

TEXTBOOKS

1. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics", S. Chand and Co., 12th Edition, 2016.
2. Giovanni Parmigiani, Lurdes Inou, "Decision Theory Principles and Approaches", Wiley Publication, 2009.
3. I.T. Jolliffe, "Principal Component Analysis", Second Edition, springer publications,2002.

REFERENCE BOOKS:

1. Richard Arnold Johnson, Irwin Miller, John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.

2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	TOPICS	CO's	Reference
DISCUSSION ON OBE			
1	Outcome based education: what is Outcome based education,what are POs,PSOs,PEOs and COs ,discussion of COs of the course PMR, The Evaluation and attainment process in brief.		
CONTENT DELIVERY (THEORY)			
2	Introduction on Principal Component Analysis	CO 1	T3:26.3
3	Population Principal Components	CO 1	T3:21.48
4	sample principal coefficients	CO 1	T3:21.48
5	covariance matrix of data set	CO 1	T3:26.6, R2:21.50
6	Dimensionality reduction	CO 1	T3:26.6, R2:21.50
7	Singular value decomposition	CO 1	T3:26.7, R2:21.51
8	Singular value decomposition.	CO 1	T3:26.7, R2:21.51
9	Gram Schmidt process	CO 1	T3:26.7, R2:21.51
11	normal distribution-MGF, Gaussian distribution.	CO 2	T1:26.10
12	cumulant generating function, skewness, kurtosis	CO 2	T1:26.14, R2:21.55
13	exponential distribution-memory less property	CO 2	T1:26.16, R2:21.61
14	Decision functions, basic concepts	CO 3	T2:25.12
15	the loss function, minimax, expected utility principle	CO 3	T2:25.16
16	the Neyman-Pearson lemma as a decision theoretic result	CO 3	T2:25.14
17	point estimation and interval estimation	CO 3	T2:21.14
18	mixture models the EM algorithm.	CO 3	T2:21.33
19	Maximum likelihood estimate	CO 4	T1:27.2, R2:21.64
20	log-likelihood function-Binomial	CO 4	T1:27.2
21	log-likelihood function-Poisson	CO 4	T1:27.2
22	Cramer-Rao Lower Bound and applications.	CO 4	T1:27.2
23	minimum variance unbiased estimator	CO 4	T1:27.3, R2:21.71

24	Deriving the likelihood function	CO 4	T1:27.12, R2:21.75
25	Bayes' rule	CO 5	T1:27.8, R2:21.72
26	Applications of Bayes' rule	CO 5	T1:27.8, R2:21.73
27	Statistical tests and Bayesian model comparison	CO 5	T1:27.14, R2:21.78
28	Bit, Surprisal	CO 5	R1:27.19, T2:21.80
29	Entropy	CO 5	R1:27.19, T2:21.80
30	Joint entropy	CO 5	R1:27.19, T2:21.80
31	Conditional entropy	CO 5	R1:27.19, T2:21.81
32	Applications of entropy	CO 5	R1:27.19, T2:21.81
33	Source coding theorem	CO 5	R1:27.12, T2:21.82
34	Kullback-Leibler distance	CO 5	R1:27.12, T2:21.82
35	Applications of entropy	CO 5	R1:27.19, T2:21.81
36	Source coding theorem	CO 5	R1:27.12, T2:21.82
37	Kullback-Leibler divergence-I	CO 6	R1:27.12, T2:21.82
38	Kullback-Leibler divergence-II	CO 6	R1:27.12, T2:21.82
39	Types of entropy	CO 6	R1:27.19, T2:21.81
40	Applications of Source coding theorem	CO 6	R1:27.12, T2:21.82
41	Applicatoions of Kullback-Leibler divergence	CO 6	R1:27.12, T2:21.82
PROBLEM SOLVING/ CASE STUDIES			
42	Problem solving session on covariance matrix of data set	CO 1	T3:26.3
43	Problem solving session on singular value decomposition	CO 1	T3:21.48
44	Problem solving session on dimensionality reduction	CO 1	T3:21.48

45	Problem solving session on Gaussian distribution	CO 2	T3:26.6, R2:21.50
46	Problem solving session on exponential distribution	CO 2	T3:26.6, R2:21.50
47	Problem solving session on memory less property	CO 2	T3:26.7, R2:21.51
48	Problem solving session on minimax, expected utility principle	CO 3	T3:26.7, R2:21.51
49	Problem solving session on interval estimation	CO 3	T3:26.7, R2:21.51
50	Problem solving session on Neyman-Pearson lemma	CO 3	T3:26.8
51	Problem solving session on maximum likely hood estimation	CO 4	T1:26.10
52	Problem solving session on log likely hood estimation	CO 4	T1:26.14, R2:21.55
53	Problem solving session on CRLB	CO 5	T1:26.16, R2:21.61
54	Problem solving session on Baye's rules	CO 6	T2:25.12
55	Problem solving session on entropies	CO 6	T2:25.16
56	Problem solving session on Kullback-Leibler divergence	CO 6	T2:25.14
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Matrix decomposition algorithms-dimensions reduction	CO 1	T3,R2
58	Continuous distributions and Gaussian models	CO 2	T3,R2
59	Decision theory	CO 3	T3,R2
60	Maximum likelhood parameteer estimation	CO 4, CO 5	T3,R2
61	Bayesian methods of inference and information theory	CO 6	T3,R2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
62	Matrix decomposition algorithms-dimensions reduction	CO 1	T3,R2
63	Continuous distributions and Gaussian models	CO 2	T3,R2
64	Decision theory	CO 3	T3,R2
65	Maximum likelhood parameteer estimation	CO 4, CO 5	T3,R2
66	Bayesian methods of inference and information theory	CO 6	T3, R2

Signature of Course Coordinator **HOD,CSE(AI& ML)**
Mr. Ch Chaitanya, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COMPUTER SCINECE AND ENGINEERING (AI & ML)
COURSE DESCRIPTION

Course Title	**DATA STRUCTURES LABORATORY**				
Course Code	ACSC10				
Program	B.Tech				
Semester	III	AI & ML			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mrs. K LAXMINARAYANAMMA,Assistant Professor,IT				

I COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC02	I	Python Programming Laboratory
B.Tech	ACSC08	III	Data Structures

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Structures Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.

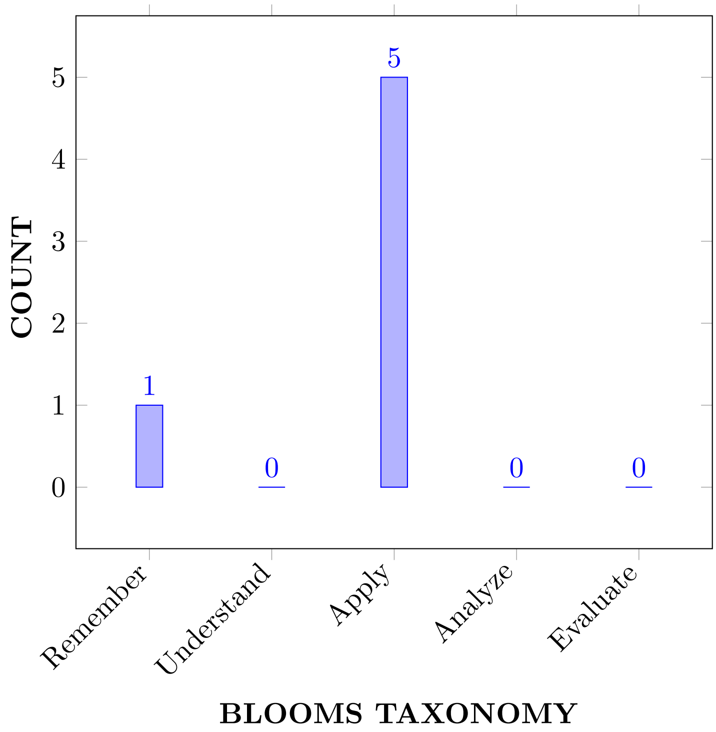
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching. .
III	The fundamentals of how to store, retrieve, and process data efficiently.
IV	To provide practice by specifying and implementing these data structures and algorithms in Python.
V	Understand essential for future programming and software engineering courses.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** appropriate searching technique for efficient retrieval of data stored location. .	Apply
CO 2	**choose** sorting technique to represent data in specified format to to optimize data searching.	Apply
CO 3	**Make use of** stacks and queues representation, operations and their applications to organize specified data	Understand
CO 4	**utilize** linked lists to implement and perform operations for for organizing specified data	Apply
CO 5	**Construct** tree to perform different traversal techniques	Apply
CO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph	Remember

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercises
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences	3	Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	Lab Exercises
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	2	Lab Exercises
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercises
PO 6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	2	Lab Exercises
PO 8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice	3	Lab Exercises
PO 9	**Individual and Teamwork** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	3	Lab Exercises
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	4	Lab Exercises

PO 12	**Life - Long Learning:**Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	2	Lab Exercises
PSO 2	Focus on improving software reliability, network security or information retrieval systems.	2	Lab Exercises
PSO 3	PMake use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
CO 1	PO 1	Identify appropriate searching technique for efficient retrieval of data stored location by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Identify appropriate searching technique for efficient retrieval of data stored location by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** appropriate searching technique for efficient retrieval of data stored location by applying **Design/Development of Solutions**	3
	PO 4	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Computer software / simulation packages / diagnostic equipment / technical library resources / literature search toolsl	1

	PO 6	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Identify appropriate searching technique for efficient retrieval of data stored location in **search engines**	2
	PSO 2	Identify appropriate searching technique for efficient retrieval of data stored location in **mobile and web applications development**	2
	PSO 3	Identify appropriate searching technique for efficient retrieval of data stored location **in shipping real world software, using industry standard tools**	3
CO 2	PO 1	choose sorting technique to represent data in specified format to optimize data searching by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	choose sorting technique to represent data in specified format to optimize data searching by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** choose sorting technique to represent data in specified format to optimize data searching by applying **Design/Development of Solutions**	3
	PO 4	**choose** sorting technique to represent data in specified format to optimize data searching by applying **Conduct Investigations of Complex Problems**	2
	PO 5	choose sorting technique to represent data in specified format to optimize data searching by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	choose sorting technique to **represent** data in specified format to optimize data searching by applying **reasoning informed by the contextual knowledge**	2

	PO 8	**choose** sorting technique to represent data in specified format to optimize data searching by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	choose sorting technique to **represent** data in specified format to optimize data searching by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	choose**Apply** sorting technique to represent data in specified format to optimize data searching by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**choose** sorting technique to **represent** data in specified format to optimize data searching by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **search engines**	2
	PSO 2	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **mobile and web applications development**	2
	PSO 3	choose**Apply** sorting technique to represent data in specified format to optimize data searching **in shipping real world software, using industry standard tools**	3
CO 3	PO 1	Make use of stacks and queues representation, operations and their applications to organize specified data by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify**, **Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **Design/Development of Solutions**	3
	PO 4	Make use of **Apply**stacks and queues representation, operations and their applications to organize specified data by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Make use of stacks and queues **representation**, operations and their applications to organize specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Make use of stacks and queues representation, **operations and their applications** to organize specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Make use of stacks and queues **representation**, operations and their applications to organize specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Make use of stacks and queues **representation**, operations and their applications to organize specified data in **search engines**	2
	PSO 2	Make use of stacks and queues **representation**, operations and their applications to organize specified data **mobile and web applications development**	2
	PSO 3	Make use of stacks and queues **representation**, operations and their applications to organize specified data **in shipping real world software, using industry standard tools**	2
CO 4	PO 1	utilize linked lists to implement and perform operations for organizing specified data by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	utilize linked lists to implement and perform operations for organizing specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	utilize**Apply** linked lists to **implement** and perform operations for organizing specified data by applying **Design/Development of Solutions**	3
	PO 4	utilize linked lists to **implement** and perform operations for organizing specified data by applying **Conduct Investigations of Complex Problems**	2

	PO 5	utilize linked lists to implement and perform operations for organizing specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	utilize linked lists to implement and perform operations for organizing specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	utilize linked lists to **implement** and perform operations for organizing specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	utilize **Apply**linked lists to implement and perform operations for organizing specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	utilize linked lists to implement and **perform** operations for organizing specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	utilize**Apply** linked lists to implement and perform operations for organizing specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	utilize**Apply** linked lists to implement and perform operations for organizing specified in **search engines**	2
	PSO 2	utilize**Apply** linked lists to implement and perform operations for organizing specified in **mobile and web applications development**	2
	PSO 3	utilize**Apply** linked lists to implement and perform operations for organizing specified **in shipping real world software, using industry standard tools**	2
CO 5	PO 1	Construct tree to perform different traversal techniques by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Construct tree to perform different traversal techniques by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Construct**Apply** tree to **perform** different traversal techniques by applying **Design/Development of Solutions**	3
	PO 4	**Construct** tree to perform different traversal techniques by applying **Conduct Investigations of Complex Problems**	2

	PO 5	Construct tree to perform different traversal techniques by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1
	PO 6	Construct tree to **perform** different traversal techniquesby applying **reasoning informed by the contextual knowledge**	2
	PO 8	ConstructApply tree to perform different traversal techniques by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Construct tree to perform different traversal techniquesby applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of **people in an organization**	3
	PO 10	Construct tree to **perform** different traversal techniques by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Construct** tree to perform different traversal techniques by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Construct tree to **perform** different traversal techniques in **search engines**	2
	PSO 2	Construct tree to **perform** different traversal techniques in **mobile and web applications development**	2
	PSO 3	Construct tree to **perform** different traversal techniques **in shipping real world software, using industry standard tools**	2
CO 6	PO 1	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying **Design/Development of Solutions**	3
	PO 4	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **reasoning informed by the contextual knowledge**	2
	PO 8	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **search engines**	2
	PSO 2	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **mobile and web applications development**	2
	PSO 3	**Select** Appropriate graph traversal techniques to visit the vertices of a graph **in shipping real world software, using industry standard tools**	2

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	**Program Outcomes/ No. of Key Competencies Matched**												**PSO'S**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	2	3	1	-	1	2	3	-	2	2	1	1
CO 2	1	2	2	2	3	1	-	2	3	3	-	2	1	1	1
CO 3	1	2	2	1	3	1	-	-	2	3	-	2	2	2	-
CO 4	1	2	1	1	3	1	-	-	2	3	-	2	2	1	1
CO 5	1	1	2	1	3	1	-	2	2	3	-	2	2	1	1
CO 6	1	1	2	1	3	1	-	1	3	3	-	2	2	1	1

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**SEARCHING TECHNIQUES**
	Write Python programs for implementing the following searching techniques. a. Linear search. b. Binary search. c. Fibonacci search.
WEEK II	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Bubble sort. b. Insertion sort. c. Selection sort
WEEK III	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Quick sort. b. Merge sort.
WEEK IV	**IMPLEMENTATION OF STACK AND QUEUE**
	Write Python programs to a. Design and implementation Stack and its operations using Arrays. b. Design and implementation Queue and its operations using Arrays
WEEK V	**APPLICATIONS OF STACK**
	Write Python programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression.
WEEK VI	**IMPLEMENTATION OF SINGLE LINKED LIST**
	Write Python programs for the following: a. Uses functions to perform the following operations on single linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal b. To store a polynomial expression in memory using linked list.
WEEK VII	**IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on Circular linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal
WEEK VIII	**IMPLEMENTATION OF DOUBLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on double linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal in both ways.
WEEK IX	**IMPLEMENTATION OF STACK USING LINKED LIST**
	Write Python programs to implement stack using linked list.
WEEK X	**IMPLEMENTATION OF QUEUE USING LINKED LIST**
	Write Python programs to implement queue using linked list.
WEEK XI	**GRAPH TRAVERSAL TECHNIQUES**
	Write Python programs to implement the following graph traversal algorithms: a. Depth first search. b.Breadth first search.

WEEK XII	**IMPLEMENTATION OF BINARY SEARCH TREE**
	Write a Python program that uses functions to perform the following: a. Create a binary search tree. b.Traverse the above binary search tree recursively in pre-order, post-order and in-order. c. Count the number of nodes in the binary search tree.

TEXTBOOKS

1. Rance D. Necaise, "Data Structures and Algorithms using Python", Wiley Student Edition.
2. Benjamin Baka, David Julian, "Python Data Structures and Algorithms", Packt Publishers, 2017.

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1. Michael H Goldwasser, David Letscher, —Object Oriented Programming in Python‖, Prentice Hall, 1 st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, —Let us Python‖, BPB publication, 1st Edition, 2019.
3. Ashok Kamthane, Amit Kamthane, —Programming and Problem Solving with Python‖, McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, —Python Programming – A modular approach‖, Pearson, 2017.
5. R Nageswara Rao, —Core Python Programming‖, Dreamtech Press, 2017 Edition.

WEB REFERENCES:

1. https://realpython.com/python3-object-oriented-programming
2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/Object-Oriented-Programming.html
4. https://www.programiz.com/python-programming/
5. . https://www.geeksforgeeks.org/python-programming-language

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Searching Techniques	CO 1	T1
2	Sorting Techniques.	CO 2	T1
3	Sorting Techniques	CO 2	T1,T2
4	Implementation of Stack and Queue	CO 3	T1,T2
5	Applications of Stack.	CO 3	T1, W1
6	Implementation of Single Linked List	CO 4	T1,W2
7	Implementation of Circular Single Linked List.	CO 4	T1,W3

8	Implementation of Double Linked List	CO 4	T2,W3
9	Implementation of Stack Using Linked List.	CO 3,CO 4	T2,W2
10	Implementation of Queue Using Linked List	CO 3,CO 4	T2,W5
11	Graph Traversal Techniques.	CO 6	T2,W2
12	Implementation of Binary Search Tree	CO 5	T1,W5

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Design a Data Structure SpecialStack that supports all the stack operations like push(), pop(), isEmpty(), isFull() and an additional operation getMin() which should return minimum element from the SpecialStack. All these operations of SpecialStack must be O(1). To implement SpecialStack, you should only use standard Stack data structure and no other data structure like arrays, list, . etc.
2	**Open channel:** In class, we studied binary search trees that do not allow us to insert duplicate elements. However, sometimes we do need to store duplicates. For example, a database of student marks might contain one record for every mark by every student; so if you've taken two courses, there will be two records with the same key (your student number) and different data (your two marks). To accomplish this, we might use a data structure called a "BST with duplicates", or BSTD
3	**Capillary action:** The variable tos in the Stack class is the index of the array element that would be filled the next time push() is called. Modify the code so that tos is the index of the top element actually in use. In other words, tos is to be the index of the top array element occupied by a value that has been "pushed" onto the stack. Write your changes on the code above. Don't forget to fix the comments. You do not need to add preconditions as in part-a.
4	**Buoyancy** Given an adjacency matrix representation of a graph, describe with pseudo code an algorithm that finds a single path, if one exists, between any two different vertices.
5	**Flow through pipes:** There is a garage where the access road can accommodate any number of trucks at one time. The garage is building such a way that only the last truck entered can be moved out. Each of the trucks is identified by a positive integer (a truck-id). Write a program to handle truck moves, allowing for the following commands: a) On-road (truck-id); b) Enter-garage (truck- id); c) Exit-garage (truck-id); d) Show-trucks (garage or road); If an attempt is made to get out a truck which is not the closest to the garage entry, the error message Truck x not near garage door

Signature of Course Coordinator **HOD, CSE()AI&ML)**
Mrs. K LAXMINARAYANAMMA, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)
COURSE DESCRIPTION

Course Title	**Programming with Objects Laboratory**				
Course Code	AITC03				
Program	B.Tech				
Semester	III	AI & ML			
Course Type	CORE				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	0	0	-	3	1.5
Course Coordinator	Mr.N.V.Krishna Rao, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	II	Programming for Problem Solving
B.Tech	ACSC08	III	Data Structure

II COURSE OVERVIEW:

Thiscoursepresentstheprinciplesofobjectorientedprogrammingusingthe Javalanguage, one of the most increasingly preferred languages for programming today. The knowledge gained in this course can be applied later to other languages such as python, C++. This course uses Net beans IDE to afford a more interactive experience. This course helps to develop different applications in various domains like GUI Applications, BigData, Web-based Applications, etc..

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Programming with Objects	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	Problem-solving strategy to break down a complex problem in to a series of simpler tasks..
II	The semantics of exception handling in Java, and use it to write reliable Java code.

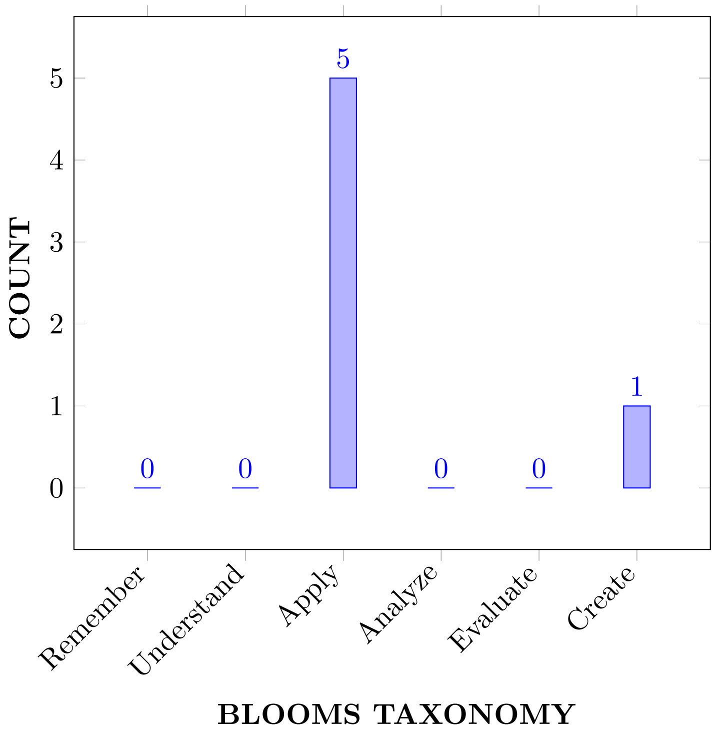
III	The event-driven programming principles by developing programs using graphical user interface.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** operators, precedence of operators, associatively while evaluating expressionsin program statements. .	Apply
CO 2	**Make use of** the concept of class and objects with access control and polymorphism techniques to represent real worldentities.	Apply
CO 3	**Demonstrate** design principles fincluding information hiding, encapsulation and exceptional handling .	Apply
CO 4	**Implement** the concepts of Multi-threading and files in soft real time systems.	Apply
CO 5	**Apply** the concepts of abstract class and inheritance for code reusability and extensibility.	Apply
CO 6	**Design** event-driven programming principles for developing programs using graphical user interface..	Create

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercise, CIE,SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complexengineering-problemsreachingsubstantiatedconclusionsusingfirst principles of mathematics, natural sciences ,and engineering sciences.	2	Lab Exercise, CIE,SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercise, CIE,SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercise, CIE,SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	Lab Exercise, CIE,SEE
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercise, CIE,SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)	3	Lab Exercises
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems	3	Lab Exercises

PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Make use of Usage of object oriented programming fundamentals **using principles of mathematics, science, and engineering fundamentals.**	3
	PO 2	Make use of Usage of object oriented programming fundamentals **with Problem statement and system definition, Problem formulation.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	2
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	2
	PSO 2	Focus on improving software reliability, **network security or information retrieval systems..**	2
	PSO 3	Describe the well utilization of r **resources for the better performance of the system.**	2
CO 2	PO 1	Describe to use indexing mechanisms for extracting a portion of data in a sequence**using principles of mathematics ,and engineering fundamentals..**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Under stand the concepts of polymorphism techniques , **and apply real world entity.**	2
	PSO 2	Demonstrate on writing programs using object and classes concepts for applications such as computational geometry, Big data **by understanding and applying the engineering principles..**	2
	PSO 3	Describe the well utilization of r **resources for the better performance of the system.**	2

CO 3	PO 1	Demonstrate on information hiding encapsulation with regard to how they will be implemented using the **using fundamentals of mathematics ,science, and engineering.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 2	Make use of exceptional handling to design and develop **efficient real-time computational problems.**	3
CO 4	PO 1	Describe the use of multi threading problem solving **using the knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 3	Usage of Demonstrate the importance of file structures for developing programs in real-time scenarios **by communicating effectively with engineering community.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Understand the concepts of multithread, elements of **parallel program execution and importance of CPU utilization.**	2
	PSO 3	Describe the well utilization of r **resources for the better performance of the system.**	2
CO 5	PO 1	Describe the importance of abstract class and inheritance **by understanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 3	Usage of Build strong foundation of writing efficient modular programs using parameter passing mechanisms for career building. **By communicating effectively with engineering community.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3

	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 2	Understand he concepts of abstract class and inheritance **for code reusability and extensibility.**	3
CO 6	PO 1	Make use of appropriate modules/packages in Java while developing solutions **using the knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 3	Usage of Demonstrate the usage of modules/packages in designing and developing . **solutions of complex engineering applications..**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Understand the concepts event-driven programming principles for **developing programs using graphical user interface.**	2
	PSO 2	Usage of Make use of modern computer tools and appropriate modules in building **real-time applications for a successful career.**	3
	PSO 3	Describe the well utilization of **resources for the better performance of the system.**	2

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	PO1	PO2	PO3	PO5	PO10	PO12	PSO1	PSO2	PSO3
CO1	1	2		3	2	1	-	2	2
CO2	2			3	3	2	2	2	2
CO3	2			3	3	2	-	2	
CO4	1		2	3	2	4	3		2
CO5	1		2	3	3	-	-	3	
CO6	2	2		3	3	3	2	3	2

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**BASICPROGRAMS**
	1.Try debug step by step with small program of about 10 to 15 lines which contains at least one if else condition and a for loop. 2. Write a java program that prints all real solutions to the quadratic equation ax2 +bx+c=0. Read in a, b, c and use the quadratic formula. 3. The Fibonacci sequence is defined by the following rule. The first two values in the sequence are 1 and 1. Every subsequent value is the sum of the two values preceding it. Write a java program that uses both recursive and non-recursive functions .
WEEK II	**MATRICES, OVERLOADING, OVERRIDING**
	1. Write a java program to multiply two given matrices. 2. Write a java program to implement method overloading and constructors overloading. 3. Write a java program to implement method overriding
WEEK III	**PALINDROME, ABSTRACT CLASS**
	1. Write a java program to check whether a given string is palindrome. 2. Write a java program for sorting a given list of names in ascending order. 3. Write a java program to create an abstract class named Shape that contains two integers and an empty method named print Area (). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area () that prints the area of the given shape. .
WEEK IV	**INTERFACE**
	Write a program that creates a user interface to perform integer division. The user enters two numbers in the text fields, Num1 and Num2. The division of Num1 and Num2 is displayed in the Result field when the Divide button is clicked. If Num1 and Num2 were not integers, the program would throw a Number Format Exception. If Num2 were zero, the program would throw an Arithmetic Exception Display the exception in a message dialog box.

WEEK V	**MULTITHREADING**
	1. Write a java program that implements a multi-thread application that has three threads. First thread generates random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number. 2. Write a java program that correct implements of producer consumer program.
WEEK VI	**FILES**
	1. Write a java program that reads a file name from the user, and then displays information about whether the file exists, whether the file is readable, whether the file is writable, the type of file and the length of the file in bytes. 2. Write a java program that displays the number of characters, lines and words in a text file. 3. Write a java program that reads a file and displays the file on the screen with line number before each line
WEEK VII	**FILES**
	1. Suppose that table named table.txt is stored in a text file. The first line in the file is the header, and the remaining lines correspond to rows in the table. The elements are separated by commas. Write a java program to display the table using labels in grid layout. 2. Write a java program that connects to a database using JDBC and does add, delete, modify and retrieve operations.
WEEK VIII	**JAVA PROGRAM WITH DATABASE**
	1. Write a java program that loads names and phone numbers from a text file where the data is organized as one line per record and each field in a record are separated by a tab (/t). It takes a name or phone number as input and prints the corresponding other value from the hash table. Hint: Use hash tables. 2. Implement the above program with database instead of a text file.
WEEK IX	**FILES**
	1. Write a java program that takes tab separated data (one record per line) from a text file and insert them into a database. 2. Write a java program that prints the metadata of a given table.
WEEK X	**TRAFFIC LIGHT**
	1. Write a java program that simulates a traffic light. The program lets the user select one of three lights: Red, Yellow or Green with radio buttons. On selecting a button an appropriate message with —STOP‖ or —READY‖ or ‖GO‖ should appear above the buttons in selected color. Initially, there is no message shown.
WEEK XI	**MOUSE EVENTS**
	1. Write a java program that handles all mouse events and shows the event name at the center of the window when a mouse event is fired. Use adapter classes. 2. Write a java program to demonstrate the key event handlers.
WEEK XII	**CALCULATOR**
	Write a java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +,-,*, operations. Add a text field to display the result. Handle any possible exception like divided by zero.

WEEK XIII	**APPLET**
	1. Develop an applet that displays a simple message. 2. Develop an applet that receives an integer in one text field and computes its factorial value and returns it in another text field, when the button named —compute‖ is clicked.

TEXTBOOKS

1. HerbertSchildt and DaleSkrien,“JavaFundamentals– A comprehensive Introduction ” , McGrawHill, 1stEdition,2013.
2. HerbertSchildt, “Java the Complete Reference”, McGraw Hill, Osborne, 7thEdition, 2011

REFERENCE BOOKS:

1. P. J. Deitel, H. M. Deitel, —Java for Programmers‖, Pearson Education, PHI, 4 th Edition, 2007.
2. P. Radha Krishna, —Object Oriented Programming through Java‖, Universities Press, 2 nd Edition, 2007.
3. Bruce Eckel, —Thinking in Java‖, Pearson Education, 4 th Edition, 2006. 4. Sachin Malhotra, Saurabh Chaudhary, —Programming in Java‖, Oxford University Press, 5 th Edition, 2010

WEBREFERENCES:

1. www.niecdelhi.ac.in .
2. https://www.linkedin.com/in/achin-jain-85061412
3. www.rank1infotech.com

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Operators and Expressions..	CO 1	T2:4.1– 4.8
2	Selection/ConditionalBranchingStatements:if,if-else,nestedif,if-elseif-elsestatement.	CO 1,CO 2	T2:2.1– 2.9
3	Abstract class and interface mplementation.	CO 4	T2:2.1–2.9 T2:10.2
4	Polymorphism and inheritance implementation.	CO 3,CO 5	T2:8.1– 8.7
5	Multithreading programming In java..	CO 4	T2:11.1–11.6
6	File's handling using java programming.	CO 3,CO 4	T2:13.5–13.6
7	Database connectivity using java programming.	CO 2,CO 6	T2:24.1–24.6
8	Event handling and abstract window.	CO 2,CO 6	T2:24.1–24.6
9	Event handling and layouts.	CO 2, CO 6	T2:24.1–24.6 T2:21.61
10	Applets.	CO 2, CO 6	T2:25.4–25.6

11	Loop Structures/Iterative Statements– While and for loop, Nested loops. .	CO 2,CO 6	T2:5.1– 5.3 T:21.29
12	Classes and Objects–Defining Classes, Creating Objects.	CO 2	T2:6.1– 6.5

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	You are the owner of a big company. You are so rich, that the government has allowed you to print as many notes as you want of any single value that you like. You also have peculiar behavior altra its and you often do things that look weird to a third person. You have N N employees, where the employee has salary Ai Ai. You want to pay them using a denomination that you create. You are also eco friendly and wish to save paper. So, you wish to pay them using as few notes as possible. Find out the minimum number of notes required if you can alter the salary of at most one employee to any positive integer that you like, and choose the positive integer value that each note is worth (called its denomination). Each employee must receive the exact value of his/her salary and no more.
2	You're given a tree with N vertices numbered from 1 to N Your go a list of handle queries. For each query you are given K nodes v1,v2,...,vK. Find if there exists a simple path in the tree covering the give n vertices.

Signature of Course Coordinator **HOD,AI & ML**
Mr.N.V.Krishna Rao Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI&ML)
COURSE DESCRIPTION

Course Title	**R for Probabilistic Modeling and Reasoning Laboratory**				
Course Code	ACAC02				
Program	B.Tech				
Semester	III	CSE(AI&ML)			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	1	-	-	2	2
Course Coordinator	Dr. Myneni Madhu Bala, Professor CSE				

I COURSE OVERVIEW:
This course will expose the students to R programming environment, introduces to sampling and exploring data. It also provides a foundation in both probability theory and mathematical statistics and provides an indication of the relevance and importance of the theory in solving practical problems in the real world.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC08	II	Probability and Statistics

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
R FOR PROBABILISTIC MODELING AND REASONING LABORATORY	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:
Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	How to manipulate data within R and to create simple graphs and charts used in introductory statistics. .
II	The given data using different distribution functions in R.
III	The hypothesis testing and calculate confidence intervals; perform linear regression models for data analysis.
IV	The relevance and importance of the theory in solving practical problems in the real world.

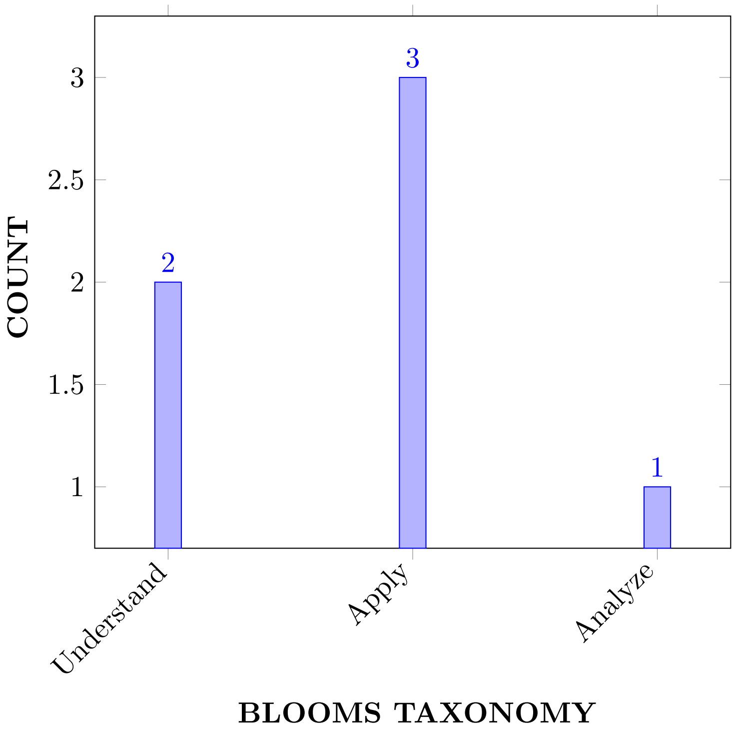
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the basic data types and functions of R programming for describing data.	Understand
CO 2	**Illustrate** the shape and distribution of data with visualization methods in R for describing relationships.	Apply
CO 3	**Articulate** sampling techniques and perform various hypothesis tests, display the probability distributions of data.	Apply

CO 4	**Present** various data analysis, data visualization functions on population data set Inferring the data insights using exploratory data analysis.	Apply
CO 5	**Demonstrate** Demonstrate hypothesis testing.	Understand
CO 6	**Analyze** Create a prediction model like recommender systems, social media applications etc.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** UCreate, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Lab Exercises
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Demonstrate the data types of R Programming by understating their importance and applicability (apply) in. **solving (complex) engineering problems by applying the principles of Mathematics and Engineering.**	3

	PO 2	Demonstrate the data types of R Programming **with provided information and data in reaching substantiated conclusions by the interpretation of results.** .	3
	PO 5	Demonstrate the data types of R Programming **for solving problems with the help of built in function in R programming Tool.** .	3
	PSO 3	Use real time data to implement machine learning basics with R programming **using basic packages and functions for describing data.** .	3
CO 2	PO 1	Illustrate the distribution of data by using built in functions of R programming for visualizing the shape and distribution of data **by applying principles of Mathematics, Science and Engineering.**	3
	PO 2	Illustrate the distribution of data by using built in functions of R programming **for visualizing the shape and distribution of data in solving analysis problems.** .	2
	PO 5	Illustrate the distribution of data by using built in functions of R programming **for visualizing the shape and distribution of data with the help of built in function in R programming Tool.** .	3
	PSO 3	Use real time data to implement machine learning basics with R programming **by visualizing the data and its relationships.** .	3
CO 3	PO 1	Explain the probability distributions of data and applicability in solving (complex) data centric engineering problems **by applying the principles of Mathematics, Science and Engineering.** .	3
	PO 2	Explain the probability distributions of data and applicability in solving (complex) data centric engineering problems **from the provided information and substantiate with the interpretation of variations in the results.** .	3
	PSO 3	Implement machine learning basics with R programming **by exploring probability distribution to solve complex problems.** .	3
CO 4	PO 1	Conclude the insights of data using exploratory data analysis **by applying the principles of Mathematics, Science and Engineering.**.	3
	PO 5	Define Hive commands for reading, writing and managing large datasets in hdfs **Find the statistical conclusions and visualizations of the.**.	2
	PSO 3	Implement machine learning tasks with R programming **by exploring statistical analysis and data visualization for generating predictions.** .	3

CO 5	PO 1	Apply the hypothesis testing on probabilistic problems **by understanding the appropriate parametric assumptions and limitations based on mathematical fundamentals...**	3
	PO 3	Understand the given problem statement and formulate (complex) engineering system **for deriving chances of occurrences od different states of outcomes with the interpretation of variations in the results...**	2
	PO 5	Make use of packages and functions **for creating conclusions of various testing on hypothesis..**	3
	PSO 3	Understand the hypothesis by performing various tests to interpret the sampling **from distributions to visualize the data to analyze the complexity..**	3
CO 6	PO 1	Apply the knowledge of **engineering fundamentals**, and an **Mathematics and Engineering fundamentals principles to create a linear prediction model on continuous data**.	3
	PO 3	Apply linear and multiple regression techniques on the **prediction of continuous data by understating the problem** reaching **substantiated conclusions**.	3
	PSO 3	Use packages and function in R tool **for applying linear and multiple regression techniques on the prediction of continuous data on complex probels**.	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES				PROGRAM OUTCOMES		
	PO 1	PO 2	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	2		2	3			3
CO 2	3		3				3
CO 3	3	2	3				3
CO 4	3		3				3
CO 5	3	2	3				3
CO 6	3	2	3				3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**INTRODUCTION TO COMPUTING**
	a.Installation of R. b. The basics of R syntax, workspace c. Basic data types, Matrices and lists d. Subsetting e. System-defined functions; the help system f. Errors and warnings; coherence of the workspace
WEEK 2	**GETTING USED TO R: DESCRIBING DATA**
	a. Viewing and manipulating Data b. Reading the data from console, file (.csv) local disk and we. c. Working with larger datasets
WEEK 3	**SHAPE OF DATA AND DESCRIBING RELATIONSHIPS**
	a. Tables, charts and plots b. Univariate data, measures of central tendency, frequency distributions, variation, and Shape c. Multivariate data, relationships between a categorical and a continuous variable d. Relationship between two continuous variables – covariance, correlation coefficients, comparing multiple correlations e. Visualization methods – categorical and continuous variables, two categorical variables, two continuous variables
WEEK 4	**PROBABILITY DISTRIBUTIONS**
	a. Sampling from distributions – Binomial distribution, normal distribution b. tTest, zTest, Chi Square test c. Density functions d. Data Visualization using ggplot – Box plot, histograms, scatter plotter, line chart, bar chart, heat maps
WEEK 5	**EXPLORATORY DATA ANALYSIS**
	Demonstrate the range, summary, mean, variance, median, standard deviation histogram, box plot, scatter plot using population dataset https://statsandr.com/blog/descriptive-statistics-in-r/#data
WEEK 6	**TESTING HYPOTHESES**
	a. Null hypothesis significance testing b. Testing the mean of one sample c. Testing two means Testing the mean of one sample
WEEK 7	**PREDICTING CONTINUOUS VARIABLES**
	a. Linear models b. Simple linear regression c. Multiple regression d. Bias-variance trade-off – cross-validation
WEEK 8	**CORRELATION**
	a. How to calculate the correlation between two variables b. How to make scatter plots c. Use the scatter plot to investigate the relationship between two variables
WEEK 9	**TESTS OF HYPOTHESES**

	a. Perform tests of hypotheses about the mean when the variance is known b. Compute the p-value c. Explore the connection between the critical region, the test statistic, and the p-value
WEEK 10	**ESTIMATING A LINEAR RELATIONSHIP**
	Demonstration on a Statistical Model for a Linear Relationship a. Least Squares Estimates b. The R Function lm c. Scrutinizing the Residuals
WEEK 11	**APPLY-TYPE FUNCTIONS**
	Defining user defined classes and operations, Models and methods in R b. Customizing the user's environment c. Conditional statements d. Loops and iterations
WEEK 12	**STATISTICAL FUNCTIONS IN R**
	a. Write Demonstrate Statistical functions in R b. Statistical inference, contingency tables, chi-square goodness of fit, regression, generalized linear models, advanced modeling methods

TEXTBOOKS

1. Sandip Rakshit, "Statistics with R Programming", McGraw Hill Education, 2018.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "AN Introduction to Statistical Learning: with Applications in R", Springer Texts in Statistics, 2017.
3. Joseph Schmuller, "Statistical Analysis with R for Dummies", Wiley, 2017.
4. K G Srinivasa, G M Siddesh, Chetan Shetty, Sowmya B J, "Statistical Programming in R", Oxford Higher Education, 2017.

REFERENCE BOOKS:

1. www.oikostat.ch.
2. https://learningstatisticswithr.com/
3. https://www.coursera.org/learn/probability-intro#syllabus.
4. https://www.isibang.ac.in/ athreya/psweur/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Introduction To Computing	CO 1	R1: 1
2	Getting Used To R: Describing Data	CO 1	R3: 2
3	Shape Of Data And Describing Relationships	CO 2	R1: 7
4	Probability Distributions	CO 3	R1: 8
5	Exploratory Data Analysis	CO 4	R1: 2.4
6	Testing Hypotheses	CO 5	R1: 9
7	Predicting Continuous Variables	CO 6	R1: 10
8	Correlation	CO 2	R3: 15
9	Tests Of Hypotheses	CO 5	R1: 9

10	Estimating A Linear Relationship	CO6	R1: 10
11	Apply-Type Functions	CO 1	R4:7
12	Statistical Functions In R	CO 1	R4:10

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Twin vortex formation: Demonstration of twin vortex formation and calculation of vortex size for different geometries.
2	Open channel: Demonstration of streamline at different angle of attack and calculation of separation point for different Reynolds number.
3	Capillary action: By modeling capillary action using two cups of water and a paper towel, you'll gain a better understanding of the importance of this process in trees.
4	Buoyancy Calculation of meta center and displacement volume for various geometries and materials.

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Dr. Myneni Madhu Bala, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI & ML)
COURSE DESCRIPTION

Course Title	**DATABASE MANAGEMENT SYSTEMS**				
Course Code	AITC05				
Program	B.Tech				
Semester	IV	CSE (AI & ML)			
Course Type	Core				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs. A. Rajitha, Assistant Professor				

I COURSE OVERVIEW:

Database management system is intended to provide a clear understanding of fundamentals with emphasis on their applications to create and manage large data sets. It emphasizes on technical overview of database software to retrieve data from database. This includes database design principles, normalization, and concurrent transaction processing, security, recovery and file organization techniques. This will provide adequate knowledge to understand future evolutions of data technologies.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB01	II	Programming for Problem Solving
B.Tech	ACSB03	III	Data Structures

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Database Management Systems	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Concept Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

Continuous Internal Assessment (CIA): CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool Table 3.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
33 %	Remember
27 %	Understand
33 %	Apply
07 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Examination (CIE): Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz –Online Examination: Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT): This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.The AAT chosen for this course is given in table 3.

ASSESSMENT PATTERN FOR AAT:

5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30 %	10%	10%

VI COURSE OBJECTIVES:

The students will try to learn:

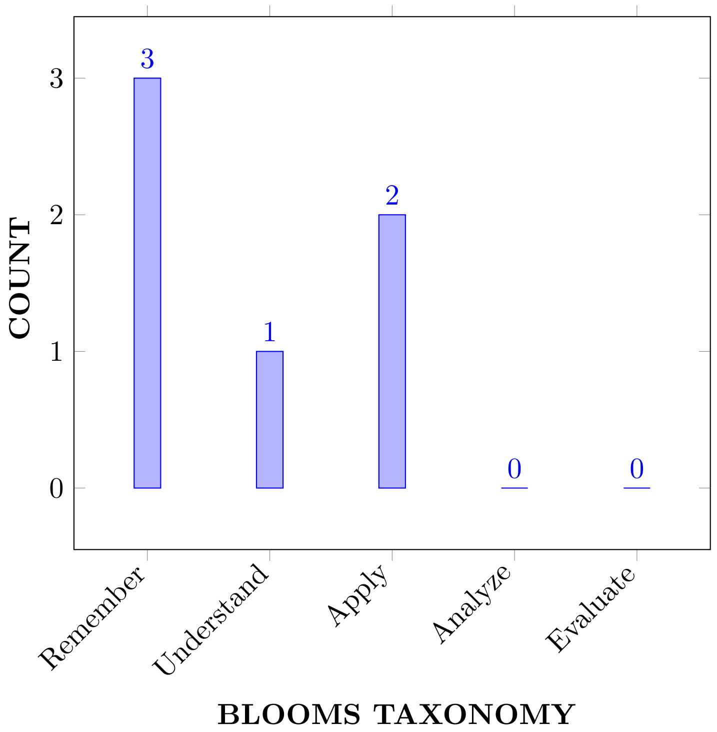
I	Acquire analytical thinking and identify efficient ways of designing database by encapsulating data requirements for business and organizational scenarios.
II	Develop expertise in database language SQL to develop sophisticated queries to extract information from large datasets.
III	Enhance skills to develop and manage data in solving related engineering problems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** data models, schemas, instances, view levels and database architecture for voluminous data storage.	Remember
CO 2	**Define** the concept of Relational Algebra and Relational Calculus from set theory to represent queries.	Remember
CO 3	**Make Use of** SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation.	Apply
CO 4	**Illustrate** the definition of Functional Dependencies, Inference rules and minimal sets of FD's to maintain data integrity.	Understand
CO 5	**State** the concepts of transaction, states and ACID properties in data manipulation.	Remember
CO 6	**Apply** indexing ,hashing techniques to access the records from the file effectively.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions..	3	CIE/Quiz/AAT
PO 4	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction analysis and interpretation of data, and synthesis of the information to provide valid conclusions and modeling to complex engineering activities with an understanding of the limitations.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)	2	Industry exposure/AAT

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	✓	✓	✓	-	-	-	-	-	-	-		✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	-	-	-	-	-	-		-	-	-

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Describe data models, schemas, instances, view levels and database architecture for voluminous data storage using principles of **mathematics, science, and engineering fundamentals.**	3
	PO 2	Describe data models, schemas, instances, view levels and database architecture for voluminous data storage with Problem statement and system definition , **Problem formulation and abstraction**	2
CO 2	PO 1	Define the concept of Relational Algebra and Relational Calculus from set theory to represent queries with **knowledge of mathematics, science and engineering fundamentals for capacitance calculation.**	3
CO 3	PO 2	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation with the Problem statement and system definition, Problem formulation and **abstraction , Information and data collection, Model translation**	4
	PO 3	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation with the help of Investigate and define a problem and identify constraints, Manage the design process and evaluate outcomes,	3
	PO 4	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation by Understanding of contexts in which **engineering knowledge can be applied, Understanding use of technical literature** , Understanding of appropriate codes of practice and industry standards.	3
	PSO 1	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation by using a set of steps.	1
CO 4	PO 1	Illustrate the definition of Functional Dependencies, Inference rules and minimal sets of FD's to maintain data integrity basic fundamentals of **mathematics and engineering fundamentals.**	2
	PO 2	Illustrate the definition of Functional Dependencies, Inference rules and minimal sets of FD's to maintain data integrity with the Problem statement and system **definition, Problem formulation and abstraction ,** Information and data collection, Model translation	4
CO 5	PO 1	State the concepts of transaction, states and ACID properties in data manipulation basic fundamentals of **mathematics and engineering fundamentals.**	2

	PO 2	State the concepts of transaction, states and ACID properties in data manipulation the Problem statement and system definition, Problem formulation and abstraction , **Information and data collection, Model translation**	4
CO 6	PO 1	Apply indexing ,hashing techniques to access the records from the file effectively with basic fundamentals of**mathematics and engineering fundamentals.**	2
	PO 2	Apply indexing ,hashing techniques to access the records from the file effectively through statement and system definition, Problem formulation and abstraction ,**Information and data collection, Model translation**	4
	PO 3	Apply indexing ,hashing techniques to access the records from the file effectively by Investigate and define a problem and identify constraints,**Understand customer and user needs, Manage the design process and evaluate outcomes,**	4
	PSO 1	Apply indexing ,hashing techniques to access the records from the file effectively by using a set of instructions	1

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	4	3	4	-	-	-	-	-	-	-	-	-	1	-
CO 4	2	4	-	3	-	-	-	-	-	-	-		1	-	-
CO 5	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	4	4	-	-	-	-	-	-	-	-		-	1	-

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	100	20.0	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	100	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	40.0	30.0	36.36	-	-	-	-	-	-	-		-	50	-
CO 4	66.6	40.0	40.0	27.27	-	-	-	-	-	-	-		16.66	-	-
CO 5	66.6	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.6	40.0	40.0	-	-	-	-	-	-	-	-		-	50	-

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

2 - $40\% < C < 60\%$ –Moderate

1-5 $< C \leq 40\%$ – Low/ Slight

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	1	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	1	1	1	-	-	-	-	-	-	-	-	-	2	-
CO 4	3	1	1	1	-	-	-	-	-	-	-		1	-	-
CO 5	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	1	1	-	-	-	-	-	-	-	-		-	2	-
TOTAL	**15**	6	3	2	-	-	-	-	-	-	-	-	1	4	-
AVERAGE	**3.0**	1	1	1	-		-	-	-	-	-	-	1.0	2	-

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1,PO 2	SEE Exams	PO 1,PO 2	Seminars	PO 1
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	PO 1,PO 2, PO 5	5 Minutes Video	PO 10	Open Ended Experiments	-
Assignments	-				

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVII SYLLABUS:

MODULE I	**CONCEPTUAL MODELING INTRODUCTION**
	Introduction to Data bases: Purpose of Database Systems, View of Data, Data Models, Database Languages, Database Users, Various Components of overall DBS architecture, Various Concepts of ER Model, Basics of Relational Model.

MODULE II	**RELATIONAL APPROACH**
	Relational algebra and calculus: Relational algebra, selection and projection, set operations, renaming, joins, division, examples of algebra queries, relational calculus: Tuple relational calculus, Domain relational calculus, expressive power of algebra and calculus.
MODULE III	**SQL QUERY - BASICS, RDBMS NORMALIZATION**
	SQL – Data Definition commands, Queries with various options, Mata manipulation commands, Views, Joins, views, integrity and security; Relational database design: Pitfalls of RDBD, Lossless join decomposition, Functional dependencies , Armstrong Axioms, Normalization for relational databases 1st 2nd and 3rd normal forms, Basic definitions of MVDs and JDs, 4th and 5th normal forms.
MODULE IV	**TRANSACTION MANAGEMENT**
	Transaction processing: Transaction Concept, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability. Concurrency Control: Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols,Multiple Granularity, Multiversion Schemes, Deadlock Handling. Recovery: Failure Classification, Storage Structure ,Recovery and Atomicity, Log-Based Recovery,Shadow Paging, Recovery With Concurrent Transactions Buffer Management.
MODULE V	**DATA STORAGE AND QUERY PROCESSING**
	Data storage: Overview of Physical Storage Media, Magnetic Disks, Storage Access, File Organization,Organization of Records in Files.Indexing and Hashing: Basic Concepts: Ordered Indices, B+-Tree Index Files, B-Tree Index Files, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing.Query Processing: Overview, Measures of Query Cost.

TEXTBOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill 6th Edition, 2017

REFERENCE BOOKS:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 6th Edition, 2014.

2. Raghu Ramakrishnan, "Database Management System", Tata McGraw Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 3rd Edition, 2007

3. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database System Implementation", Pearson Education, United States, 1st Edition, 2000.

4. Peter Rob, Corlos Coronel, "Database System, Design, Implementation and Management", Thompson Learning Course Technology, 5th Edition, 2003.

XVIII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
1-2	Introduction, Data base System Applications, Purpose of data base Systems, View of Data – Data Abstraction, Instances and Schemas Data Models, Database Languages, Data base access for applications Programs	CO 1,CO 2	T2: 1.1-1.5
3-4	Transaction Management component of DB architecture, Data base users, History of database systems, Database design, ER Diagrams.	CO 3,CO 4	T2:1.6 -1.8 T1: 2.1
5-6	Entities, Attributes and entity sets, Relationships and relationship sets, Additional features of ER model, Conceptual design with ER model, Conceptual design for large enterprises	CO 4	T1: 2.2-2.6
7-8	Relational Model: Introduction to the Relational Model – Integrity Constraint Over relations, Enforcing Integrity constraints – Querying relational data	CO 5	T1: 3.1-3.7
9-10	Relational Algebra and Calculus: Relational Algebra – Selection and projection –set operations – renaming, Joins – Division	CO 6,CO 6	T1:4.1,4.2.2
11-12	Relational calculus – Tuple relational Calculus – Domain relational calculus – Expressive Power of Algebra and calculus.	CO 2,CO 2	T1:4.3, 4.4
13-14	Form of Basic SQL Query – Examples of Basic SQL Queries Comparison Operators – Aggregative Operators, NULL values , Logical connectivity's – AND, OR and NOT, complex Integrity Constraints in SQL	CO 3	T1: 5.2-5.5
15-16	Introduction to Nested Queries – Correlated Nested Queries Set Comparison Operators – Aggregative Operators, Triggers and Active Data bases	CO 3	T1: 5.6-5.8
17-18	Introduction to Schema refinement – Problems Caused by redundancy ,Decompositions – Problem related to decomposition	CO 4	T1: 9.1,19.1.3
19-21	Functional dependencies, reasoning about FDS ,Lossless join Decomposition ,Dependency preserving Decomposition	CO 3	T2: 19.4-19.8
22-25	Schema refinement in Data base Design, Normal Forms, MVDs, JDs	CO 3	T2: 19.8-19..9
26-29	Transaction Management: Transaction Concept-Transaction State-Implementation of atomicity and Durability, Concurrent Executions, Serializability , Recoverability, Implementation of Isolation, Testing for Serializability.	CO 4	T2:15.1-15.29

30-33	Concurrency Control: Lock-Based Protocols –time Stamp Based protocols-,Validation Based Protocols-Multiple Granularity	CO 5	T2: 16.1, 16.2 T2: 16.3, 16.4
34-37	Recovery System-Failure Classification-storage Structure recovery and Atomicity-Log Based Recovery	CO 4	T2:17.1-17.10
38-39	Overview of Storage and Indexing: Data on External Storage File Organization and Indexing – Cluster Indexes, Primary and Secondary Indices	CO 5	T1: 8.1,8.2
40-42	Index data Structures – Hash Based Indexing ,Tree base Indexing – Comparison of File Organizations, ISAM	CO 6,CO 4	T1: 8.3-8.4
43-45	Tree Structured Indexing: B+ Trees, Hashing	CO 6	T1: 10 10.2

Signature of Course Coordinator **HOD,CSIT**
Mrs.A.Rajitha, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**DESIGN AND ANALYSIS OF ALGORITHMS**				
Course Code	ACSC13				
Program	B.Tech				
Semester	IV	AI & ML			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr.S.Sreekanth, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB01	II	Programming for problem solving
B.Tech	ACSB03	III	Data structures

II COURSE OVERVIEW:

Design and analysis of algorithms is the process of finding the computational complexity of algorithms. It helps to design and analyze the logic on how the algorithm will work before developing the actual code for a program. It focuses on introduction to algorithm, asymptotic complexity, sorting and searching using divide and conquer, greedy method, dynamic programming, backtracking, branch and bound. NP-hard and NP-complete problems. The applications of algorithm design are used for information storage, retrieval, transportation through networks, and presentation to users.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Design and Analysis of Algorithms	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
20 %	Understand
70%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

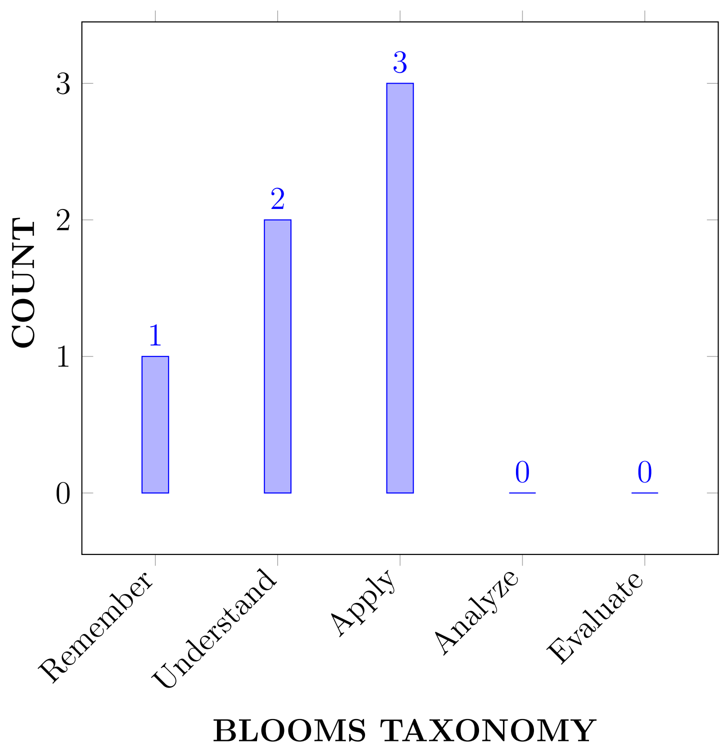
I	Mathematical approach for Analysis of Algorithms.
II	Methods and techniques for analyzing the correctness and resource requirements of algorithms.
III	Different paradigms of algorithm design including recursive algorithms, divide-and-conquer algorithms, dynamic programming, greedy algorithms, Backtracking , Branch and Bound and graph algorithms.
IV	Strategies for solving problems not solvable in polynomial time.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Find** the (worst case, randomized, amortized) running time and space complexity of given algorithms using techniques such as recurrences and properties of probability.	Remember
CO 2	**Apply** divide and conquer algorithms for solving sorting, searching and matrix multiplication.	Apply
CO 3	**Make Use of** appropriate tree traversal techniques for finding shortest path.	Understand
CO 4	**Compare** Identify suitable problem solving techniques for a given problem and finding optimized solutions using Greedy and Dynamic Programming techniques	Understand
CO 5	**Apply** greedy algorithm Utilize backtracking and branch and bound techniques to deal with traceable and in-traceable problems.	Apply
CO 6	**Apply** Describe the classes P, NP, NP-Hard, NP- complete for solving deterministic and non deterministic problems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / Quiz / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	5	CIE / Quiz / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / Quiz / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4	
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	4	CIE / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE / Quiz / AAT
PSO2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	CIE / Quiz / AAT
PSO3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	✓	✓
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 5	✓	-	-	✓	-	-	-	-	-	✓	-	✓	✓	-	✓
CO 6	✓	-	-	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Analyze the running time and space complexity of given algorithms using techniques such as recurrences, potential functions, properties of probability by applying the **mathematical principles ,engineering principles and scientific principles**	3
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
	PSO 1	Understand the basic properties of asymptotic notations, probability analysis for designing **algorithms, system software and Networking.**	4
CO 2	PO 1	Apply divide and conquer algorithms for solving sorting, searching and matrix multiplication problems to integrate **mathematical principles, engineering Principles and Scientific Principles**	3
	PO 2	Understand the given problem and develop the solution for solving sorting, searching and matrix multiplication problems and **Interpretation of results.**	4
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
	PSO 1	Build divide and conquer algorithms for solving sorting, searching, **Big data** analysis and matrix multiplication problems through **system software.**	4
CO 3	PO 1	Utilize appropriate tree traversal techniques for solving graph problems to integrate**mathematical principles and computer science methodologies**	2
	PO 2	Understand the given traversal techniques to develop the solution for graph problems and **interpretation of results.**	6
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
CO 4	PO 1	Finding the solution of complex **engineering problems and extend the efficiencies of same problem using different algorithms in engineering disciplines.**	2
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
	PSO 1	Make use of the concept of different algorithms for developing **intelligent systems, next generation computer systems and networking devices.**	4
CO 5	PO 1	Choose (Pick) greedy algorithms for finding solutions of minimization and maximization problems to support study of their own **engineering discipline and methodologies.**	3
	PO 2	Understand the given problem and develop the solution using greedy methods in reaching substantiated conclusions from the provided **information and interpret of results.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
CO 6	PO 1	Apply the knowledge of dynamic programing algorithms for calculating optimized solution of complex Engineering problems by understanding **mathematical principles and computer science methodologies**	3
	PO 2	Understand the given **problem** and **choose appropriate technique** of dynamic programing algorithms for solving the given problem from the provided **Information and data** in reaching substantiated conclusions by the **interpretation of results.**	6
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
	PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
	PSO 1	Make use of dynamic programming algorithms for higher studies in field of **machine Learning, Big data** and Understand, design and analyze computer programs in the areas related to **Algorithms**	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	2	-	2	3	2	1
CO 2	3	5	-	-	-	-	-	-	-	2	-	2	2	2	1
CO 3	3	5	-	-	-	-	-	-		2	-	2	2	-	-
CO 4	3	6	6	-	-	-	-	-	-	2	-	2	2	-	-
CO 5	2	-	-	2	-	-	-	-	-	2	-	2	2	-	1
CO 6	3	-	-	-	5	-	-	-	-	2	-	2	2	2	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	50	-	25	50	50	25
CO 2	100	50	-	-	-	-	-	-	-	50	-	25	50	50	25
CO 3	100	50	-	-	-	-	-	-	-	50	-	25	25	-	-
CO 4	100	60	60	-	-	-	-	-	-	50	-	25	50	-	-
CO 5	66.7	-	-	46.6	-	-	-	-	-	50	-	25	50	-	25
CO 6	100	-	-	45	-	-	-	-	-	50	-	25	50	50	25

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	2	-	1	2	2	1
CO 2	3	2	-	-	-	-	-	-	-	2	-	1	2	2	1
CO 3	3	2	-	-	-	-	-	-	-	2	-	1	1	-	-
CO 4	3	3	3	-	-	-	-	-	-	2	-	1	2	-	-
CO 5	3	-	-	2	-	-	-	-	-	2	-	1	2	-	1
CO 6	3	-	-	2	-	-	-	-	-	2	-	1	2	2	1
TOTAL	18	7	3	4	-	-	-	-	-	12	-	6	11	6	4
AVERAGE	3.0	2.33	3	2	-	-	-	-	-	2.0	-	1.0	1.66	2	1

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Algorithm: Pseudo code for expressing algorithms; Performance analysis: Space complexity, time complexity; Asymptotic notations: Big O notation, omega notation, theta notation and little o notation, amortized complexity; Divide and Conquer: General method, binary search, quick sort, merge sort, Strassen's matrix multiplication.
MODULE II	**SEARCHING AND TRAVERSAL TECHNIQUES**
	Disjoint set operations, union and find algorithms; Efficient non recursive binary tree traversal algorithms, spanning trees; Graph traversals: Breadth first search, depth first search, connected components, bi-connected components.
MODULE III	**GREEDY METHOD AND DYNAMIC PROGRAMMING**
	Greedy method: The general method, job sequencing with deadlines, knapsack problem, minimum cost spanning trees, single source shortest paths. Dynamic programming: The general method, matrix chain multiplication optimal binary search trees, 0/1 knapsack problem, single source shortest paths, all pairs shortest paths problem, the travelling salesperson problem.
MODULE IV	**BACKTRACKING AND BRANCH AND BOUND**
	Backtracking: The general method, the 8 queens problem, sum of subsets problem, graph coloring, Hamiltonian cycles; Branch and bound: The general method, 0/1 knapsack problem, least cost branch and bound solution, first in first out branch and bound solution, travelling salesperson problem.
MODULE V	**NP-HARD AND NP-COMPLETE PROBLEM**
	Basic concepts: Non-deterministic algorithms, the classes NP - Hard and NP, NP Hard problems, clique decision problem, chromatic number decision problem, Cook's theorem.

TEXTBOOKS

1. Ellis Horowitz, Satraj Sahni, Sanguthevar Rajasekharan, —Fundamentals of Computer Algorithms, Universities Press, 2nd Edition, 2015.

2. Tom White, —Hadoop: The Definitive Guide, O'Reilly, 3rd Edition, 2012.

3. Alfred V. Aho, John E. Hopcroft, Jeffrey D, —The Design And Analysis Of Computer Algorithms, Pearson India, 1st Edition, 2013.

REFERENCE BOOKS:

1. Levitin A, —Introduction to the Design and Analysis of Algorithms‖, Pearson Education, 3rd Edition, 2012.

2. Goodrich, M. T. R Tamassia, —Algorithm Design Foundations Analysis and Internet Examples‖, John Wileyn and Sons, 1st Edition, 2001.

3. Base Sara Allen Vangelder, —Computer Algorithms Introduction to Design and Analysis‖, Pearson, 3rd Edition, 1999

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Discussion on mapping COs with POs. (OBE)		
CONTENT DELIVERY (THEORY)			
2	Describe Pseudo code for expressing algorithms.	CO 1	T1:1.1,1.2
3	Summarize the concept of Space complexity, time complexity.	CO 1	T1: 1.2.7, 1.2.8
4-6	Describe Big O notation, omega notation, theta notation, little o notation and amortized complexity.	CO 1	T1:1.2.9, 1.2.11, 1.3
7-10	Use the concept of Divide and Conquer such as general method, binary search and quick sort.	CO 2	T1:1.5, 1.4.2,1.4.3
11-13	Describe the concept of merge sort, Strassen's matrix multiplication.	CO 2	T1:1.4.3, 1.4.4, 2.3.1, 2.3.2,2.3.6, 2.3.7,2.3.8
14-15	Determine disjoint set operations, union and find algorithms.	CO 3	R2:4.3 T1:2.4.1, 2.4.2,2.4.3, 4.1
16-17	Understand efficient non recursive binary tree traversal algorithms.	CO 3	T1:3.1,3.2 R1:6.2-6.8
18	Describe the concept of spanning trees with suitable examples.	CO 3	R1: 7.1-7.6
19-21	Use breadth first search and depth first search graph traversals.	CO 3	R2:8.1
22-23	Describe connected components, biconnected components.	CO 3	R2:8.2, 8.3
24-27	Understand general method of greedy method, job sequencing with deadlines, knapsack problem.	CO 4	R2: 9.1-9.3
28-29	Analyze the concept of minimum cost spanning trees, single source shortest paths.	CO 4	R2: 9.8, 9.9, 10.1, 10.2
30	Describe general method of dynamic programming, matrix chain multiplication.	CO4	T2:5.5, 5.9, 5.10
31-32	Understand optimal binary search trees, 0/1 knapsack problem, single source shortest paths.	CO 5	R2:10.4, 10.6,10.7
33-34	Define all pairs shortest paths problem, the travelling salesperson problem.	CO 5	T1:5.8-5.9
35	Discuss the concept of Backtracking, the 8 queen's problem.	CO 5	T1:7.1-7.2

36	Understand sum of subsets problem, graph coloring.	CO 5	T1:7.3-7.4
37	Summarize the concept of Hamiltonian cycles, Branch and bound.	CO 5	T1:7.5,8.1.1
38	Discuss 0/1 knapsack problem, least cost branch and bound solution.	CO 5	T1:8.2.1
39	Apply the concept of first in first out branch and bound solution, travelling salesperson problem.	CO 5	T1:8.2.2, 8.3
40	Knowledge about basic concepts of NP Hard and NP Complete, Non-deterministic algorithms.	CO 6	T1:11.1
41	Apply Working with the classes NP - Hard and NP.	CO 6	T1:11.1
42	Understand NP Hard problems, clique decision problem.	CO 6	T1:11.3
43	Implement chromatic number decision problem.	CO 6	T1:11.3
44	Cook's theorem in np hard and np complete problems.	CO 6	T1:1.1,1.2
PROBLEM SOLVING/ CASE STUDIES			
45	Discuss problems onSpace complexity, time complexity.	CO 1	T1: 1.2.7,
46	Discuss the concept of Divide and Conquer such as general method, binary search and quick sort.	CO 2	T1:1.5, 1.4.2,1.4.3
47	Describe the concept of merge sort, Strassen's matrix multiplication.	CO 2	T1:1.4.3, 1.4.4, 2.3.1, 2.3.2,2.3.6, 2.3.7,2.3.8
48	Understand efficient non recursive binary tree traversal algorithms.	CO 3	T1:3.1,3.2 R1:6.2-6.8
49	Describe the concept of spanning trees with suitable examples.	CO 3	R1: 7.1-7.6
50	Analyze the concept of minimum cost spanning trees, single source shortest paths.	CO 4	R2: 9.8, 9.9, 10.1, 10.2
51	Describe general method of dynamic programming, matrix chain multiplication.	CO4	T2:5.5, 5.9, 5.10
52	Define all pairs shortest paths problem, the travelling salesperson problem.	CO 5	T1:5.8-5.9
53	Discuss the concept of Backtracking, the 8 queen's problem.	CO 5	T1:7.1-7.2
54	Apply Working with the classes NP - Hard and NP.	CO 6	T1:11.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
55	Time and space complexity, Asymptotic notations	CO 1	T1:1.1,1.2, T1:1.2.7, 1.2.8
56	Divide and conquer Algorithms	CO 2	T1:1.5, 1.4.2,1.4.3
57	Binary traversal, BFS,DFS Algorithms	CO 3	R2:8:2

58	General method of greedy method, job sequencing with deadlines, knapsack problem,minimum cost spanning trees, single source shortest paths.	CO 4	R2: 9.1-9.3 ,R2: 9.8, 9.9
59	The concept of Hamiltonian cycles, Branch and bound, Basic concepts of Deterministic and non deterministic Problems	CO 5 and 6	T1:7.5, 8.1.1
DISCUSSION OF QUESTION BANK			
60	Questions on module-1	CO 1, 2	T1:1.1,1.2, T1:1.2.7, 1.2.8
61	Questions on module-2	CO 3	T1:3.1,3.2
62	Questions on module-3	CO4	R2: 9.8, 9.9,
63	Questions on module-4	CO5	T1:5.8-5.9
64	Questions on module-5	CO6	T1:11.1

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr.S.Sreekanth, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE & ENGINEERING (AI & ML)

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE & ENGINEERING (AI & ML)**				
Course Title	**FOUNDATIONS OF MACHINE LEARNING**				
Course Code	ACAC03				
Program	B.Tech				
Semester	IV	CSE(AI & ML)			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	3	3	1	2
Course Coordinator	Ms Jalaja Vishnubhotla, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACAC03	IV	Basic knowledge of computer Hardware and Software

II COURSE OVERVIEW:

The main emphasis of this course is to provide systems the ability to automatically learn and improve from experience without being explicitly programmed. The course includes the fundamental concepts to build, train, and predict data models using machine learning (ML) algorithms. This course provides a clear understanding on concepts of supervised learning through decision trees, advanced techniques like neural networks, Naive Bayes and k-nearest neighbor algorithm and introduction to unsupervised and reinforcement learning. Machine Learning has revolutionized industries like medicine, healthcare, manufacturing, banking, and several other industries

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Foundations of Machine Learning	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
%	Remember
%	Understand
%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

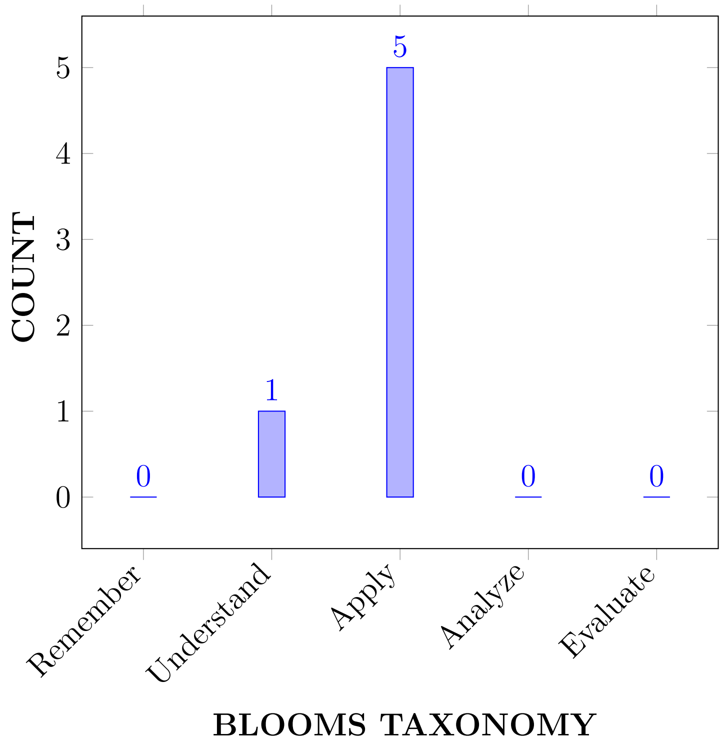
I	The fundamental concepts and techniques of machine learning.
II	The underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
III	The skills of using machine learning software for solving practical problems.
IV	To choose suitable machine learning algorithms and evaluate the performance of algorithms to provide solutions for various real-world problems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the characteristics of Machine Learning that make it useful to solve real-world problems	Understand
CO 2	**Make use of** Supervised Learning Algorithm for Classification Model and Decision Tree Learning.	Apply
CO 3	**Build** a Prediction Model by using Linear Regression Techniques and Ensemble Techniques.	Apply
CO 4	**Make use of** Bayesian Learning for Classification Model and outline Unsupervised learning Algorithms for determining hidden patterns in data	Apply
CO 5	**Discuss** the methodology of Neural Networks and Support Vector Machines to classify the Linear and Non-Linear data	Apply
CO 6	**Identify** appropriate Machine Learning Algorithms depending on the nature of the Learning System	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 10	**Project management and finance:**Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE / Quiz / AAT
PO 5	Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	CIE / Quiz / AAT
PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	CIE / Quiz / AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	CIE / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Understand, design and analyse computer programs in the areas related to Algorithms, System Software, Web design, Bigdata, Artificial Intelligence, Machine Learning and Networking.	3	CIE / Quiz / AAT
PSO 2	Focus on improving software reliability, network security and information retrieval systems.	2	CIE / Quiz / AAT
PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	2	CIE / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	-	-	✓	✓	-	-	-	-	-	-	-	✓	✓	-	-
CO 2	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-
CO 3	-	-	✓	-	-	-	-	-	-	-	-	✓	✓	-	-
CO 4	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-
CO 5	-	-	-	-	✓	-	-	-	-	-	-	✓	-	-	-
CO 6	-	-	✓	✓	✓	-	-	-	-	-	-	✓	✓	-	

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 3	Trying to define and identify **the characteristics required to design a learning system**	3
	PO 4	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**	4
	PO 12	Applying Machine Learning Algorithms **to solve real world problems**	6
CO 2	PO 4	Making use of Supervised Learning Algorithm **to build a Classification Model**	3
	PO 12	Ability to relate Hypothesis space search**for an Application using Decision Tree Learning**	4
	PSO 1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems**	4
	PSO 3	Use Supervised Learning Algorithm **for buiding Classification Model and Decision Tree Learning**	4

CO 3	PO 3	Building a Prediction Model using Linear Regression Techniques**and Ensemble Techniques**	2
CO 4	PO 4	Using Bayesian Learning for Classification model**and outlining Unsupervised Learning Algorithm for determining hidden patterns of data**	2
	PO 5	Trying to determine hidden patterns of data **using Unsupervised Learning Algorithms**	4
	PO 12	Knowledge of Bayesian Learning to find hidden patterns of data **using Unsupervised Learning Algorithms and techniques**	7
	PSO 2	Using Bayesian Learning to outline Unsupervised Learning Techniques **to determine hidden patterns of data**	5
CO 5	PO 4	Choosing Unsupervised Learning Techniques for optimizing the solution **and solving Classification and Regression Problems** .	1
CO 6	PO 2	Identify appropriate Machine Learning Algorithms to categorize Learning Tasks **depending on the nature of the Learning System**	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched											PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	1	2	3
CO 1	-	-	3	1	-	-	-	-	-	-	-		-	-	-
CO 2	-	-	-	2	-	-	-	-	-	-	-	-	1	-	1
CO 3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	3	1	-	-	-	-	-	5	-	-	4	-
CO 5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	1	-	-	-	-	-	-	-	-	-		-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	-	-	30	9	-	-	-	-	-	-	-		16	-	-
CO 2	66.7	-	-	-	-	-	-	-	-	-	-	-	16	-	50
CO 3	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	27	1	-	-	-	-	-	-	-	-	50	-
CO 5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	1	-	-	-	-	-	-	-	-	-		66.7	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0≤ C≤ 5% – No correlation
2 - 40 % <C < 60% –Moderate
1-5 <C≤ 40% – Low/ Slight
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	-	-	1	1	-	-	-	-	-	-	-		1	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	1	1	-	2
CO 3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	1	0	-	-	-	-	3	-		-	2	-
CO 5	-	-	-	-	0	-	-	-	-	3	-	-	-	-	-
CO 6	-	0	-	-	-	-	-	-	-	3	-		-	-	-
TOTAL	0	0	2	3	0	0	0	0	0	0	0	0	2	2	2
AVERAGE	0	0	0.3	0.5	0	0	0	0	0	0	0	0.3	0.3	0.3	0.3

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1,PO 2, PO 3, PO 4	SEE Exams	PO 1,PO 2, PO 3, PO 4	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 4	Open Ended Experiments	-
Assignments	PO 1, PO 2, PO 3, PO 4				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO MACHINE LEARNING**
	Machine Learning Foundations: Introduction to machine learning, learning problems and scenarios, need for machine learning, types of learning, standard learning tasks, the Statistical Learning Framework, Probably Approximately Correct (PAC) learning.

MODULE II	**SUPERVISED LEARNING ALGORITHMS**
	Learning a Class from Examples, Linear, Non-linear, Multi-class and Multi-label classification, Decision Trees: ID3, Classification and Regression Trees (CART), Regression: Linear Regression, Multiple Linear Regression, Logistic Regression
MODULE III	**ENSEMBLE AND PROBABILISTIC LEARNING**
	Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking Bayesian Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Mining Frequent Patterns
MODULE IV	**UNSUPERVISED LEARNING**
	Introduction to clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Self-Organizing Map, Expectation Maximization, Gaussian Mixture Models, Principal Component Analysis (PCA), Locally Linear Embedding (LLE), Factor Analysis
MODULE V	**ADVANCED SUPERVISED LEARNING**
	Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and NonLinear, Kernel Functions, K-Nearest Neighbors.

TEXTBOOKS

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, PHI, 3rd Edition, 2014.

2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2nd Edition, 2018.

REFERENCE BOOKS:

1. Tom M. Mitchell, “Machine Learning”, McGraw Hill, Indian Edition, 2017.

2. Sahi Shalev-Shwartz, Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2014.

3. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2010

4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning: Data Mining, Inference, and Prediction”, Springer, 2nd Edition, 2009.

5. Avrim Blum, John Hopcroft,Ravindran Kannan,”Foundations of Data Science”,Cambridge University Press, 2020

6. Gareth James, Daniela Witten, Trevor Hastie and Rob Tibshirani, “An Introduction to Statistical Learning: with applications in R”, Springer Texts in Statistics, 2017.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Institutions adopting OBE try to bring changes to the curriculum by dynamically adapting to the requirements of the different stakeholders like Students, Parents, Industry Personnel and Recruiters. OBE is all about feedback and outcomes. In this we will discuss about the course outcomes and program outcomes and their attainment		
	CONTENT DELIVERY (THEORY)		
1-2	Machine Learning Foundations:Introduction to Machine Learning, types of learning	CO1	T2: 1
2-3	Learning problems and scenarios, need for machine learning	CO1	T2: 2-6
3-4	Need for machine Learning, Types of Machine Learning	CO1	R2:-21-22
4-6	Standard learning tasks	CO1	T2:3
6-7	the Statistical Learning Framework,	CO1	R2:33-37
7-9	Probably Approximately Correct (PAC) learning.	CO1	R2:43
10-12	Learning a Class from Examples,	CO2	T1: 21
13-14	Decision Trees:	CO2	T1: 191
15-16	ID3, Classification and Regression Trees (CART),	CO2	T1: 191
17-18	Regression: Linear Regression, Multiple Linear Regression, Logistic Regression	CO2	R2:123-126
19-21	Ensemble Learning Model Combination Schemes, Voting	CO3	T1: 423-424
22-23	Error-Correcting Output Codes,	CO3	T1:427
24-25	Bagging: Random Forest Trees, Boosting: Adaboost, Stacking	CO3	T1:62-69
25-27	Bayesian Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Mining Frequent Patterns	CO3	R1:154-171,R1:174-190
28-30	Introduction to Clustering	CO4	T1:143-145
31-32	Partitional: K-means clustering	CO4	T1:144-145
32-33	Expectation Maximization, Gaussian Mixture Models,Hierarchical: AGNES, DIANA,	CO4	T1:149,157
33-36	Self-Organizing Map, Principal Component Analysis(PCA), Locally Linear Embedding (LLE), Factor Analysis	CO4	T1:113-120,286
37-40	Neural Networks: Introduction, Perceptron, Multilayer Perceptron	CO5	T1: 233-245
41-42	Support vector machines: Linear and NonLinear, Kernel Functions	CO5	T1:309-313
43-45	K-Nearest Neighbors.	CO5	T1:168-170

CASE STUDIES			
1	Let us say our hypothesis class is a circle instead of a rectangle. What are the parameters? How can the parameters of a circle hypothesis be calculated in such a case? What if it is an ellipse? Why does it make more sense to use an ellipse instead of a circle? How can you generalize your code to K greater than 2 classes?	CO 6	T1:43
2	Imagine our hypothesis is not one rectangle but a union of two (or m greater than 1) rectangles. What is the advantage of such a hypothesis class? Show that any class can be represented by such a hypothesis class with large enough m.	CO 6	T1:43
3	The complexity of most learning algorithms is a function of the training set. Can you propose a filtering algorithm that finds redundant instances?	CO 6	T1:43
4	For a two-class problem, generate normal samples for two classes with different variances, then use parametric classification to estimate the discriminant points. Compare these with the theoretical values	CO 6	T1:84
5	Assume a linear model and then add 0-mean Gaussian noise to generate a sample. Divide your sample into two as training and validation sets. Use linear regression using the training half. Compute error on the validation set. Do the same for polynomials of degrees 2 and 3 as well	CO 6	T1:85
6	In document clustering, ambiguity of words can be decreased by taking the context into account, for example, by considering pairs of words, as in cock tail party vs. party elections.Discuss how this can be implemented.	CO 6	T1:107
7	If we have a supervisor who can provide us with the label for any x, where should we choose x to learn with fewer queries?	CO 6	T1:43
8	One source of noise is error in the labels. Can you propose a method to find data points that are highly likely to be mislabeled	CO 6	T1:44
9	Take a word, for example, “machine.” Write it ten times. Also ask a friend to write it ten times. Analyzing these twenty images, try to find features, types of strokes, curvatures, loops, how you make the dots, and so on, that discriminate your handwriting from your friend’s	CO 6	T1:19
10	In basket analysis, we want to find the dependence between two items X and Y. Given a database of customer transactions, how can you find these dependencies? How would you generalize this to more than two items	CO 6	T1:18
11	Let us say we are building an OCR and for each character, we store the bitmap of that character as a template that we match with the read character pixel by pixel. Explain when such a system would fail. Why are barcode readers still used?	CO 6	T1:18

12	Imagine you have two possibilities: You can fax a document, that is, send the image, or you can use an optical character reader (OCR) and send the text file. Discuss the advantage and disadvantages of the two approaches in a comparative manner. When would one be preferable over the other?	CO 6	T1:18
13	Let us say you are given the task of building an automated taxi. Define the constraints. What are the inputs? What is the output? How can you communicate with the passenger? Do you need to communicate with the other automated taxis, that is, do you need a "language"?	CO 6	T1:18
14	In your everyday newspaper, find five sample news reports for each category of politics, sports, and the arts. Go over these reports and find words that are used frequently for each category, which may help us discriminate between different categories. For example, a news report on politics is likely to include words such as "government," "recession," "congress," and so forth, whereas a news report on the arts may include "album," "canvas," or "theater." There are also words such as "goal" that are ambiguous.	CO 6	T1:18
15	Assume we are given the task to build a system that can distinguish junk email. What is in a junk e-mail that lets us know that it is junk? How can the computer detect junk through a syntactic analysis? What would you like the computer to do if it detects a junk e-mail delete it automatically, move it to a different file, or just highlight it on the screen?	CO 6	T1:18
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Module I: INTRODUCTION TO MACHINE LEARNING	CO 1	T1:1-13
2	Module II: SUPERVISED LEARNING ALGORITHMS	CO 2	T1:21-41
3	Module III: ENSEMBLE AND PROBABILISTIC LEARNING	CO 3	T1:47-69
4	Module IV: UNSUPERVISED LEARNING	CO 4	T1:86-123
5	Module V: ADVANCED SUPERVISED LEARNING	CO 5	T1:125-158
DISCUSSION OF QUESTION BANK			
1	Module I: INTRODUCTION TO MACHINE LEARNING	CO 1	T1:1-13
2	Module II: SUPERVISED LEARNING ALGORITHMS	CO 2	T1:21-41
3	Module III: ENSEMBLE AND PROBABILISTIC LEARNING	CO 3	T1:47-69
4	Module IV: UNSUPERVISED LEARNING	CO 4	T1:86-123
5	Module V: ADVANCED SUPERVISED LEARNING	CO 5	T1:125-158

Signature of Course Coordinator **HOD,CSE (AI & ML)**
Ms. Jalaja Vishnubhotla, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING (AI & ML)					
Course Title	**THEORY OF COMPUTATION**					
Course Code	AITC04					
Program	B.Tech					
Semester	IV					
Course Type	Core					
Regulation	UG-20					
Course Structure	Theory			Practical		
	Lecture	Tutorials	Credits	Laboratory	Credits	
	3	1	4	-	-	
Course Coordinator	Mr. U Sivaji, Assistant Professor					

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC08	II	Probability and Statistics.
B.Tech	ACSB03	III	Data Structures
B.Tech	ACSB04	III	Discrete Mathematical Structures

II COURSE OVERVIEW:

This course focuses on infinite languages in finite ways, and classifies machines by their power to recognize. It includes finite automata, regular grammar, push down automata, context free grammars, and Turing machines It is applicable in designing phrasing and lexical analysis of a compiler, genetic programming and recursively enumerable languages

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Theory of computation	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Quiz						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could

be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
20%	Remember
20 %	Understand
0%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

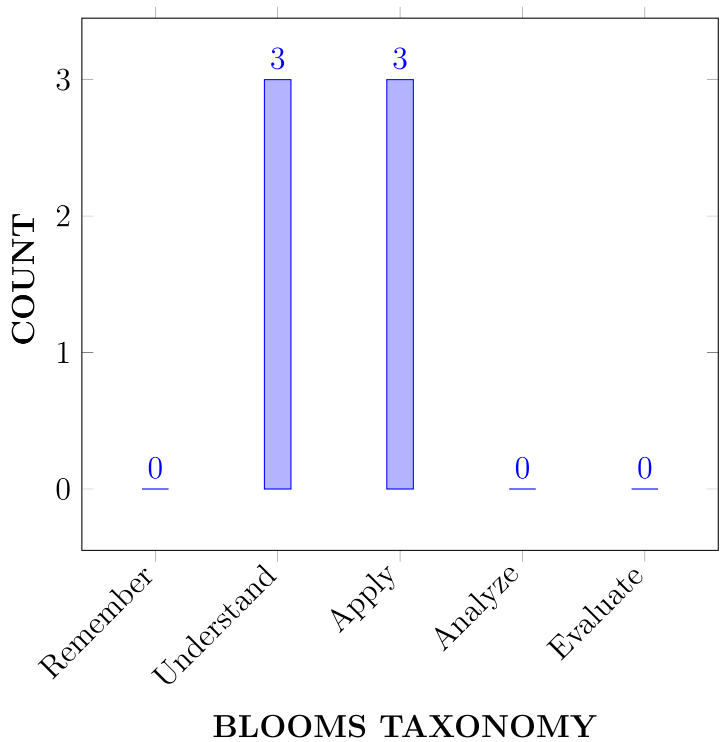
I	The fundamental knowledge of automata theory which is used to solve computational problems
II	The reorganization of context free language for processing infinite information using push down automata.
III	The computer based algorithms with the help of an abstract machine to solve recursively Enumerable problems

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** deterministic finite automata and non deterministic finite automata for modeling lexical analysis and text editors.	Apply
CO 2	**Extend** regular expressions and regular grammars for parsing and designing programming languages.	Understand
CO 3	**Illusrate** the pumping lemma on regular and context free languages for perform negative test .	Understand
CO 4	**Demonstarte** context free grammars, normal forms for generating patterns of strings and minimize the ambiguity in parsing the given strings.	Understand
CO 5	**Construct** push down automata for context free languages for developing parsing phase of a compiler.	Apply
CO 6	**Apply** Turing machines and Linear bounded automata for recognizing the languages,complex problems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
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PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
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PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1.2	AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1.5	SEE / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	CIE / Quiz / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1.5	CIE / Quiz / AAT /Tech-Talk

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	2.3	Group discussion/ Short term courses
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1.0	Research papers/ Industry exposure

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	✓
CO 2	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	✓	✓	✓	✓		-	-	-	-	-	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Evaluate properties of grammar for the given problem with the help of alphabet and strings and language by applying the mathematical principles and scientific principles.	2
	PSO 3	Demonstrate the basic text editors in real world software, using industry standard tools and collaboration techniques in the field of computational programming.	1
CO 2	PO 1	Understand the basics of context free grammars, its types and properties for finding pumping lemma by applying mathematical principles and scientific principles.	2
	PO 10	Understand the types of grammars and their properties and write effective reports and documentation .	1
	PSO 1	Make use of the concept of finite automata for developing algorithms of machine learning and networking concepts..	3
CO 3	PO 1	Find an optimized solution for the given problem using regular grammar by applying the knowledge of mathematical principles and computer engineering methodologies.	2
	PO 2	Understand the given problem and develop the solution using right and left linear grammar from the provided information and interpret of results.	4
	PO 3	Explain and demonstrate the translation of simple statements, by applying grammars by engineering processes.	2
CO 4	PO 1	Describe the role of Ambiguity in construction of context free grammars by understanding mathematical principles and scientific principles.	2
	PO 2	Understand the given problem and analyze the grammar and eliminate ambiguity using derivation trees and document the results for interpretation. .	3
	PO 10	Understand normalization techniques such as (Chomsky and griebach)to minimize the ambiguity.	1
	PSO 1	Understand the normalization techniques in the area related to parsing desire for higher studies in field of compiler design, machine Learning and data science.	3
CO 5	PO 1	Describe acceptance of context free language by final state and by empty stack problems by understanding mathematical principles, engineering methodologies and scientific principles.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Understand equivalence of context free language and pushdown automata for validation and design of inter conversionforsolving the given problem related to engineering from the provided information and data.	3
	PSO 3	Understand the principle of languages , grammars for computational programming to achieve engineering objectives.	1
CO 6	PO 1	Describe the recursively enumerable languages and churchs hypothesis using mathematical principles and scientific principles.	3
	PO 2	Understand the given problem statement and formulate the (complex) engineering problems in the Design of Turing machine in reaching substantiated conclusions by the interpretation of results.	3
	PO 3	Make Use ofTuring machinesto develop programs (define problem)for finding the solution (innovative) of complex engineering problems which satisfy the user constraints.	4
	PO 4	Ability to identify ,classify and describe the performance of turing machine by using analytical methods and modeling techniques.	4
	PSO 1	Analyze computable functions in the areas related to simulation of Turing machine, software testing, high performance computing, machine learning, software engineering and computer networks	6

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	-	-	-	-		-	-	1
CO 2	2	-	-	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	2	4	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	3	-	-		-	-	-	-	1	-	-	3	-	-
CO 5	2	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO 6	3	3	4	4	-	-	-	-	-	-	-		6	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	-	-	-	-	-	-	-	-	-	-		-	-	33.3
CO 2	66.7	-	-	-	-	-	-	-	-	20.0	-	-	50.0	-	-
CO 3	66.7	40.0	20.0	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.7	30.0	-	-		-	-	-	-	20.0	-	-	50.0	-	-
CO 5	100.0	30.0	-	-	-	-	-	-	-	-	-	-	-	-	33.3
CO 6	100.0	30.0	40.0	36.3		-	-	-	-	-	-		100.0	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 5	3	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 6	3	1	2	1	-	-	-	-	-	-	-	-	3	-	-
TOTAL	18	5	3	1	-	-	-	-	-	2	-	-	7	-	2
AVERAGE	3.0	1.25	1.5	1.0	-	-	-	-	-	1	-	-	2.3	0	1.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**FINITE AUTOMATA**
	Fundamentals: Alphabet, strings, language, operations; Introduction to finite automata: The central concepts of automata theory, deterministic finite automata, nondeterministic finite automata, an application of finite automata, finite automata with and without epsilon transitions, Conversion of NFA to DFA, Moore and Melay Machines.
MODULE II	**REGULAR LANGUAGES**
	Regular sets, regular expressions, identity rules, constructing finite automata for a given regular expressions, conversion of finite automata to regular expressions, pumping lemma of regular sets, closure properties of regular sets (proofs not required), regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and finite automata, inter conversion.
MODULE III	**CONTEXT FREE GRAMMARS**
	Context free grammars and languages: Context free grammar, derivation trees, sentential forms, right most and leftmost derivation of strings, applications. Ambiguity in context free grammars, minimization of context free grammars, Chomsky normal form, Greibach normal form, pumping lemma for context free languages, enumeration of properties of context free language (proofs omitted)
MODULE IV	**PUSHDOWN AUTOMATA**
	Pushdown automata, definition, model, acceptance of context free language, acceptance by final state and acceptance by empty stack and its equivalence, equivalence of context free language and pushdown automata, inter conversion;(Proofs not required); Introduction to deterministic context free languages and deterministic pushdown automata.
MODULE V	**TURING MACHINE**
	Turing machine: Turing machine, definition, model, design of Turing machine, computable functions, recursivey enumerable languages, Church's hypothesis, counter machine, types of Turing machines (proofs not required), linear bounded automata and context sensitive language, Chomsky hierarchy of languages.

TEXTBOOKS

1. John E. Hopcroft , Rajeev Motwani, Jeffrey D. Ullman, —Introduction to Automata, Theory, Languages and Computation, Pearson Education, 3rd Edition, 2007.

REFERENCE BOOKS:

1. John C Martin, —Introduction to Languages and Automata Theory, Tata McGraw Hill, 3rd Edition, 2017

2. Daniel I.A. Cohen, Introduction to Computer Theory, John Wiley Sons, 2nd Edition, 2004.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106103070

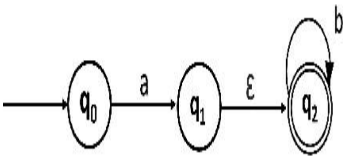
COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=account/login

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	In Outcome-Based Education (OBE), we discussed about course delivery assessment that are planned to achieve stated objectives and outcomes. We will focuses on measuring student performance i.e. outcomes at different levels. Course outcomes(CO),Program Outcomes(PO)and Program Specific Outcomes(PSO) and also mapping of CO's to PO's PSO's and their attainments are discussed.		
CONTENT DELIVERY (THEORY)			
1	Alphabet, strings, language and operations	CO1	T1:1.5-1.6
2	finite automata and concepts of automata theory	CO1	T1:2.1-2.2, R2:38-64
3	Demonstrate the behavior of deterministic finite automata	CO 1	T1:2.2-2.3
4-6	Understand the functionality of non- deterministic finite automata and Finite automata with epsilon transitions.	CO 1	T1:2.3-2.4, R1:3.1-3.3, R2:142-148
7	application of finite automata,Conversion of NFA to DFA, Moore and Melay Machines.	CO 1	T1:2.3-2.4, R1:3.1-3.3, R2:142-148
8-10	understand the Regular sets, regular expressions, identity rules	CO 2	T1: 3.1-3.2
11-13	finite automata for a given regular expressions, finite automata to regular expressions	CO 2	T1: 3.1-3.2
14-15	find the pumping lemma of regular sets, regular grammars, right linear and left linear grammars	CO 3	T1: 4.1-4.2
16-19	Regular grammars-right linear and left linear grammars	CO 4	T1: 4.4-4.5
20-22	regular linear grammar and finite automata, inter conversion.	CO 2	T1: 4.4-4.5
23-24	Apply Context free grammar on derivation trees	CO 4	T1: 5.1-5.5, R1:4.2-4.4
25-27	sentential forms, right most and leftmost derivation of strings	CO 4	T1: 5.1-5.5, R1:4.2-4.4
28-29	Ambiguity in context free grammars	CO 4	T1: 5.1-5.5, R1:4.2-4.4
30-32	Understand Minimization of context free grammars, Chomsky normal form, Greibach normal form	CO 4	T1: 7.4-7.5, R1:6.1-6.2
33-34	Pumping lemma for context free languages, properties	CO 3	T1: 7.4-7.5, R1:6.1-6.2
35-37	Apply the push down automata for acceptance of context free Languages	CO 5	T1: 6.1-6.2, R1:5.2-5.4
38-41	push down automata for given context free languages	CO 5	T1: 6.1-6.2, R1:5.2-5.4

42-43	acceptance by empty stack and its Equivalence.	CO 5	T1: 6.1-6.2, R1:5.2-5.4
44-45	Describe Equivalence of context free language and pushdown automata	CO 5	T1: 6.3-6.4
46-47	inter conversion, deterministic push down automata.	CO 5	T1: 6.3-6.4
48-53	Describe Turing machine, definition, model, computable functions	CO 6	T1: 8.1-8.2, R1:7.2-7.4
54-56	Apply Recursively enumerable languages	CO 6	T1: 8.2-8.6, R1:7.5-7.6
57-58	Types of Turing machines and Church's hypothesis.	CO 6	T1: 8.2-8.6, R1:7.5-7.6
59-60	Linear bounded automata and context sensitive language.	CO 6	T1:9.1-9.8, R2:551-560
61-62	Chomsky hierarchy of languages.	CO 6	T1:9.1-9.8, R2:551-560
	PROBLEM SOLVING/ CASE STUDIES		
1	Describe a DFA for the following language L={w/|w | mod5=0,w belongs to (a,b)*} L={w/|w | mod5=1,w belongs to (a,b)*}	CO 1	T1:2.3-2.4, R1:3.1-3.3
2	Convert NFA with ϵ to equivalent NFA M=({q0,q1,q2},{0,1,2}, δ, q0, {q2}) where δ is given by [δ (q0,0)={q0}, δ (q0,1)=ϕ, δ (q0,2)=ϕ, δ(q0, ϵ)=q1] [δ (q1,0)=ϕ, δ (q1,1)=q1 , δ (q1,2)=ϕ ,δ (q1, ϵ)=q2] [δ (q2,0)=ϕ, δ (q2,1)= ϕ , δ (q2,2)= {q2},δ (q2, ϵ)= ϕ]	CO1	T1:2.3-2.4, R1:3.1-3.3
3	Convert NFA with ϵ to equivalent DFA  	CO 1	T1:2.3-2.4, R1:3.1-3.3
4	Describe Pumping Lemma for Regular Languages. Prove that the language L = {a^n/ n is a n^5} is not regular	CO 3	T1: 7.4-7.5, R1:6.1-6.2
5	Convert the following automata into Regular expression M=({q1,q2,q3},{0,1}, δ, q1, {q2,q3}) where δ is given by [δ (q1,0)={q2}, δ (q1,1)={q3}] [δ (q2,0)={q1}, δ (q2,1)={q3}] [δ (q3,0)={q2}, δ (q3,1)= {q2}]	CO 2	T1: 3.1-3.2
6	Describe the DFA Transition diagram for equivalent Regular expression (ab+a) *(aa+b)	CO 1	T1:3.1-3.2
7	Convert the following grammar into GNF S→ABA/AB/BA/AA/B A→aA/a, B→bB/b	CO 4	T1: 7.4-7.5, R1:6.1-6.2
8	Describe the context free grammars in the four tuple form.(V,T,P,S) for the given languages on $\sum$={a,b} i. All strings having at least two a's ii. All possible strings not containing triple b's	CO 4	T1: 7.4-7.5, R1:6.1-6.2
9	Describe the steps to show the following is not CFG. { a$^m b^n c^p$| m< n or n< p}	CO 4	T1: 7.4-7.5, R1:6.1-6.2
10	Construct PDA for equal number of x's and y's. eg: xyyxxy	CO 5	T1: 6.1-6.2, R1:5.2-5.4

11	Construct NDPDA for L = { W$\neq$W$^R/W\in$(X + Y)*}	CO 5	T1: 6.1-6.2, R1:5.2-5.4
12	Construct DPDA for L = { W$\neq$W$^R/W\in$(X + Y)*}	CO 5	T1: 6.1-6.2, R1:5.2-5.4
13	Construct a Turing Machine that accepts the language L = {a$^{2n}b^n$|n$\geq$0}.Give the transition diagram for the Turing Machine obtained.	CO 6	T1: 8.2-8.6, R1:7.5-7.6
14	Construct a Turing Machine to accept the following languages L = { w$^n x^n y^n z^n$| n$\geq$1}	CO 6	T1:8.2-8.6, R1:7.5-7.6
15	Design a Turing Machine that accepts the language denoted by regular expression (000)*	CO 6	T1:8.2-8.6, R1:7.5-7.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Alphabet, strings, language and operations	CO 1	T1:1.5-1.6
2	understand the Regular sets, regular expressions, identity rules	CO 2	T1:3.1-3.2
3	Understand Minimization of context free grammars, Chomsky normal form, Greibach normal form	CO 4	T1:7.4-7.5, R1:6.1-6.2
4	push down automata for given context free languages	CO 5	T1:6.1-6.2, R1:5.2-5.4
5	Types of Turing machines and Church's hypothesis.	CO 6	T1:8.2-8.6, R1:7.5-7.6
DISCUSSION OF QUESTION BANK			
1	Describe the DFA with the set of strings having "aaa as a substring over an alphabet $\sum$ ={a,b}.	CO 1	T1:1.5-1.6
2	Convert Regular Expression (11+0)*(00+1)* to Finite Automata.	CO 2	T1:3.1-3.2
3	Describe a CFG for the languages L={a$^i b^j$| i$\leq$2j}	CO 4	T1:7.4-7.5, R1:6.1-6.2
4	Define the NPDA(Nondeterministic PDA) and DPDA(deterministic PDA) equivalent? Illustrate with an example.	CO 5	T1:6.1-6.2, R1:5.2-5.4
5	Describe a Turing Machine. With a neat diagram explain the working of a Turing Machine.	CO 6	T1: 8.2-8.6, R1:7.5-7.6

Signature of Course Coordinator **HOD,CSE(AI & ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING (AI & ML)				
Course Title	WEB APPLICATION DEVELOPMENT				
Course Code	AITC10				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	1.5
Course Coordinator	Mrs. S. ASWANI, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming
B.Tech	ACSC04	IV	Programming For Problem Solving Using C

II COURSE OVERVIEW:

This course introduces students to create concurrently a web app and a native app (for Android and iOS) with React Native and React Native Web. It covers HTML5 for structuring and presenting content on the World Wide Web. CSS3 being used to format structured content. To create a dynamic and interactive experience for the user it covers JAVASCRIPT. How build the applications using React concepts such as JSX, REDUX.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Foundations of Cyber Security	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.3%	Remember
55.5 %	Understand
11.1 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

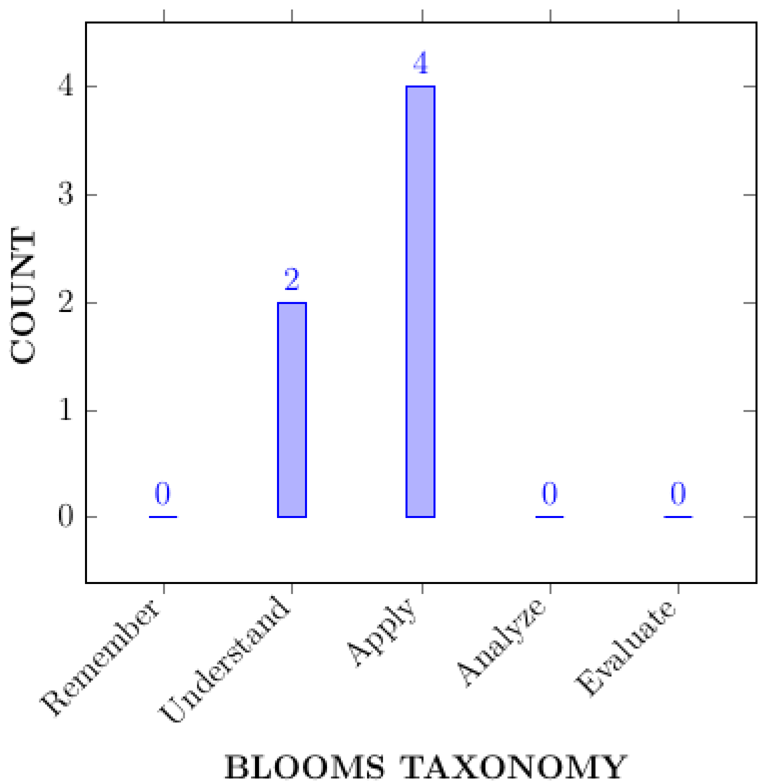
I	The characteristics, systematic methods, model for developing web applications.
II	The fundamentals of HTML and CSS to design static and dynamic web pages.
III	The concepts of client - server programming with JavaScript, Servlets, JSX.
IV	The MVC architecture, about React and built single and multiple page applications using REACT with REDUX.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** HTML elements and attributes for structuring and presenting content of webpage based on the requirement .	Understand
CO 2	**Classify** CSS properties for formatting webpages.	Understand
CO 3	**Develop** responsive webpage using Bootstrap for viewing web pages in various devices	Apply
CO 4	**Utilize** the concepts of JS with event actions for displaying information on webpages.	Apply
CO 5	**Identify** UI binding library elements for deploying a reusable complex UI.	Apply
CO 6	**Develop** a native web application with the help of React framework.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES :

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	6	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	4	Assignments/ Discussion
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	CIE/Quiz/AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Quiz
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	1	Quiz
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1	Quiz

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-
CO 2	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	✓	-			-	-	-	-	-		-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	-	-		-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**	3
	PO 3	**Designing and developing** static and dynamic web pages can help the student to design and develop **practical solutions**, to common problems, over the web.	2
	PO 12	Moderately mapped as students describe rationale for requirement for **continuing professional development**.	1
	PSO1	Moderately mapped as students understandand **use systems software** packages.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**	3
	PO 3	**Designing and developing** static and dynamic web pages can help the student to **design and develop** practical solutions, to common problems, over the web.	2
CO 3	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**.	3
	PO4	**Design of experiments** with the **knowledge** in web architecture	2
	PO 5	**Developing** real world web application using Javascript familiarize the student to modern tools for web development	1
	PSO1	Moderately mapped as students the **use of** concepts in writing theHTML and CSSprograms to **build web pages** 2	
CO 4	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**	3
	PO 3	**Designing and developing** static and dynamic web pages can help the student to design and develop **practical solutions**, to common problems, over the web.	2
CO 5	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**	3
CO 6	PO 1	**Knowledge** of web and components strongly helps student to **design and develop** web based **engineering solutions**	3
	PO 2	With the **analysis** of Javascript applications Analyze **complex engineering** problems.	2
	PO 3	**Designing and developing** static and dynamic web pages can help the student to design and develop **practical solutions**, to common problems, over the web.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	2	-	-	-	-	-	-	-	-	1	1	-	-
CO 2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	2	1	-	-	-	-	-	-	-	2	-	-
CO 4	3	-	2	-	-	-	-	-	-	-	-		-	-	-

CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	2	-	-	-	-	-	-	-	-		-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	20	-	-	-	-	-	-	-	-	8	16.6	-	-
CO 2	100	-	20	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	-	-	18	100	-	-	-	-	-	-	-	66.6	-	-
CO 4	100	-	20	-	100	-	-	-	-	-	-		-	-	-
CO 5	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	20	20	-	-	-	-	-	-	-	-		-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	1	-	-	-	-	-	-	-	-	1	1	-	-
CO 2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	1	3	-	-	-	-	-	-	-	3	-	-
CO 4	3	-	1	-	3	-	-	-	-	-	-		-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	1	1	-	-	-	-	-	-	-	-		-	-	2
TOTAL	18	1	4	-	6		-	-	-	-	-	1	4	-	-
AVERAGE	3	1	1	1	4		-	-	-	-	-	1	2	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	-	-	-	

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO WEB APPLICATION AND HYPERTEXT MODELLING**
	Introduction to web application, Basics of hypertext modeling, hypertext structure modeling concepts, access modeling concepts, relation to content modeling, presentation modeling, relation to hypertext modeling, customization modeling, relation to content, hypertext, and presentation modeling. Basics of HTML5 and web design, creating tables, HTML forms, styles and classes to your web pages, web page layouts with CSS, introduction to responsive web design with CSS3 and HTML5.
MODULE II	**BUILD INTERFCAES USING BOOTSTARP**
	Introduction to web design from an evolutionary perspective, user interface design through bootstrap, containers, tables, jumptrons, list, cards, carousal, navigation, modals, flex and forms, responsive web page design, basic UI grid structure.
MODULE III	**INTERACTIVE USER INFERFACE AND WEB APPLICATION DEVELOPMENT**
	JavaScript variable naming rules, data types, expressions and operators, pattern matching with regular expressions, managing web page styles using JavaScript and CSS, script forms, introduction to AJAX. Introduction to web design from an evolutionary perspective, create a native and web app, JSX, class and function components, props, state, lifecycle methods, and hooks
MODULE IV	**UI BINDING LIBRARY FOR REACT**
	Introduction to client-side routing using React Router, global state management and transitions using REDUX, server side rendering and testing using Jest, Enzyme and more. Web Development Using REACT is delivered both in a blended learning and self-paced mode.
MODULE V	**CONNECT TO AN EXTERNAL API**
	REDUX store using the official create store function, REDUX toolkit has a configure store API, loading state for that particular API, adding an API service as a middleware, example uses create REACT App.

TEXTBOOKS

1. Alok Ranjan Abhilasha Sinha, Ranjit Battewad, "JavaScript for Modern Web Development: Building a Web Application Using HTML, CSS, and JavaScript", 1st Edition,2020.

2. Alex Banks and Eve Porcello, "Learning React: Functional Web Development with React and Redux", 2017

REFERENCE BOOKS:

1. Adam Boduch and Roy Derks, "React and React Native: A complete hands-on guide to modern web and mobile development with React.js", 3rd Edition, 2020.

2. W Hans Bergsten, "Java Server Pages", O'Reilly, 3rd Edition, 2003.

3. D.Flanagan, "Java Script", O'Reilly, 6th Edition, 2011.

4. Jon Duckett, "Beginning Web Programming", WROX, 2nd Edition, 2008.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Institutions adopting OBE try to bring changes to the curriculum by dynamically adapting to the requirements of the different stakeholders like Students, Parents, Industry Personnel and Recruiters. OBE is all about feedback and outcomes. In this we will discuss about the course outcomes and program outcomes and their attainment		
CONTENT DELIVERY (THEORY)			
1-2	Introduction to web application	CO1	T2: 1.1-1.3
2-5	Basics of hypertext modeling	CO2	T1: 2.2-2.3
6-9	presentation modeling,	CO2	T1: 2.1,2-3-2.6
11-12	introduction to responsive web design with CSS3 and HTML5	CO2	R2: 3.4-3.9
11-12	user interface design through bootstrap	CO3	R2: 4.1-4.3
12-13	flex and forms, responsive web page design	CO3	T1: 27.1, T1:27.2, 27.6
14	JavaScript variable naming rules, data types, expressions and operators	CO3	T1: 28.1
15-17	web page styles using JavaScript and CSS	CO3	T2: 4.1-4.3
18-19	create a native and web app, JSX, class and function components	CO5,CO4	T1: 4.4-4.7
20-21	, props, state, lifecycle methods, and hooks	CO4	R1: 1.1-1.4
22-24	Introduction to client-side routing using React Router	CO5	T1 8.1-8.4
25-28	global state management and transitions using REDUX	CO5, CO6	T1:9.1, 9.3,9.4,9.6
29-33	server side rendering and testing using Jest	CO5	T1:11.1,11.3-11.4
34-37	Web Development Using REACT	CO5	T1:10.2, 10.5

38-44	Web Development Using REACT is delivered both in a blended learning and self-paced mode.	CO5	T1:17.3,17.6-17.8 T1:18.1-18.6
45-47	REDUX store using the official create store function	CO6	T1:10.1-1.3
48-51	REDUX toolkit	CO6	T1: 26.2, 26.6.4, T2:26.6.6, 26.10
52-55	state for that particular API	CO5,CO6	T1:26.1-26.3 28.1-28.7
56-59	adding an API service as a middleware	CO5,CO6	T1:27.1-27.6
60-62	example uses create REACT App	CO6	T1:25.1-25.6
CASE STUDIES			
1	Design the static web pages required for an online book store web site	CO 2	T1:11.2.1
2	Design A basic Bootstrap table has a light padding and only horizontal dividers.	CO3	T1:11.2.2
3	Creating buttons with Bootstrap 2Creating outline buttons styles in Bootstrap 3.Creating large buttons with Bootstrap 4.Creating small buttons with Bootstrap 5.Creating block buttons with Bootstrap 6.Creating disabled Bootstrap buttons using the input and button element	CO3	T1:11.2.18
4	Write a sum method which will work properly when invoked using either syntax below. console.log(sum(2,3)); // Outputs 5 console.log(sum(2)(3)); // Outputs 5	CO4	T1:11.2.25
5	How would you create a private variable in JavaScript?.	CO 6	T1:11.4.1
6	Write a recursive function that performs a binary search.	CO 4	T1:11.4.2
7	What are the different ways to style a React component?define them with example?	CO 4	R2:7.5
8	Write down the program to create a switching component for displaying different pages?	CO 6	R2:7.5
9	Write down the program to create forms in React?	CO 6	R2:7.5
10	layers of software engineering.	CO 6	R2:7.5
11	COCOMO model.	CO 6	T1:11.4.1
12	callback function	CO 6	T1:11.4.2
13	a recursive function that performs a binary search	CO 6	T1:11.5.1
14	types of functions	CO 6	T1:11.5.2
15	“native” methods using javascript? s	CO 6	T2:7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Module I: Introduction To Web Application and Hypertext Modelling	CO 1	R1:2.1-2.11

2	Module II:Build Interfcaes using Bootstarp	CO 2, 3	R1:4.2-4.11
3	Module III:Interactive user Interface and Web Application Development	CO 4	R2:5.6-5.9
4	Module IV:UI Binding Library for React	CO 5	R4:8.1-8.9
5	Module V:Connect to an External API	CO 6	R2:12.1-12.16
DISCUSSION OF QUESTION BANK			
1	Module I: Introduction To Web Application and Hypertext Modelling	CO 1	R1:2.1-2.11
2	Module II:Build Interfcaes using Bootstarp	CO 2, 3	R1:4.2-4.11
3	Module III:Interactive user Interface and Web Application Development	CO 4	R2:5.6-5.9
4	Module IV:UI Binding Library for React	CO 5	R4:8.1-8.9
5	Module V:Connect to an External API	CO 6	R2:12.1-12.16

Signature of Course Coordinator **HOD, CSE (AI & ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND INFORMATION TECHNOLOGY**				
Course Title	**DATABASE MANAGEMENT SYSTEMS LABORATORY**				
Course Code	AITC07				
Program	B.Tech				
Semester	IV	AI & ML			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr Y. Manohar Reddy, Assistant Professor				

I COURSE OVERVIEW:

This Laboratory course introduces the query language for design and development of a database by using various software's such as SQL, ORACLE, and MS – Access etc. It provides practice on built-in SQL functions using languages like DDL, DCL, DML and TCL to create and manage database systems and perform Set operations, Sub Queries, Joins; and PL/SQL programs to implement Exceptions, Cursors, Stored Functions, Views, Sequences, Locks and Triggers. This is essential for mobile and web application development for business, scientific and engineering applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC08	III	Data Structures

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Database Management Systems Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

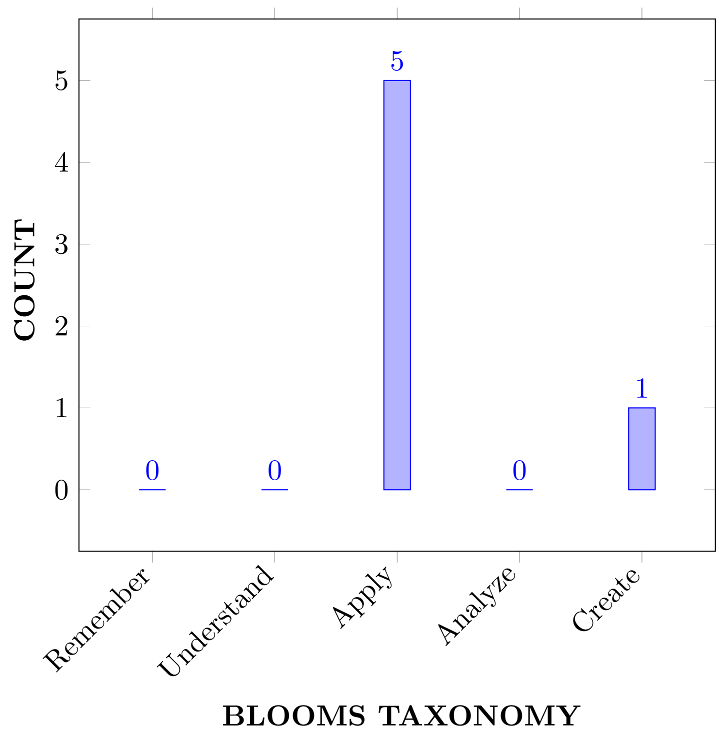
I	The SQL commands for data definition, manipulation, control and perform transactions in database systems.
II	The procedural language for implementation of functions, procedures, cursors and triggers using PL/SQL programs.
III	The logical design of a real time database system with the help of Entity Relationship diagrams.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** database creation and manipulation concepts with the help of SQL queries. .	Apply
CO 2	**Make use of** inbuilt functions of SQL queries to perform data aggregations, subqueries, embedded queries and views.	Apply
CO 3	**Apply** key constraints on database for maintaining integrity and quality of data.	Apply
CO 4	**Demonstrate** normalization by using referential key constraint.	Apply
CO 5	**Implement** PL/SQL programs on procedures, cursors and triggers for enhancing the features of database system to handle exceptions..	Apply
CO 6	**Design** database model with the help of Entity Relationship diagrams for a real time system or scenario.	Create

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 2	**Problem Analysis::** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Exercises,CIE,SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIA
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Exercises
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions..	3	Lab Exercises,CIE,SEE
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change..	2	Lab Exercises,CIE,SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 2	Demonstrate the use of SQL for database creation and maintenance with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	3
	PO 3	Demonstrate the use of SQL for database creation and maintenance with the help of Investigate and define a problem and identify constraints Manage the design process and evaluate outcomes,	4
	PO 5	Demonstrate the use of SQL for database creation and maintenance by Understanding of contexts in which engineering knowledge can be applied, understanding use of technical literature, Understanding of appropriate codes of practice and industry standards	3
	PSO 2	**Demonstrate** the use of SQL for database creation and maintenance by using a set of instructions	1
CO 2	PO 2	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	3
	PO 3	Demonstrate the use of SQL for database creation and maintenance with the help of Investigate and define a problem and identify constraints Manage the design process and evaluate outcomes,	4
	PO 5	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation by Understanding of contexts in which engineering knowledge can be applied, understanding use of technical literature, Understanding of appropriate codes of practice and industry standards.	3
	PO 10	Build strong foundation on SQL queries for career building by communicating effectively with engineering community.,	3
	PSO 2	Make Use of SQL queries for data aggregation, calculations, views, sub-queries, embedded queries manipulation by using a set of steps.	3
CO 3	PO 2	Define the relational data model, its constraints and keys to maintain integrity of data with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	4
	PO 10	Build strong foundation on relational model and keys for career building by communicating effectively with engineering community..	2

CO 4	PO 2	Apply normalization techniques to normalize a database with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	4
	PO 3	Apply normalization techniques to normalize a database Investigate and define a problem and identify constraints, understand customer and user needs, Manage the design process and evaluate outcomes, Investigate and define a problem and identify constraints, understand customer and user needsManage the design process and evaluate outcomes	4
	PO 5	Apply normalization techniques to normalize a database by Understanding of contexts in which engineering knowledge can be applied, Understanding use of technical literature, Understanding of appropriate codes of practice and industry standards.	3
	PSO 2	Apply normalization techniques to normalize a database by using sequence of steps	1
CO 5	PO 2	Define PL/SQL programs on procedures, cursors and triggers for enhancing the features of database system to handle exceptions. with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	4
CO 6	PO 2	Model the real-world database systems using Entity Relationship Diagrams from the requirement specification with the Problem statement and system definition, Problem formulation and abstraction, Information and data collection, Model translation	4
	PO 3	Model the real-world database systems using Entity Relationship Diagrams from the requirement specification through Investigate and define a problem and identify constraints, Understand customer and user needs, Manage the design process and evaluate outcomes.	4
	PO 5	Model the real- world database systems using Entity Relationship Diagrams from the requirement specification Understanding of contexts in which engineering knowledge can be applied, Understanding use of technical literature, Understanding of appropriate codes of practice and industry standards.	3
	PO 12	Build strong foundation on SQL and ER diagrams for career building by communicating effectively with engineering community.	2
	PSO 2	Model the real-world database systems using Entity Relationship Diagrams from the requirement specification by using sequence of steps	1

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE	PROGRAM OUTCOMES					PSO'S
OUTCOMES	PO 2	PO 3	PO 5	PO 10	PO12	PSO 2
CO 1	2	3	3			3
CO 2	2	3	3	2		3
CO 3	2			3		
CO 4	2	3	3			2
CO 5	2					
CO 6	2	3	3		2	3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**CREATION OF TABLES**
	1. Create a table called Employee with the following structure. Name Type Emp no Number E name Varchar2(20) Job Varchar2(20) Mgr Number Sal Number • Add a column commission with domain to the Employee table • Insert any five records into the table. • Update the column details of job • Rename the column of Employ table using alter command. • Delete the employee whose empno is19. 2.Create department table with the following structure. Name Type Dept no Number Dept name Varchar2(20) location Varchar2(20) • Add column designation to the department table. • Insert values into the table. • List the records of emp table grouped by dept no. Update the record where dept no is 9. • Delete any column data from the table. 3. Create a table called Customer table Name Type Cust Name Varchar2(20) Cust city Varchar2(20) Cust city Varchar2(20) • Insert records into the table. • Add salary column to the table. • Alter the table column domain. • Drop salary column of the customer table. • Delete the rows of customer table whose cust city is hyd. 4. Create a table called branch table. Name Type Branch Name Varchar2(20) Branch city Varchar2(20) Asserts Number • Increase the size of data type for asserts to the branch. • Add and drop a column to the branch table. • Insert values to the table. • Update the branch name column • Delete any two columns from the table 5. Create a table called sailor table Name Type S Name Varchar2(20) Rating Varchar2(20) Sid Number • Add column age to the sailor table. • Insert values into the sailor table. • Delete the row with rating¿8. • Update the column details of sailor. • Insert null values into the table. 6. Create a table called reserves table. Name Type Boat Id Number Day Number Sid Number • Insert values into the reserves table. • Add column time to the reserves table. • Alter the column day data type to date. • Drop the column time in the table. • Delete the row of the table with some condition.

WEEK II	**QUERIES USING DDL AND DML**
	1. a. Create a user and grant all permissions to the user. b. Insert the any three records in the employee table and use rollback. Check the result. c. Add primary key constraint and not null constraint to the employee table. d. Insert null values to the employee table and verify the result. 2. a. Create a user and grant all permissions to the user. b. Insert values in the department table and use commit. c. Add constraints like unique and not null to the department table. d. Insert repeated values and null values into the table. 3. a. Create a user and grant all permissions to the user. b. Insert values into the table and use commit. c. Delete any three records in the department table and use rollback. d. Add constraint primary key and foreign key to the table. 4. a. Create a user and grant all permissions to the user. b. Insert records in the sailor table and use commit. c. Add save point after insertion of records and verify savepoint. d. Add constraints not null and primary key to the sailor table. 5. a. Create a user and grant all permissions to the user. b. Use revoke command to remove user permissions. c. Change password of the user created. d. Add constraint foreign key and not null. 6. a. Create a user and grant all permissions to the user. b. Update the table reserves and use savepoint and rollback. c. Add constraint primary key , foreign key and not null to the reserves table

WEEK III	**QUERIES USING AGGREGATE FUNCTIONS**
	1. a. By using the group by clause, display the enames who belongs to deptno 10 , whose salary is same as respective departments average salary. b. Display lowest paid employee details under each department. c. Display number of employees working in each department and their department number. d. Using builtin functions, display number of employees working in each department and their department name from dept table. Insert deptname to dept table and insert deptname for each row, do the required thing specified above. e. List all employees which start with either B or C. f. Display only these ename of employees where the maximum salary is greater than or equal to 5000. Page 9 2. a. Calculate the average salary for each different job. b. Show the average salary of each job excluding manager. c. Show the average salary for all departments employing more than three people. d. Display employees who earn more than the lowest salary in department 30 e. Show that value returned by sign (n)function. f. How many days between day of birth to current date. 3. a. Show that two substring as single string. b. List all employee names, salary and 15c. Display lowest paid emp details under each manager d. Display the average monthly salary bill for each deptno. e. Show the average salary for all departments employing more than two people. f. By using the group by clause, display the eid who belongs to deptno 05 along with average salary. 4. a. Count the number of employees in department20 b. Find the minimum salary earned by clerk. c. Find minimum, maximum, average salary of all employees. d. List the minimum and maximum salaries for each job type. e. List the employee names in descending order. f. List the employee id, names in ascending order by empid. 5. a. Find the sids ,names of sailors who have reserved all boats called "INTERLAKE Find the age of youngest sailor who is eligible to vote for each rating level with at least two such sailors. b. Find the sname , bid and reservation date for each reservation. c. Find the ages of sailors whose name begin and end with B and has at least 3 characters. d. List in alphabetic order all sailors who have reserved red boat. e. Find the age of youngest sailor for each rating level. 6. a. List the Vendors who have delivered products within 6 months from order date. b. Display the Vendor details who have supplied both Assembled and Subparts. c. Display the Sub parts by grouping the Vendor type (Local or NonLocal). d. Display the Vendor details in ascending order.

WEEK IV	**PROGRAMS ON PL/SQL**
	1. a. Write a PL/SQL program to swap two numbers. b. Write a PL/SQL program to find the largest of three numbers. 2. a. Write a PL/SQL program to find the total and average of 6 subjects and display the grade. b. Write a PL/SQL program to find the sum of digits in a given number. Page 10 3. a. Write a PL/SQL program to display the number in reverse order. b. Write a PL / SQL program to check whether the given number is prime or not. 4. a. Write a PL/SQL program to find the factorial of a given number. b. Write a PL/SQL code block to calculate the area of a circle for a value of radius varying from 3 to 7. Store the radius and the corresponding values of calculated area in an empty table named areas, consisting of two columns radius and area. 5. a. Write a PL/SQL program to accept a string and remove the vowels from the string. (When hello passed to the program it should display Hll removing e and o from the world Hello). b. Write a PL/SQL program to accept a number and a divisor. Make sure the divisor is less than or equal to 10. Else display an error message. Otherwise Display the remainder in words
WEEK V	**PROCEDURES AND FUNCTIONS**
	1. Write a function to accept employee number as parameter and return Basic +HRA together as single column. 2. Accept year as parameter and write a Function to return the total net salary spent for a given year. 3. Create a function to find the factorial of a given number and hence find NCR. 4. Write a PL/SQL block o pint prime Fibonacci series using local functions. 5. Create a procedure to find the lucky number of a given birthdate. 6. Create function to the reverse of given number.
WEEK VI	**TRIGGERS**
	1. Create a row level trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old values and new values: CUSTOMERS table. 2. Creation of insert trigger, delete trigger, update trigger practice triggers using the passenger database. Passenger (Passport id INTEGER PRIMARY KEY, Name VARCHAR (50) Not NULL, Age Integer Not NULL, Sex Char, Address VARCHAR (50) Not NULL); a. Write a Insert Trigger to check the Passport id is exactly six digits or not. b. Write a trigger on passenger to display messages 1 Record is inserted, 1 record is deleted, 1 record is updated when insertion, deletion and updation are done on passenger respectively. Page 11 3. Insert row in employee table using Triggers. Every trigger is created with name any trigger have same name must be replaced by new name. These triggers can raised before insert, update or delete rows on data base. The main difference between a trigger and a stored procedure is that the former is attached to a table and is only fired when an INSERT, UPDATE or DELETE occurs. 4. Convert employee name into uppercase whenever an employee record is inserted or updated. Trigger to fire before the insert or update. 5. Trigger before deleting a record from emp table. Trigger will insert the row to be deleted into table called delete emp and also record user who has deleted the record and date and time of delete. 6. Create a transparent audit system for a table CUST MSTR. The system must keep track of the records that are being deleted or updated.

WEEK VII	**PROCEDURES**
	1. Create the procedure for palindrome of given number. 2. Create the procedure for GCD: Program should load two registers with two Numbers and then apply the logic for GCD of two numbers. GCD of two numbers is performed by dividing the greater number by the smaller number till the remainder is zero. If it is zero, the divisor is the GCD if not the remainder and the divisors of the previous division are the new set of two numbers. The process is repeated by dividing greater of the two numbers by the smaller number till the remainder is zero and GCD is found. 3. Write the PL/SQL programs to create the procedure for factorial of given number. 4. Write the PL/SQL programs to create the procedure to find sum of N natural number. 5. Write the PL/SQL programs to create the procedure to find Fibonacci series. 6. Write the PL/SQL programs to create the procedure to check the given number is perfect or not.
WEEK VIII	**CURSORS**
	1. Write a PL/SQL block that will display the name, dept no, salary of fist highest paid employees. 2. Update the balance stock in the item master table each time a transaction takes place in the item transaction table. The change in item master table depends on the item id is already present in the item master then update operation is performed to decrease the balance stock by the quantity specified in the item transaction in case the item id is not present in the item master table then the record is inserted in the item master table. 3. Write a PL/SQL block that will display the employee details along with salary using cursors. 4. To write a Cursor to display the list of employees who are working as a Managers or Analyst. Page 12 5. To write a Cursor to find employee with given job and deptno. 6. Write a PL/SQL block using implicit cursor that will display message, the salaries of all the employees in the employee table are updated. If none of the employees salary are updated we get a message 'None of the salaries were updated'. Else we get a message like for example, 'Salaries for 1000 employees are updated' if there are 1000 rows in "employee table.
WEEK IX	**CASE STUDY: BOOK PUBLISHING COMPANY**
	A publishing company produces scientific books on various subjects. The books are written by authors who specialize in one particular subject. The company employs editors who, not necessarily being specialists in a particular area, each take sole responsibility for editing one or more publications. A publication covers essentially one of the specialist subjects and is normally written by a single author. When writing a particular book, each author works with on editor, but may submit another work for publication to be supervised by other editors. To improve their competitiveness, the company tries to employ a variety of authors, more than one author being a specialist in a particular subject for the above case study, do the following: 1. Analyze the data required. 2. Normalize the attributes. Create the logical data model using E-R diagrams.

WEEK X	**CASE STUDY GENERAL HOSPITAL**
	A General Hospital consists of a number of specialized wards (such as Maternity, Pediatric, Oncology, etc). Each ward hosts a number of patients, who were admitted on the recommendation of their own GP and confirmed by a consultant employed by the Hospital. On admission, the personal details of every patient are recorded. A separate register is to be held to store the information of the tests undertaken and the results of a prescribed treatment. A number of tests may be conducted for each patient. Each patient is assigned to one leading consultant but may be examined by another doctor, if required. Doctors are specialists in some branch of medicine and may be leading consultants for a number of patients, not necessarily from the same ward. For the above case study, do the following. 1. Analyze the data required. 2. Normalize the attributes. 3. Create the logical data model using E-R diagrams.
WEEK XI	**CASE STUDY: CAR RENTAL COMPANY**
	A database is to be designed for a car rental company. The information required includes a description of cars, subcontractors (i.e. garages), company expenditures, company revenues and customers. Cars are to be described by such data as: make, model, year of production, engine size, fuel type, number of passengers, registration number, purchase price, purchase date, rent price and insurance details. It is the company policy not to keep any car for a period exceeding one year. All major repairs and maintenance are done by subcontractors (i.e. franchised garages), with whom CRC has long-term agreements. Therefore the data about garages to be kept in the database includes garage names, addresses, range of services and the like. Some garages require payments immediately after a repair has been made; with others CRC has made arrangements for credit facilities. Company expenditures are to be registered for all outgoings connected with purchases, repairs, maintenance, insurance etc. Similarly the cash inflow coming from all sources: Car hire, car sales, insurance claims must be kept of file. CRC maintains a reasonably stable client base. For this privileged category of customers special credit card facilities are provided. These customers may also book in advance a particular car. These reservations can be made for any period of time up to one month. Casual customers must pay a deposit for an estimated time of rental, unless they wish to pay by credit card. All major credit cards are accepted. Personal details such as name, address, telephone number, driving license, number about each customer are kept in the database. For the above case study, do the following: 1. Analyze the data required. 2. Normalize the attributes

WEEK XII	**CASE STUDY: STUDENT PROGRESS MONITORING SYSTEM**
	A database is to be designed for a college to monitor students' progress throughout their course of study. The students are reading for a degree (such as BA, BA (Hons) M.Sc., etc) within the framework of the modular system. The college provides a number of modules, each being characterized by its code, title, credit value, module leader, teaching staff and the department they come from. A module is coordinated by a module leader who shares teaching duties with one or more lecturers. A lecturer may teach (and be a module leader for) more than one module. Students are free to choose any module they wish but the following rules must be observed: Some modules require pre- requisites modules and some degree programme have compulsory modules. The database is also to contain some information about students including their numbers, names, addresses, degrees they read for, and their past performance i.e. modules taken and examination results. For the above case study, do the following:1. Analyze the data required. 2. Normalize the attributes. 3. Create the logical data model i.e., ER diagrams. 4. Comprehend the data given in the case study by creating respective tables with primary keys and foreign keys wherever required. 5. Insert values into the tables created (Be vigilant about Master- Slave tables). 6. Display the Students who have taken M.Sc course. 7. Display the Module code and Number of Modules taught by each Lecturer. 8. Retrieve the Lecturer names who are not Module Leaders. 9. Display the Department name which offers "English" module. 10. Retrieve the Prerequisite Courses offered by every Department(with department names). 11. Present the Lecturer ID and Name who teaches "Mathematics. 12. Discover the number of years a Module is taught. 13. List out all the Faculties who work for Statistics Department. 14. List out the number of Modules taught by each Module Leader. 15. List out the number of Modules taught by a particular Lecturer. 16. Create a view which contains the fields of both Department and Module tables. (Hint The fields like Module code, title, credit, Department code and its name). 17. Update the credits of all the prerequisite courses to 5. Delete the Module ":History from the Module table.

TEXTBOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", Mc raw-Hill, 4th Edition,2002

2. Ivan Bayross, "SQL, PL/SQL The programming language of oracle", BPB publications, 4th Revised Edition, 2010.

REFERENCE BOOKS:

1. Ramez Elmasri, Shamkant, B. Navathe, "Database Systems", Pearson Education, 6th Edition, 2013

2. Peter Rob, Carles Coronel, "Database System Concepts", Cengage Learning, 7th Edition, 2008

3. M L Gillenson, "Introduction to Database Management", Wiley Student Edition,2012.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Introduction to database management system environments.	CO 1	T1:4.1, T2:1.1
2	Creation of tables using DDL and DML commands.	CO 2	T1:4.9,4.11, T2:7
3	Working with integrity constraints	CO 3	T1:3, T2:8
4	Working with DCL and TCL commands	CO 1,CO 2	T1:6.6, T2:12
5	Queries using aggregate functions.	CO 3	T1:4.4, T2:10
6	Nested queries using comparison keywords and logical operators.	CO	T1:4.6, T2:10
7	Working with Programs on pl/sql.	CO 6	T2:15
8	Working with Procedures. .	CO 3,CO 6	T2:18
9	Working with Triggers.	CO 6	R2: 5.2
10	Working with functions.	CO 5	T2:18
11	Working with Cursors. .	CO 6	T2:10
12	Case study	CO 6	T1:2, T2:1

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Implementation of views using SQL.
2	**Open channel:** Practical Implementation of assertions using PL/SQL..

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Mr.Y Manohar Reddy, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Course Title	**FOUNDATIONS OF MACHINE LEARNING LABORATORY**				
Course Code	ACAC04				
Program	B.Tech				
Semester	IV	AIML			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	-	2	2
Course Coordinator	Dr. P.Chandana, Associate Professor				

I COURSE OVERVIEW:

This course introduces, the learning problem identification, collection of related data and problem solving approaches using intelligent algorithms such as decision trees (ID3 and CART), regression techniques (linear, multiple, and logistic), ensemble models (bagging, boosting, Voting), Bayesian Network (Naïve Bayes), unsupervised learning with clustering algorithm like k-means.

II COURSE PRE-REQUISITES:

Level	**Course Code**	**Semester**	**Prerequisites**
B.Tech	ACSC01	I	Python Programming

III MARKS DISTRIBUTION:

Subject	**SEE Examination**	**CIE Examination**	**Total Marks**
Foundations of Machine Learning	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

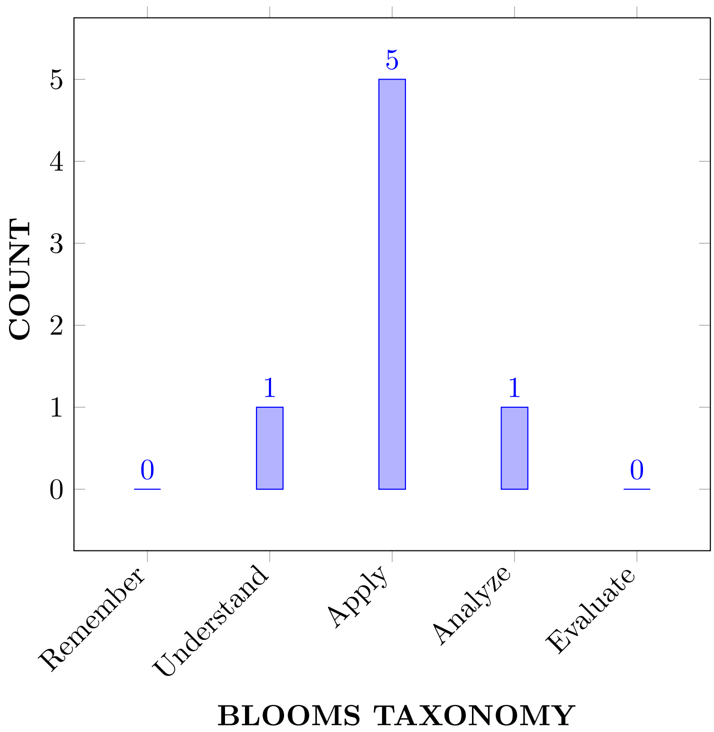
I	The supervised learning algorithms for solving learning problems such as classification and prediction.
II	The need of unsupervised learning for specific data.
III	The implementation of supervised and unsupervised learning algorithms with the help of python library functions.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the characteristics of Machine Learning that make it useful to solve real-world problems using Python	Understand
CO 2	**Make use of** Supervised Learning Algorithm for Classification Model and Decision Tree Learning.	Apply
CO 3	**Build** a Prediction Model by using Linear Regression Techniques and Ensemble Techniques.	Apply
CO 4	**Make use of** Bayesian Learning for Classification Model and outline Unsupervised learning Algorithms for determining hidden patterns in data	Apply
CO 5	**Discuss** the methodology of Clustering and EM Algorithms to understand the Linear and Non-Linear data	Apply
CO 6	**Discuss** the methodology of Neural Networks and Support Vector Machines to classify the Linear and Non-Linear data	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** UCreate, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Lab Exercises
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Trying to define and identify **the characteristics required to design a learning system**	2
	PO 3	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**	3

	PSO 3	Understand, design and analyze **basics of Machine Learning Algorithms to solve real world problems**	3
CO 2	PO 3	Making use of Supervised Learning Algorithm **to build a Classification Model** Ability to relate Hypothesis space search**for an Application using Decision Tree Learning**	3
	PSO 1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems**	3
CO 3	PO 5	Building a Prediction Model using Linear Regression Techniques**and Ensemble Techniques**	2
	PSO 2	Use Ensemble Algorithms **for Bagging , Boosting and Voting Process.**	3
CO 4	PO 3	Using Bayesian Learning for Classification model**and outlining Unsupervised Learning Algorithm for determining hidden patterns of data**	2
	PSO 2	Using Bayesian Learning to outline Unsupervised Learning Techniques **to determine hidden patterns of data**	3
CO 5	PO 3	Choosing Unsupervised Learning Techniques for optimizing the solution **and solving classification problem**.	1
	PSO 2	Using Bayesian Learning to outline Unsupervised Learning Techniques **to determine hidden patterns of data**	3
CO 6	PO 3	Build an Artificial Neural Network model and Support Vector Machine to **understand and cluster data.**	2
	PSO 2	Using ANN and SVM perform Unsupervised Learning Techniques **to determine hidden patterns of data**	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PROGRAM OUTCOMES		
	PO 1	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	2	2				3
CO 2		3		3		
CO 3			3		3	
CO 4		3			3	
CO 5		3			3	
CO 6		3				

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, PO 3, PSO 3	SEE Exams	PO 1,PO 3, PO 5, PSO 3	Seminars	-
Laboratory Practices	PO 1,PO 3, PO 5, PSO 3	Student Viva	PO 1, PO 5	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

<table>
<tr><td>WEEK I</td><td>ID3 (ITERATIVE DICHOTOMISER 3) ALGORITHM</td></tr>
<tr><td></td><td>Illustrate the decision tree by using ID3 algorithm and represent the knowledge in the form of rules to decide whether Saturdays are feasible for playing Tennis. Dataset link: https://www.kaggle.com/fredericobreno/play-tennis.</td></tr>
<tr><td>WEEK II</td><td>CART (CLASSIFICATION AND REGRESSION TREES) ALGORITHM</td></tr>
<tr><td></td><td>Demonstrate the working of CART algorithm. Use play tennis data set for building the decision tree and apply this knowledge to classify a new sample.</td></tr>
<tr><td>WEEK III</td><td>LINEAR REGRESSION</td></tr>
<tr><td></td><td>Design a simple linear regression model by considering whether to wear a jacket or not depending on the weather using the dataset below.
<table>
<tr><th>Outside Temperature (in °C)</th><th>Wear a Jacket</th></tr>
<tr><td>30</td><td>No</td></tr>
<tr><td>25</td><td>No</td></tr>
<tr><td>20</td><td>No</td></tr>
<tr><td>15</td><td>Yes</td></tr>
<tr><td>10</td><td>Yes</td></tr>
</table>
Consider the following sample data to observe the relationship by applying linear regression model.
<table>
<tr><th colspan="3">X</th><th rowspan="2">Y</th></tr>
<tr><th>X1</th><th>X2</th><th>X3</th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>14</td></tr>
<tr><td>4</td><td>5</td><td>6</td><td>32</td></tr>
<tr><td>11</td><td>12</td><td>13</td><td>74</td></tr>
<tr><td>21</td><td>22</td><td>23</td><td>134</td></tr>
<tr><td>5</td><td>5</td><td>5</td><td>30</td></tr>
</table>
</td></tr>
<tr><td>WEEK IV</td><td>MULTIPLE REGRESSION</td></tr>
<tr><td></td><td>Develop a predictive model by using multiple regression to predict the level of CO2 emission of a car based on the size of the engine. Dataset link: https://www.kaggle.com/datasets/gangliu/oc2emission " FuelConsumptionCo2.csv"</td></tr>
<tr><td>WEEK V</td><td>LOGISTIC REGRESSION</td></tr>
<tr><td></td><td>Apply Logistic Regression model to predict the purchase of company's newly launched Product. Hint: The dataset contains information of users from a company's database. It contains information about UserID, Gender, Age, EstimatedSalary, item purchased. We are using this dataset for predicting that a user will purchase the company's newly launched product or not.</td></tr>
<tr><td>WEEK VI</td><td>ENSEMBLE MACHINE LEARNING ALGORITHMS</td></tr>
</table>

	Demonstrate an ensemble machine learning algorithms using bagging, boosting and voting models on Pima Indians diabetes dataset.
WEEK VII	**NAÏVE BAYES CLASSIFIER**
	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
WEEK VIII	**HEART DISEASE PREDICTION USING BAYESIAN NETWORK**
	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.
WEEK IX	**CLUSTERING USING EM AND k-MEANS ALGORITHM**
	Apply EM algorithm to cluster a set of data stored in a .CSV file and visualize the clusters.
WEEK X	**k-NEAREST NEIGHBOUR ALGORITHM**
	Apply k-Nearest Neighbor algorithm to classify the iris data set.to identify false predictions. The Iris Dataset contains four features (length and width of sepals and petals) of 50 samples of three species of Iris (Iris setosa, Iris virginica and Iris versicolor).Print both correct and false predictions.
WEEK XI	**CLUSTERING AND k-MEANS ALGORITHM**
	Consider the Iris dataset. The data set contains 3 classes with 50 instances each, and 150 instances in total, where each class refers to a type of iris plant. Apply K-means clustering algorithm is to find groups in the data, with the number of groups represented by the variable K. i. Choose the number of clusters k ii. Select k random points from the data as centroids iii. Assign all the points to the closest cluster centroid iv. Recompute the centroids of newly formed clusters and repeat steps (iii) and (iv) v. Using the elbow method determine the optimal number of clusters for k-means clustering.
WEEK XII	**ARTIFICIAL NEURAL NETWORK**
	Churn Modelling data set: This data set contains details of a bank's customers and the target variable (binary variable) reflecting the fact whether the customer left the bank (closed his account) or he continues to be a customer. Dataset link: https://www.superdatascience.com/pages/deep-learning Build an Artificial Neural Network for Customer Churn Prediction using Churn Modeling dataset.

TEXTBOOKS

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, PHI, 3rd Edition, 2014.
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2nd Edition, 2018.

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1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, PHI, 3rd Edition, 2014.
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2nd Edition, 2018.
3. Yuxi (Hayden) Liu ,"Python Machine Learning By Example: Build intelligent systems using Python, TensorFlow 2, PyTorch, and scikit-learn",Packt Ingram, 3rd Edition,2017.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	ID3 (ITERATIVE DICHOTOMISER 3) ALGORITHM.	CO 2	R1: 1.2
2	CART (CLASSIFICATION AND REGRESSION TREES) ALGORITHM	CO 2	R2: 3.5
3	LINEAR REGRESSION	CO 3	R1: 3.4
4	MULTIPLE REGRESSION	CO 3	R1: 2.2
5	LOGISTIC REGRESSION	CO 3	R1: 2.4
6	ENSEMBLE MACHINE LEARNING ALGORITHMS	CO 4	R3: 4.5
7	NAÏVE BAYESIAN CLASSIFIER	CO 4	R3: 4.6
8	HEART DISEASE PREDICTION USING BAYESIAN NETWORK	CO 4	R2: 5.1
9	CLUSTERING USING EM AND k-MEANS ALGORITHM	CO 5	R2: 5.2
10	k-NEAREST NEIGHBOUR ALGORITHM	CO5	R1: 7.1
11	CLUSTERING AND k-MEANS ALGORITHM	CO 5	R1:7.2
12	ARTIFICIAL NEURAL NETWORK	CO 6	R1:7.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Decision Tree:** Decision Tree Classification demostration for the C4.5, ID3, CHAID and CART algorithms using Decision Tree classifier.
2	**Ensemble Methods:** Demonstration of Ensemble Methods for the improving accuracy and Performance using various ML models.
3	**Bayesian Networks:** Modelling Bayesian Networks for the topic and Opinion mining examples.
4	**Clustering:** Demostration of Heirarchical and Partitional Clustering Approaches.
5	**Neural Networks:** Encourage students to design and analyze Neural Networks by increasing hidden layers.

Signature of Course Coordinator
Dr. P Chandana, Associate Professor

HOD,CSE(AI & ML)

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Course Title	**WEB APPLICATION DEVELOPMENT LABORATORY**				
Course Code	AITC10				
Program	B.Tech				
Semester	IV	AI & ML			
Course Type	CORE				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Dr. D.Durga Bhavan,i Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming
B.Tech	ACSC04	IV	Programming For Problem Solving Using C

II COURSE OVERVIEW:

This course introduces students to developing web applications. This course presents the basics of HTML5 and CSS3, Other HTML tags for Web application Development. Learn to create links in HTML, Uses of HTML forms. Introduction to the use of Reacts trap for Bootstrap 4-base d responsive UI design. React router and its use in developing single-page applications, designing controlled forms. Redux and use it to develop React-Redux powered applications, client-server communication and the use of REST API on the server side, React primitives render to native platform UI.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Web Application Development	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

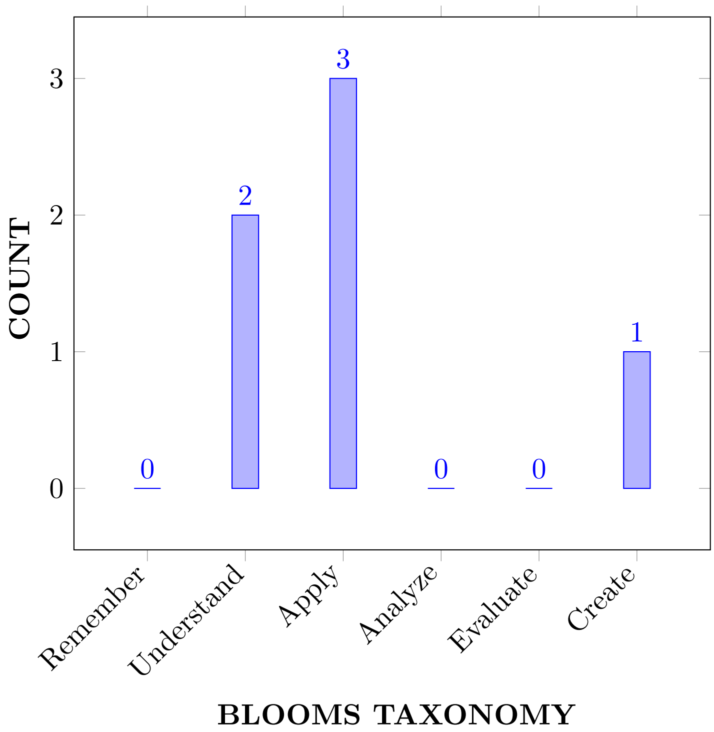
I	The characteristics, systematic methods, model for developing web applications.
II	The fundamentals of HTML and CSS to design static and dynamic web pages.
III	The concepts of client - server programming with JavaScript, Servlets, JSX..
IV	The MVC architecture, about React and built single and multiple page applications using REACT with REDUX.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classifyf** HTML elements and attributes for structuring and presenting content of webpage based on the requirement . .	Understand
CO 2	**Classify** CSS properties for formatting webpages.	Understand
CO 3	**Develop** responsive webpage using Bootstrap for viewing web pages in various devices .	Apply
CO 4	**Utilize** the concepts of JS with event actions for displaying information on webpages.	Apply
CO 5	**Identify** UI binding library elements for deploying a reusable complex UI.	Apply
CO 6	**Develop** ea native web application with the help of React framework.	Create

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercise, CIE,SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complexengineering-problemsreachingsubstantiatedconclusionsusingfirst principles of mathematics, natural sciences ,and engineering sciences.	2	Lab Exercise, CIE,SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercise, CIE,SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercise, CIE,SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	Lab Exercise, CIE,SEE
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercise, CIE,SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Problem-Solving Skills: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success	3	Lab Exercises
PSO 2	Focus on improving software reliability, network security or information retrieval systems	3	Lab Exercises

PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Make use of Usage of HTML elements and fundamentals **using principles of mathematics, science, and engineering fundamentals.**	3
	PO 2	Make use of Usage of HTML elements and fundamentals **with Problem statement and system definition, Problem formulation.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	2
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	2
	PSO 2	Focus on improving software reliability, **network security or information retrieval systems..**	2
	PSO 3	Describe the well utilization of r **resources for the better performance of the system.**	2
CO 2	PO 1	Describe to use CSS properties for formatting web pages **using principles of mathematics ,and engineering fundamentals..**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Under stand the concepts of CSS techniques and **apply real world entity**	2
	PSO 2	Demonstrate on writing programs using classes and ID's concepts for applications such as computational geometry, Big data **by understanding and applying the engineering principles.**	2
	PSO 3	Describe the well utilization of **resources for the better performance of the system.**	2

CO 3	PO 1	Develop responsive webpage using Bootstrap **using fundamentals of mathematics ,science, and engineering.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 2	Make use of Bootstrap programming and develop **efficient real-time computational problems.**	2
CO 4	PO 1	Describe the use of Java Script with event actions **using the knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 3	Usage of Demonstrate the importance of Java Script for developing programs in real-time scenarios **by communicating effectively with engineering community.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Understand the concepts of JS with event actions **for displaying information on web pages.**	2
	PSO 3	Describe the well utilization of **resources for the better performance of the system.**	2
CO 5	PO 1	Describe the importance of UI binding library elements **by understanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 3	Usage of Build strong foundation of UI binding library elements for deploying a reusable complex UI **By communicating effectively with engineering community.**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3

	PSO 2	Understand the concepts of UI binding library elements **for deploying a reusable complex UI .**	3
CO 6	PO 1	Make use of appropriate React framework **using the knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 3	Usage of Demonstrate the usage of React Framework in designing and developing **solutions of complex engineering applications..**	2
	PO 5	Understanding **of the limitations of Modern Tool Usage.**	3
	PO 10	Build strong foundation of programming Schemes for career building by communicating **effectively with engineering community.**	3
	PO 12	Build strong foundation of programming schemes for career **building by communicating effectively with engineering concepts.**	3
	PSO 1	Understand the concepts React framework for developing programs **using graphical user interface.**	2
	PSO 2	Usage of Make use of modern computer tools and appropriate modules in building **real-time applications for a successful career.**	3
	PSO 3	Describe the well utilization of **resources for the better performance of the system.**	2

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	PO1	PO2	PO3	PO5	PO10	PO12	PSO1	PSO2	PSO3
CO1	1	2		3	2	1	-	2	2
CO2	2			3	3	2	2	2	2
CO3	2			3	3	2	-	2	
CO4	1		2	3	2	4	3		2
CO5	1		2	3	3	-	-	3	
CO6	2	2		3	3	3	2	3	2

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams ✓	Seminars	-	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**HTML LAYOUTS AND LINKS**
	1. Develop a web application to control over different layouts. 2. Create a webpage with HTML describing your department use paragraph and list tags. 3. Apply various colors to suitable distinguish key words, also apply font styling like italics, underline and two other fonts to words you find appropriate, also use header tags. 4. Create links on the words e.g. "Wi-Fi" and "LAN" to link them to Wikipedia pages .
WEEK II	**WEB APLLICATION DESIGN FORMNG**
	1.Develop a web application with background banner image and navigation menus. 2. Develop a web application with responsive images. 3. Develop a web application using left menu. 4. Develop setting to change the theme of entire web Application.
WEEK III	**INTRODUCTION TO RESPONSIVE INTERFACE USING BOOTSRAP**
	1.Write code for developing responsive web application with Admin panel and tables with static data.
WEEK IV	**BUIDLING INTERFACES USING JAVASCRIPT**
	1. Set up the Folder Structure. 2. Write the Model code and initialize the application. 3. Implement the list objects and use cases. 4. Implement the create object use case. 5. Implement the update object use case.
WEEK V	**INTRODUCTION TO INTERATIVE FORMS AND AJAX DATA BINIDNG**
	1. Developing Web Page Styles using JavaScript and CSS, 2. Develop Script interactive forms 3. Data binding using Ajax.
WEEK VI	**REACT ENVIRONMENT SETUP**
	1.Setting up development environment. 2. Integration with Existing Apps. 3. Running on Device. 4. Debugging 5. Testing 6. Write source code using Typescript
WEEK VII	**PROGRAMMING WITH REACT**
	1.Basics Interactive examples. 2. Function Components and Class Components 3. React Native Fundamental, Handling Text Input, 4. Using a scroll View, using List View. 5. Platform Specific Code.
WEEK VIII	**BUILD A DRUNKEN SNAKE GAME USING HOOKS**
	1. Introduction and scaffolding the project. 2. Components, Props and Styles. 3. State and Lifecycle Events. 4. Extended Game Functionality. 5. Finishing up and Deployment.
WEEK IX	**PHP SESSIONS BOX React FOR DATA VISUALIZATION**

	1.Introduction and scaffolding the Project. 2. Pages and Layout. 3. Working with an API, CSS-in-JS. 4. Dynamic Pages and React Hooks. 5. Custom React Hooks, Dynamic CSS-in-JS. 6. Finishing up and Deployment. 7. Optimization and PWA.
WEEK X	**CHAT APPLICATION**
	1. Firebase Environment. Introduction and Scaffolding the project. 2. Private and Public pages, Context API. 3. Creating Side bar and Dashboard 4. Creating and displaying Chat Rooms. 5. Creating Layout for Chat page.
WEEK XI	**CHAT APPLICATION API RESPONSES**
	1.Context API Problem-solution for the chat messages. 2. De normalization of the data to be stored in app. 3. Displaying chat feed for Interactive UI along with Real time user presence.
WEEK XII	**DATABASES HANDLING**
	1. Role Based Access. 2. Messages Likes and deletion. 3. File and Audio Chat Messages 4. Extended Chat Features and Deployment

TEXTBOOKS

1. 1. Alok Ranjan Abhilasha Sinha, Ranjit Battewad, "JavaScript for Modern Web Development: Building a Web Application Using HTML, CSS, and JavaScript", 1st Edition, 2020.

2. 2. Alex Banks and Eve Porcello, "Learning React: Functional Web Development with React and Redux", 2017.

REFERENCE BOOKS:

1. Adam Boduch and Roy Derks, "React and React Native: A Complete Hands-on Guide to Modern Web and Mobile Development with React.js", 3rd Edition, 2020.

2. W Hans Bergsten, "Java Server Pages", O'Reilly, 3rd Edition, 2003.

3. D. Flanagan, "Java Script", O'Reilly, 6th Edition, 2011.

4. Jon Duckett, "Beginning Web Programming", WROX, 2nd Edition, 2008.

WEBREFERENCES:

1. https://www.codecademy.com/learn/paths/web-development/

2. https://nptel.ac.in/courses/106/105/106105084/

3. https://medium.com/@aureliomerenda/create-a-native-web-app-with-react-native-web-419acac86b82

4. https://www.coursera.org/learn/react-native

5. https://desirecourse.net/react-native-and-redux-course-using-hooks/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1-2	Introduction to web application.	CO 1	T2: 1.1-1.3
2-5	Basics of Hypertext Modeling	CO 2	T1: 2.2-2.3

6-9	Presentation Modeling.	CO 2	T1: 2.1,2-3-2.6
11-12	Introduction to responsive web design with CSS3 and HTML5.	CO 2	R2: 3.4-3.9
11-12	User Interface Design through Bootstrap.	CO 3	R2: 4.1-4.3
12-13	flex and forms, responsive web page design	CO 3	T1: 27.1,T1:27.2, 27.6
14	JavaScript variable naming rules, data types, expressions and operators.	CO 3	T2: 4.1-4.3
15-17	Web Page Styles using JavaScript and CSS.	CO 3	T2: 4.1-4.3
9	Event handling and layouts.	CO 2, CO 6	T2:24.1–24.6 T2:21.61
18-19	Create a native and web app, JSX, class and function components	CO 5,CO 4	T1: 4.4-4.7
20-21	props, state, lifecycle methods, and hooks.	CO 4	R1: 1.1-1.4
22-24	Introduction to client-side routing using React Router.	CO 5	T1 8.1-8.4
25-28	Global State Management and Transitions using REDUX.	CO 5 , CO 6	T1:9.1, 9.3,9.4,9.6
29-33	Server Side Rendering and Testing using Jest.	CO 5	T1:11.1,11.3 11.4
34-37	Web Development Using REACT.	CO5	T1:10.2, 10.5
38-44	Web Development Using REACT is delivered both in a blended learning and self-paced mode..	CO 5	T1:17.3,17.6 17.8 T1:18.1-18.6
45-47	REDUX store using the official create store function.	CO 6	T1:10.1- 1.3
48-51	REDUX toolkit	CO 6	T1: 26.2, 26.6.4, T2:26.6.6, 26.10
52-55	State for that particular API	CO 5, CO 6	T1:26.1-26.3 28.1-28.7
56-59	Adding an API Service as a Middleware	CO 5, CO 6	T1:27.1-27.6
60-62	Example uses Create REACT App	CO 6	T1:25.1-25.6

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	You are the owner of a big company. You are so rich, that the government has allowed you to print as many notes as you want of any single value that you like. You also have peculiar behavior altra its and you often do things that look weird to a third person. You have N N employees, where the employee has salary Ai Ai. You want to pay them using a denomination that you create. You are also eco friendly and wish to save paper. So, you wish to pay them using as few notes as possible. Find out the minimum number of notes required if you can alter the salary of at most one employee to any positive integer that you like, and choose the positive integer value that each note is worth (called its denomination). Each employee must receive the exact value of his/her salary and no more.
2	You're given a tree with N vertices numbered from 1 to N Your go a list of handle queries. For each query you are given K nodes v1,v2,...,vK. Find if there exists a simple path in the tree covering the give n vertices.

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr. D.Durga Bhavani, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING
COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI&ML)**				
Course Title	**COMPUTER NETWORKS**				
Course Code	AITC06				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr. P Rama Devi , Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB07	III	Computer Organization and Architecture

II COURSE OVERVIEW:

The main emphasis of this course is on the organization and management of local area networks (LANs) wide area networks (WANs). The course includes learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks. Topics include layered network architectures, addressing, naming, forwarding, routing, communication reliability, the client-server model, and web and email protocols. The applications of this course are to design, implement and maintain a basic computer networks.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Networks	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
50 %	Understand
30 %	Analyze
20 %	Evaluate

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

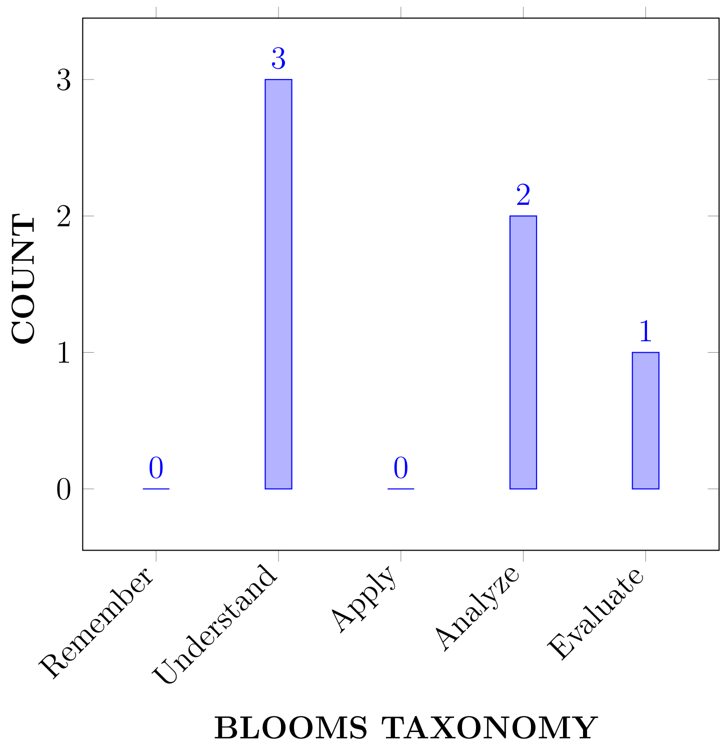
I	How computer network hardware and software operate
II	Investigate the fundamental issues driving network design
III	The data transmission through protocols across the network in wired and wireless using routing algorithms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** the basic concepts of data communications including the key aspects of networking and their interrelationship, packet, circuit and cell switching as internal and external operations, physical structures, types, models, and internetworking	Understand
CO 2	**Make use of** different types of of bit errors and the concept of bit redundancy for error detection and error correction.	Understand
CO 3	**Identify** the suitable design parameters and algorithms for assuring quality of service and internetworking in various internet protocols	Understand
CO 4	**Interpret** transport protocols (TCP,UDP) for measuring the network performance	Evaluate
CO 5	**Illustrate** the various protocols (FTP, SMTP,TELNET, EMAIL,WWW) and standards (DNS) in data communications among network.	Analyze
CO 6	**Compare** various networking models (OSI, TCP/IP) in terms of design parameters and communication modes.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering .community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions..	2	Discussion on Innovations / Presentation
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	Short term courses

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Research papers / Group discussion / Short term courses

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	Research papers / Group discussion / Short term courses
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	Research papers / Industry exposure

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	-	✓	✓	-	-	-	-	-	✓	-		✓	-	✓
CO 5	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-	✓
CO 6	✓	-	✓	-	-	-	-	-	-	-	-		-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand the importance of network types, suitable transmission medium, devices and the Internet in supporting business communications and everyday activities by understanding **fundamentals of Computer engineering specialization** and **scientific principles.**	1
CO 2	PO 1	Understand the importance of network types, suitable transmission medium, devices and the Internet in supporting business communications and everyday activities by understanding **fundamentals of Computer engineering specialization** and **scientific principles.**	2
	PO 2	Understand the **problem** statement and **choose appropriate techniques** by **analyzing** the importance of data hiding **interpretation of results.**	4
	PO 10	Recognize the importance of error detection and correction techniques for optimizing the efficiency of the networks by **communicating effectively** with **engineering community.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	Build strong foundation of the performance of a single link, logical process-to-process (end-to-end) channel, and a network as a whole (latency, bandwidth, and throughput) for career **building** by **communicating effectively** with **engineering community.**	4
CO 3	PO 1	Explain the concept of Hamming distance, and the significance of the minimum Hamming Distance and its relationship to errors by **understanding mathematical principles** and **scientific principles.**	3
	PO 2	Understand the **problem** statement and **choose appropriate techniques** by **analyzing**the importance of data hiding **interpretation of results.**	4
	PO 3	**Understand the concepts** E-mail, telnet, secure shell for **innovative solutions, evaluate the solution of the complex issues.**	3
	PO 10	Recognize the importance of error detection and correction techniques for optimizing the efficiency of the networks by **communicating effectively** with **engineering community.**	2
	PSO 1	Design **next-generation computer systems, networking devices, search engines, soft computing and intelligent systems, web browsers,** and **knowledge discovery tools.**	6
CO 4	PO 1	Describe the relationship between data and signals, their types, behavior, properties, characterization and transmission through the physical layer by **understanding mathematical principles** and **scientific principles.**	2
	PO 3	**Understand the concepts** E-mail, telnet, secure shell for **innovative solutions, evaluate the solution of the complex issues.**	3
	PO 4	Evaluate the performance of a single link, logical process-to-process (end-to-end) channel, a and **a network as a whole (latency, bandwidth, and throughput).**	2
	PO 10	Recognize the importance of error detection and correction techniques for optimizing the efficiency of the networks by **communicating effectively with engineering community.**	2
	PSO 1	Design **next-generation computer systems, networking devices, search engines, soft computing and intelligent systems, web browsers,** and **knowledge discovery tools.**	6
	PSO 3	Practical experience in **shipping real world software,using industry standard tools** and **collaboration techniques** will equip to secure and succeed in first job upon graduation in IT industry.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	Understand the basic design problems of data communications including the checksum, flow control, error control, reliability by apply the **knowledge of computer engineering fundamentals and mathematical principles.**	2
	PO 2	Understand the **problem** statement and **choose appropriate techniques by analyzing**analyzing the importance of data hiding **interpretation of results.**	3
	PO 3	**Understand the concepts** E-mail, telnet, secure shell for **innovative solutions, evaluate the solution of the complex issues.**	3
	PO 12	Build strong foundation of the performance of a single link, logical process-to-process (end-to-end) channel, and a network as a whole (latency, bandwidth, and throughput) for career **building by communicating effectively with engineering community.**	2
	PSO 1	Design **next-generation computer systems, networking devices, search engines, soft computing and intelligent systems, web browsers,** and **knowledge discovery tools.**	6
	PSO 3	Practical experience in **shipping real world software,using industry standard tools** and **collaboration techniques** will equip to secure and succeed in first job upon graduation in IT industry.	3
CO 6	PO 1	Describe the reliable inter-node transmission of chunks and congestion control methods for reliable data transmission across the network by apply the**knowledge of computer engineering fundamentals and mathematical principles.**	2
	PO 3	**Understand the concepts** E-mail, telnet, secure shell for **innovative solutions, evaluate the solution of the complex issues.**	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	2	4	-	-	-	-	-	-	-	2	-	4	-	-	-
CO 3	3	4	3	-	-	-	-	-	-	2	-	-	6	-	-
CO 4	2	-	3	2	-	-	-	-	-	2	-	-	6	-	3
CO 5	2	3	3	-	-	-	-	-	-	-	-	2	6	-	3
CO 6	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	66.7	40	-	-	-	-	-	-	-	40	-	33.3	-	-	-
CO 3	100	40	30	-	-	-	-	-	-	40	-	-	100	-	-
CO 4	66.7	-	30	18	-	-	-	-	-	40	-	-	100	100	-
CO 5	66.7	30	30	-	-	-	-	-	-	-	-	17	100	100	-
CO 6	66.7	30	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	2	-	1	-	-	-
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 4	3	-	1	1	-	-	-	-	-	1	-	-	3	3	-
CO 5	3	1	1	-	-	-	-	-	-	-	-	1	3	-	3
CO 6	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	15	5	4	1	-	-	-	-	-	4	-	2	9	3	3
AVER-AGE	2.5	1.6	1.3	1.0	-	-	-	-	-	1.3	-	1.0	3.0	1.0	1.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Introduction: Networks, network types, internet history, standards and administration; Network models: Protocol layering, TCP/IP protocol suite, the OSI model Transmission media: Introduction, guided media, unguided media; Switching: Introduction, circuit switched networks, packet switching.
MODULE II	**DATA LINK LAYER**
	Introduction: Link layer addressing; Error detection and correction: Cyclic codes, checksum, forward error correction; Data link control: DLC services, data link layer protocols, media access control: Random access, virtual LAN.
MODULE III	**NETWORK LAYER**
	Network layer design issues, routing algorithms, congestion control algorithms, quality of service, and internetworking. The network layer in the internet: IPv4 addresses, IPv6, internet control protocols, OSPF(Open Shortest Path First), IP (Internet Protocol)
MODULE IV	**TRANSPORT LAYER**
	The transport service, elements of transport protocols, congestion control; The internet transport protocols: UDP (User Datagram Protocol), TCP (Transport Control Protocol), performance problems in computer networks, network performance measurement.
MODULE V	**APPLICATION LAYER**
	Introduction, client server programming, WWW (World Wide Web) and HTTP (Hyper Text Transfer Protocol), FTP (File Transfer Protocol), E-mail, telnet, DNS (Domain Naming System), SNMP (Simple Network Management Protocol).

TEXTBOOKS

1. Behrouz A. Forouzan, “Data Communications and Networking”, Tata McGraw-Hill, 5th Edition, 2012.
2. Andrew S. Tanenbaum, David.j.Wetherall, ”Computer Networks”, Prentice-Hall, 5th Edition, 2010.

REFERENCE BOOKS:

1. Douglas E. Comer, “Internetworking with TCP/IP”, Prentice-Hall, 5th Edition, 2011
2. Peterson, Davie, Elsevier, “Computer Networks”, 5th Edition,2011
3. Comer, “Computer Networks and Internets with Internet Applications”, 4th Edition, 2004.
4. Chwan-Hwa Wu, Irwin, “Introduction to Computer Networks and Cyber Security”, CRC publications, 2014.

WEB REFERENCES:

1. https://www.geeksforgeeks.org/computer-network-tutorials/

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Introduction: Networks, network types	CO1	T1: 1.1
2	Internet history	CO1	T1:1.2
3	Standards and administration	CO1	T1: 1.3
4	Network models: Protocol layering	CO1	T1:1.4
5	TCP/IP protocol suite	CO1	T1: 1.5
6	The OSI model Transmission media: guided media, unguided media	CO1	T1:7.1
7	Switching	CO1	T1: 2.14
8	Circuit switched networks	CO1	T1: 8.1
9	Packet switching	CO1	T1: 8.2
10	Link layer addressing	CO2	T1: 10.0
11	Error detection and correction	CO2	T1: 10.1
12	Cyclic codes	CO2	T1: 10.1
13	Checksum	CO2	T1: 10.2
14	Forward error correction	CO2	T1: 10.2
15	Data link control: DLC services	CO2	T1: 11.1
16	Data link layer protocols	CO2	T1: 11.2
17	Media access control: Random access	CO2	T1: 11.3
18	Virtual LAN	CO2	T1:15.3
19	Network layer design issues	CO3	T1:19.1
20	Routing algorithms	CO3	T1: T1:19.1
21	Congestion control algorithms	CO3	T1:19.1
22	Quality of service and Internetworking	CO3	T1:19.1
23	The network layer in the internet: IPv4 addresses	CO3	T1:19.1
24	IPv6, internet control protocols	CO3	T1:19.2
25	OSPF (Open Shortest Path First)	CO3	T1:19.2
26	IP (Internet Protocol)	CO4	T1:19.1
27	The transport service	CO4	T1:23.0
28	Elements of transport protocols	CO4	T1:23.1
29	Congestion control	CO4	T1:23.1
30	The internet transport protocols: UDP (User Datagram Protocol)	CO4	T1:23.2
31	TCP (Transport Control Protocol)	CO4	T1:23.3
32	Performance problems in computer networks	CO4	T1:23.3

33	Network performance measurement	CO4	T1:23.3
34	Client server programming	CO5	T1:25.1
35	WWW (World Wide Web)	CO5	T1:25.2
36	HTTP (Hyper Text Transfer Protocol)	CO5	T1:25.3
37	FTP (File Transfer Protocol)	CO5	T1:25.4
38	E-mail, telnet	CO5	T1:25.5
39	DNS (Domain Naming System)	CO5	T1:25.6
40	SNMP (Simple Network Management Protocol)	CO5	T1:25.7
PROBLEM SOLVING/ CASE STUDIES			
41	With a network with bandwidth of 10 Mbps can pass only an average of 12,000 frames per minute with each frame carrying an average of 10,000 bits. What is the throughput of this network?	CO 1	T2:18.3.4, 18.3, 4.17
42	Demonstrate the Laplace transform of the message delay in FDMA in which every message contains a random number of packets. Compare the expected message delay with that of TDMA	CO 2	T2:24.2, 28.4
43	Why are we running out of IPv4 addresses? How does IPv6 solve this problem?	CO 3	T1: 276-296
44	Discuss in detail about the connection establishment and release in TCP.	CO 4	T2:24.3.6, 24.3.9
45	Discuss about application layer and client server programming	CO 5	T2:25.1, 25.1.2
46	Interpret the following sequences of characters (In Hexadecimals) received by a TELNET client or server. a. FFFB01 c. FFF4 FFFE01 d. FFF9	CO 5	T2:26.1.2, 26.2, 26.3, 26.4,26.5
DEFINITION AND TERMINOLOGY			
1	What is Computer Network?	CO 1	T2:2.1
2	Define Unacknowledged Information Transfer Service?	CO 2	T2:2.3
3	Define routing algorithm?	CO 3	T2:2.3.1
4	What is Secure Sockets Layer?	CO 4	T2:7.2,7.3
5	Define Network File system (NFS)?	CO 5	T2:10.3.1
DISCUSSION OF QUESTION BANK			
1	Illustrate the differences between the OSI and TCP/IP Reference Models.	CO 1	T2:2.1
2	Recognize knowledge on previous versions of internet	CO 2	T2:2.3
3	Understands on the various standards and administrations	CO 3	T2:2.3.1
4	Discuss on networks models and understand layering scenarios and protocols	CO 4	T2:7.2,7.3
5	Demonstrate on TCP/IP models	CO 5	T2:10.3.1
6	Demonstrate on Guided and Unguided medium.	CO 5	T2:13.3.2, 13.4.1

Signature of Course Coordinator **HOD, CSE(AI&ML)**
Dr. P Rama Devi, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering (AI and ML)**				
Course Title	**Image and Speech Processing**				
Course Code	ACAC05				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms. R. Venkata Sravya, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC08	II	PROBABILITY AND STATISTICS

II COURSE OVERVIEW:

This course introduces the fundamental concepts and techniques of digital image processing, concentrating on aspects of image processing in which both the inputs and outputs are images. It include image sampling and quantization, intensity transformation, spatial filtering, frequency domain filtering, image compression. It also deals with speech processing that ranges from the basic nature of the speech signal, through a variety of methods of representing speech in digital form, to applications in voice communication and automatic synthesis and recognition of speech.Speech processing in widely used is applications like google voice search, artificial intelligence voice controlled assistant like Alexa.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Image and Speech Processing	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.3%	Understand
33.3%	Apply
33.3 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

I	The fundamental concepts of digital image processing methods and techniques
II	The algorithms to solve image processing problems and meet design specifications for industry, medicine and defense applications.
III	Methods and systems for efficient quantization and coding of speech signals.
IV	The concepts of linear predictive analysis (LPC) for speech synthesis

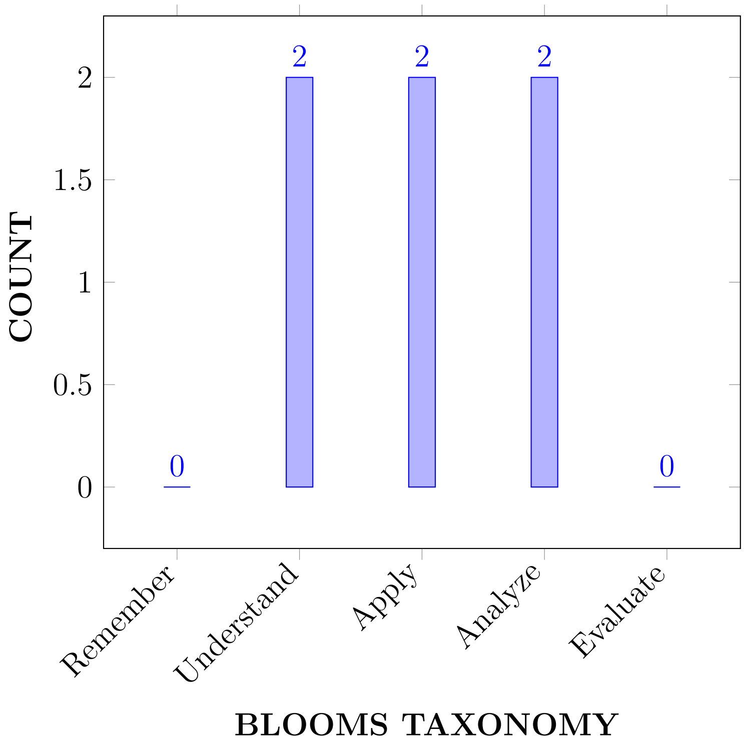
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** image transform techniques for analyzing images in transformation domain for image pre-processing.	Understand
CO 2	**List** the lossy and lossless compression models for achieving image compression.	Analyze

CO 3	**Illustate** the difference between acoustic phonetics and articulatory phonetics for speech processing	Understand
CO 4	**Utilize** digital model designed by sampled speech signal for speech processing applications like speech recognition, speech synthesis and verification.	Apply
CO 5	**Analyze** methods to estimate pitch period to design vocoders,aritificial intelligence voice-controlled assistants like Alexa	Analyze
CO 6	**Apply** linear predictive coding for speech synthesis, compression and spectrographic displays	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	1	Quiz

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Illustrate** the principles of the Digital Image Processing terminology **(knowledge)** for understanding image and its representation, pixel, intensity, gray level, relationship between the pixels by applying the **principles of engineering science to complex engineering problems**	2
	PO 2	**Identify** and **analyze** image using transformation techniques to **interpret** image properties and **model** the smoothing and sharpening filters using **frst principles of mathematics natural sciences, and Engineering sciences**	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Effective presentation and Speaking Style** on sampling and quantization and **write Subject Matter Effectively** the difference between analog and digital images.	4
	PSO 1	**Design** of experiments on image transforms with project development and execution process of **modern tools** such as MATLAB with image processing tool box, python, CV2.	2
CO 2	PO 1	**Understand** the various source coding techniques and Interpret Image Compression standards using **engineering science and mathematical models.**	3
	PO 2	**Identify and analyze** fidelity criteria, image compression models **implement** using **engineering science, design** system components for source Encoder and decoder, error free compression and **model translation using principal of mathematics.**	5
	PO 10	**Present effectively and Clarity** source encoder and **write effectively** subject matter on decoder techniques.	4
	PO 12	**Recognize the ability** of image restoration algorithms for **life-long learning** in the broadest context of image processing and constant update with the recent trends .	3
CO 3	PO 1	Applying **principles of mathematics, science and engineering** acoustic theory of speech production is understood to represent speech signal	3
	PO 2	**Define and analyze** waveforms of the acoustic phonectics of english language to **model translation** the vocal track and **implement** it using **principles of mathematics, science and engineering**.	5
	PO 10	**Communicate** effectively and **orally** present on the speech waveforms generated for different acoustic phonetics and articulatory phonetics	2
	PO 12	**Recognize the need** to analyze speech waveforms for different languages and **ability to improve** analyzing techniches of phonetics to meet the **technological needs** with **persistant learning** of CSE and engineerign concepts	4
	PSO 1	**Design** experiment on speech detection and waveform generation using phonetics and execute the process with **modern tools** like python, MATLAB	2
CO 4	PO 1	**Applying principles of mathematics, science and engineering** different mechanisms for speech prodcution is explained	3
	PO 2	**Identify** various linear digital models for **model translation** using **principles of mathmatics,science and engineering** to **define** acoustic impedance and **analyze** sampled speech signal	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Communicate** effectively and **orally** present on the digital models for generating speech signals and sampled them	2
	PO 12	**Recognize the need** for digital models to generate and analyze sampled signals and **ability to improve** the models for optimized generation of speechh signal to meet the **technological needs** with **persistant learnig** of CSE engineering conceots	4
CO 5	PO 1	Using **principles of mathematics, science, engineering** calculate pitch period, time period and zero crossing of sampled speech signal	3
	PO 2	**Analyze** average zero crossing rate, autocorrelation and AMDF models to **define** the pitch period to **solve complex** speech signals and obtain the digital models	3
	PO 10	**Communicate** effectively and **orally** present on the pitch period detection methods	2
	PO 12	**Recognize the need** for detection of pitch detection and **ability to improve** the pitch detection methods for digital modelas and meet the **technological needs** with **continuing education efforts** in advanced engineering concepts	4
CO 6	PO 1	Utilize principles of mathmatics, science and engineering to solve the linear predictive equations	3
	PO 2	**Solve** the linear predictive equations by **basic principles of mathematics, science and engineering** to **define** tranfer function and **model translation** of the digital models for generating speech signal and **validate** with the real-time speech signal for speech compression	5
	PO 10	**Communicate** effectively and **orally** present on the linear predictive coding methods	2
	PO 12	**Recognize the need** for linear predictive coding for speech synthesis and **ability to improve** the linear predictive solution to meet the **technological needs** with **constant learning** of CSE and advanced engineering concepts	4

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	5	-	-	-	-	-	-	-	4	-	-	2	-	-
CO 2	3	5	-	-	-	-	-	-	-	4	-	3	-	-	-
CO 3	3	5	-	-	-	-	-	-	-	2	-	4	2	-	-
CO 4	3	5	-	-	-	-	-	-	-	2	-	4	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	2	-	4	-	-	-
CO 6	3	5	-	-	-	-	-	-	-	2	-	4	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	66.6	50	-	-	-	-	-	-	-	80	-	-	25	-	-
CO 2	100	50	-	-	-	-	-	-	-	80	-	37.3	-	-	-
CO 3	100	50	-	-	-	-	-	-	-	40	-	50	40	-	-
CO 4	100	50	-	-	-	-	-	-	-	40	-	50	-	-	-
CO 5	100	30	-	-	-	-	-	-	-	40	-	50	-	-	-
CO 6	100	50	-	-	-	-	-	-	-	40	-	50	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	3	-	-	1	-	-
CO 2	3	2	-	-	-	-	-	-	-	3	-	1	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	2	1	-	-
CO 4	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	2	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
TOTAL	**18**	**11**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**10**	**-**	**9**	**2**	**-**	**-**
AVERAGE	3	1.8	-	-	-	-	-	-	-	1.6	-	1.8	1	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	Tech Talk	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**Digital Image Introduction and Transformation Techniques**
	Digital image basics, Brightness, Contrast and grey levels, Fundamentals steps in image processing, Intensity Transformation, Histogram equalization, Histogram matching, Smoothening and Sharpening spatial filters
MODULE II	**Image Compression**
	Fundamental Redundancy, Image Compression Models, Coding Theorems, Entropy, Error-Free Compression, Lossy Compression, LZW coding, Transform Coding, JPEG-2000 encoding, Lossless predictive coding, Lossy predictive coding.
MODULE III	**Fundamentals of Human Speech Production**
	The Process of Speech Production, Short-Time Fourier Representation of Speech, The Acoustic Theory of Speech Production. Lossless Tube Models of the Vocal Tract, Digital Models for Sampled Speech Signals.
MODULE IV	**Time Domain Models For Speech Processing**
	Time dependent processing of speech, short time energy and average magnitude, short time average zero crossing rate, discrimination between speech and silence, pitch period estimation using parallel processing, short time autocorrelation function and AMDF, pitch period estimation using autocorrelation function.
MODULE V	**Short Time Fourier Analysis and Linear Predictive Coding**
	Definition and properties, design of filter banks, implementation of filter bank summation method using FFT, spectrographic displays, pitch detection, analysis by synthesis phase, vocoder and channel vocoder, Basic principles of linear predictive analysis, the autocorrelation method, computation of the gain for the model, solution of LPC equations for auto correlation method, prediction error and normalized mean square error.

TEXTBOOKS

1. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson, 2002.
2. Lawrence R. Rabiner, Ronald W. Schafer, "Digital Processing of Speech Signals", Pearson Education, 2012

REFERENCE BOOKS:

1. Kenneth R. Castleman, "Digital Image Processing", Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB", Pearson Education Inc., 2011.
3. R. L. Rabiner, R.W. Schafer, "Digital Processing of speech signals", Pearson Education.
4. B. Gold and Nelson Morgon, "Speech and audio signal processing", Wiley India Edition,2006.
5. Dan Jurafsky and James H. Martin, "Speech and Language Processing", 2nd Edition, Pearson, 2017

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Base Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	Introduction to Image Processing	CO 1	"T1:1.4-1.5"
2	Relationship between pixels, sampling quantization	CO 1	"T1:2.4-2.5"
3	Haar, Slant, Hadamard and Walsh Image transforms	CO 1	"T1:2.4-2.5"
4	Histogram manipulation	CO 1	"T1:3.1-3.8"
5	Histogram equalization	CO 1	"T1:3.1-3.8; R2: 7.4-7.5"
6	Apply the Histogram processing technique for image enhancement"	CO 1	"T1:3.1-3.8; R2: 7.4-7.5"
7	Introduction to Image compression	CO 2	T1:8.1-8.3 ; R2: 7.4-7.5
8	Redundancies and their removal methods	CO 2	T1:8.1-8.3; R2: 7.4-7.5
9	Fidelity criteria, image compression models	CO 2	T1:8.1-8.3; R2: 7.4-7.5
10	Understand source encoder and decoder	CO 2	T1-8.1-8.1.7
11	Lossy compression & JPEG 2000 standard	CO 2	T1-8.1-8.1.7
12	Understand source encoder and decoder	CO 2	T1: 8.1-8.3
13	Error free compression	CO 2	T1: 8.1-8.3
14	Fundamentals of digital speech processing	CO 3	T2: 2.1-2.3
15	Fourier transform, discrete fourier transform	CO 3	T2: 2.4-2.6
16	Sampling,quantization	CO 3	T2: 2.4-2.5
17	Process of speech production	CO 3	T2:3.1-3.3
18	Acoustic Phonectics	CO 3	T2:3.1-3.3

19	Acoustic Theory of speech production	CO 3	T2-3.2-3.3
20	Lossless tube models boundary conditions	CO 4	T2:3.3-3.4
21	Vocal tract model	CO 4	T2-3.4-3.5
22	Transfer function of lossless tubes and vocal tract	CO 4	T2-3.3-3.4
23	Time dependent processing of speech	CO 5	T2: 4.1-4.3
24	Short-time energy and average magnitude	CO 5	T2:4.2-4.3
25	Short tie average zero crossing rate	CO 5	T2: 4.2-4.3
26	Speech vs silence discrimination methods	CO 5	T2:4.3-4.4
27	Pitch Period detection methods	CO 5	T2:4.4-4.7
28	Median smoothing and speech processing	CO 5	T2: 4.8-4.9
29	Fourier transform interpretionof speech signal	CO 6	T2:6.0-6.1
30	Linear filtering interpretation	CO 6	T2: 6.1.1-6.1.2
31	Short time synthesis methods	CO 6	T2: 6.1.4-6.15
32	Filter bank sysnthesis	CO 6	T2:6.2-6.3
33	Spectrographic displays	CO 6	T2: 6.4
34	Phase and channel vocoder	CO 6	T2: 6.6-6.7
35	Basic principles of linear predicitive analysis	CO 6	T2: 8.0-8.1
36	Solution of LPC equations	CO 6	T2: 8.2-8.3
37	Comparison of solution methods of LPC equations	CO 6	8.3-8.4
38	Frequency domain interpretation of LPC	CO 6	8.5-8.6
39	Relation of LPC analysis to digital models	CO 6	T2:8.6-8.7
40	Synthesis of speech from LPC parameters	CO 6	T2-8.9-8.10
PROBLEM SOLVING/ CASE STUDIES			
1	Problem solving on 2D-FFT and its properties	CO 1	T1-2.6-2.8, R2:5.8-5.10
2	Problem solving on Haar transform,Walsh transform, Hadmard transform	CO 1	T1:3.1-3.6

3	problem solving on histogram manipulation and equalization	CO 1	T1:3.1-3.8
4	Problem solving on image enhancement using removal of redundancies	CO 2	T1 -8.1-8.3 ,R2-7.4-7.6
5	Problem solving on image compression usinf JPEG 2000 standard	CO 2	T1:8.1-8.6
6	Problem solving on image compression using JPEG 2000 standard	CO 2	T1:8.1-8.3
7	Problem solving on transforms	CO 3	T2: 2.2-2.3
8	Problem solving on phonetics	CO 4	T2: 2.4-2.6
9	problem solving on lossless tubes	CO 4	T2:3.4-3.6
10	Problem solving on pitch period	CO 5	T2: 3.4-3.6
11	Problem solving on boundary conditions	CO 5	T2: 3.4-3.6
12	Problem solving on fourier series	CO 5	T2: 3.5-3.6
13	Problem solving on short0time fourier analysis	CO 6	T2:6.3-6.5
14	Problem solving on autocorrelation	CO 6	T2:8.1-8.2
15	Problem solving on linear predictive coding solution equations	CO 6	T2: 8.3-8.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Defnitions and terminologies on Introduction to Digital image processing	CO 1	T1:1.4-1.7
2	Defnitions and terminologies on image compression	CO 2	T1:8.1-8.3; R2: 7.4-7.5
3	Definitions and terminology on acoustic theory and phonetics	CO 3 ,4	T2: 3.0-3.3
4	Definitions and terminology on digital models and lossless tube models	CO 5	T2: 3.3 -3.5
5	Definitions and terminilogy on linear predictive analysis and solutions	CO 6	T2: 8.2-8.6
DISCUSSION OF QUESTION BANK			
1	Discussion on question bank of introduction to digital image processing	CO 1	T1: 1.4-1.6
2	Discussion on question bank of image compression	CO 2	T1:8.1 -8.4
3	Discussion on question bank of fundamentals of speech production and acoustic theory	CO 3,4	T2: 3.0-3.4

4	Discussion on question bank of time domain models for speech processing	CO 5	T2: 4.0 -4.6
5	Discussion on question bank of time fourier analysis and linear predictive coding	CO 6	T2: 6.0-6.6, T2: 8.2-8.6

Signature of Course Coordinator **HOD,ECE**
Ms. R.Venkata Sravya

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

Key Competencies for Assessing Program Specific Outcomes

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	5
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	11
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	7

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI&ML)**				
Course Title	**COMPILER DESIGN**				
Course Code	ACSC40				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms. I Sumalatha , Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	ACS01	I	Computer Programming
UG	ACS02	II	Data Structures
UG	AHS013	III	Discrete Mathematical Structures
UG	AIT002	IV	Theory of Computation

II COURSE OVERVIEW:

This course describes the basic techniques for compiler construction and tools that can be used to perform syntax-directed translation of a high-level programming language into an executable code. It will provide deeper insights into the more advanced semantics aspects of programming languages, machine independent optimizations and code generation.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Compiler Design	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

x	Chalk & Talk	✓	Quiz	✓	Assignments	x	MOOCs
✓	PPT	✓	Seminars	x	Mini Project	✓	Videos
x	open Ended Experiments						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
40 %	Understand
50 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

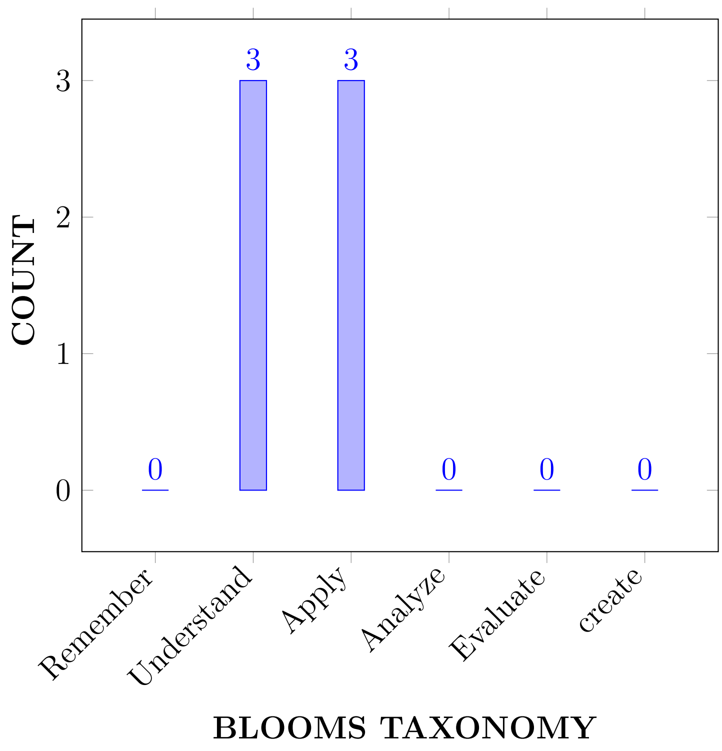
I	The process of translating a high-level language to machine code required for compiler construction.
II	The Software tools and techniques used in compiler construction such as lexical analyser and parser generators.
III	The data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines.
IV	The deeper insights into the syntax and semantic aspects of programming languages, dynamic memory allocation and code generation.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** phases of a compiler in the construction of language processors.	Understand
CO 2	**Make use of** finite automata for designing a lexical analyzer for a specific programming language constructs.	Apply
CO 3	**Choose** top down, bottom up parsing methods for developing a parser with representation of a parse table or tree.	Apply
CO 4	**Outline** syntax directed translations, intermediate forms for performing semantic analysis along with code generation.	Understand
CO 5	**Relate** symbol table, type checking and storage allocation strategies used in run-time environment.	Understand
CO 6	**Select** code optimization techniques on intermediate code form for generating target code.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Program Outcomes	
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / Quiz / AAT
PO 2	Problem analysis: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	CIE / Quiz / AAT
PO 3	Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE / Quiz / AAT
PO 5	Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	2	CIE / Quiz / AAT

PO 10	Communication: Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	CIE / Quiz / AAT/Tech-Talk

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR.	3	CIE/Quiz /AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	CIE/Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas	3	CIE/Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-
CO 4	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-
CO 5	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Describe the role of lexical analyzer and recognition of tokens, from regular expressions to finite automataby applying engineering fundamentals and provide solutions to engineering problems.	2
	PO 5	Understand the phases of compiler in optimizing regular Expressions by using the mathematical principles and computer science methodologies.	1
	PSO 1	Understand pass and phases of translation for specific problems with lexical analyzer generator.	1
CO2	PO 1	Understand the significant phases of translation, bootstrapping, LEX-lexical analyzer generator in lexical analysis using mathematical principles, fundamental of Computer engineering specialization and scientific principles.	3
	PSO 1	Understand the finite automata, regular Expressions in the area related to lexical analysis.	1
CO 3	PO 1	Understand the different types of parsing methods including the backtracking by apply the knowledge of computer engineering fundamentals and mathematical principles	2
	PO 2	Understand the problem statement and choose appropriate techniques by analyzing various grammars including stack implementation of parser by the interpretation of results.	3
	PSO 2	Understand the basic difference between top down parsing and bottom up parsing with reference to grammars and parser generator.	2
CO 4	PO 1	Describe Intermediate forms using syntax tree and three address code using mathematical principles and scientific principles.	2
	PO 3	Explain and demonstrate the translation of simple statements, Boolean expression and flow of control statements with three address code.	2
	PO 5	Understand the concepts of three address statements and its implementation in the intermediate code generation.	1
CO 5	PO 2	Analyze the process of symbol tables in runtime environment.	1
	PO 3	Understand the concepts of runtime environment evaluate the Source languageissues.	2

CO 6	PO 1	Demonstrate the code optimization by applying the principles of mathematics and engineering fundamentals.	2
	PO 2	Understand the given problem statement and formulate the (complex) engineering problems in the Design of a Code Generator and addresses in the target Code in reaching substantiated conclusions by the interpretation of results.	3
	PO 5	Create the addresses for Design of a Code Generator (complex) Engineering activities in Computer software.	1
	PO 10	Understand code optimization techniques on intermediate code forms such as syntax trees and design documentation, for improving the performance of a program.	1
	PSO 3	Demonstrate the basic optimization in real world software, using industry standard tools and collaboration techniques in the field of application programming.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2				1								1		
CO 2	3												1		
CO 3	2	3												2	
CO 4	2		2		1										
CO 5		1	2												
CO6	2	3			1					1					1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 3	66.7	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0
CO 4	66.7	0.0	66.7	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 5	0.0	33.3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 6	66.7	100	0.0	0.0	33.3	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	33.3

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0$\leq$ C$\leq$ 5% – No correlation
2 - 40 % <C < 60% –Moderate
1-5 <C$\leq$ 40% – Low/ Slight
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	2	-	-	-	-	-	-	-	2	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO 4	3	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO 5	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	2	-	-	-	-	2	-	-	-	-	2
TOTAL	15	8	6		6					2			4	3	2
AVERAGE	3	2	3		2					2			2	3	2

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO COMPILER**
	Introduction to compilers: Definition of compiler, interpreter and its differences, the phases of a compiler; Lexical Analysis: Role of lexical analyzer, input buffering, recognition of tokens, finite automata, regular Expressions, from regular expressions to finite automata, pass and phases of translation, bootstrapping, LEX-lexical analyzer generator.
MODULE II	**SYNTAX ANALYSIS**
	Syntax Analysis : Parsing, role of parser, context free grammar, derivations, parse trees, ambiguity, elimination of left recursion, left factoring, eliminating ambiguity from dangling-else grammar, classes of parsing, topdown parsing: backtracking, recursive-descent parsing, predictive parsers, LL(1) grammars Bottom-up parsing: Definition of bottom-up parsing, handles, handle pruning, stack implementation of shift- reduce parsing, conflicts during shift-reduce parsing, LR grammars, LR parsers-simple LR, canonical LR and Look Ahead LR parsers, error recovery in parsing, parsing ambiguous grammars,YACC-automatic parser generator.
MODULE III	**SYNTAX-DIRECTED TRANSLATION AND INTERMEDIATE CODE GENERATION**
	Syntax-directed translation: Syntax directed definition, construction of syntax trees, S-attributed and L- attributed definitions,syntax directed translation schemes . Intermediate code generation: Intermediate forms of source programs– abstract syntax tree, polish notation and three address code, types of three address statements and its implementation, syntax directed translation into three-address code, translation of simple statements, Boolean expressions and flow-of control statements
MODULE IV	**TYPE CHECKING AND RUN TIME ENVIRONMENT**
	Type checking: Definition of type checking, type expressions, type systems, static and dynamic checking of types, specification of a simple type checker, Run time environments: Source language issues, Storage organization, storage-allocation strategies, access to nonlocal data on the stack,garbage collection,symbol table.
MODULE V	**CODE OPTIMIZATION AND CODE GENERATION**
	Code optimization: The principle sources of optimization, optimization of basic blocks, loops in flow graphs, peephole optimization; Code generator: Issues in the design of a code generator, the target language,address in target code,Basic Blocks and flow graphs,Optimization of Basic Blocks,A simple code generator,Register allocation and assignment,DAG representation of basic blocks.

TEXTBOOKS

1. Alfred V.Aho, RaviSethi,JeffreyD, Ullman, —Compilers–Principles,TechniquesandTools, Pearson Education, 2nd Edition, 2006.

REFERENCE BOOKS:

1. Kenneth C.Louden,Thomson, —CompilerConstruction–PrinciplesandPractice, PWS Publishing, 1st Edition,1997.

2. Andrew W. Appel, —Modern Compiler Implementation C, Cambridge University Press, Revised Edition, 2004.

COURSE WEB PAGE:

1. http://csenote.weebly.com/principles-of-compiler-design.html

2. http://www.faadooengineers.com/threads/32857-Compiler-Design-Notes-full-book-pdf-download

3. http://www.e-booksdirectory.com/details.php?ebook=10166

4. http://www.e-booksdirectory.com/details.php?ebook=7400re

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	In Outcome-Based Education (OBE), we discussed about course delivery assessment that are planned to achieve stated objectives and outcomes. We will focuses on measuring student performance i.e. outcomes at different levels. Course outcomes(CO),Program Outcomes(PO)and Program Specific Outcomes(PSO) and also mapping of CO's to PO's PSO's and their attainments are discussed.		
CONTENT DELIVERY (THEORY)			
1	Introduction to compilers: Definition of compiler, interpreter and its differences	CO 1	T1:1.1-1.5 R1:1.1
2	The phases of a compiler	CO 1	T1:3.6-3.7 R1:2.2-2.4
3	Lexical Analysis: Role of lexical analyzer, input buffering	CO 1	T1: 1.5
4	recognition of tokens, finite automata.	CO 2	T1:1.1 R1:1.6
5	regular Expressions	CO 2	T1:3.8-4.3 R1:3.1-3.3
6	from regular expressions to finite automata.	CO 2	T1: 4.3-4.4 R1:4.1
7-8	pass and phases of translation, bootstrapping, LEX-lexical analyzer generator.	CO 2	T1:4.5-4.7 R1:4.3-4.5
9	Syntax Analysis: Parsing, role of parser, context free grammar.	CO 3	T1:4.5-4.7 R1:5.1-5.2
10	derivations, parse trees, ambiguity	CO 3	T1:4.7 R1:5.3
11	elimination of left recursion, left factoring	CO 3	T1: 4.7 R1:5.4-5.5
12	eliminating ambiguity from dangling-else grammar	CO 3	T1:4.7 R1:5.6

13	Types of parsing: Top-down parsing	CO 3	T1:4.9 R1:5.5
14	backtracking, recursive-descent parsing, predictive parsers,	CO 3	T1: 4.9
15	LL (1) grammars	CO 3	T1: 5.1-5.4 R1:6.1
16	Bottom-up parsing: Definition of bottom-up parsing,.	CO 3	T1:8.4-8.6
17	handles, handle pruning, stack implementation of shift-reduce parsing,	CO 3	T1: 6.1 R1:6.4-6.5
18	conflicts during shift-reduce parsing,	CO 3	T1: 7.1-7.5 R1:7.1
19	LR grammars, LR parsers-simple LR,	CO 3	T1: 7.6-7.7
20	canonical LR and Look Ahead LR parsers,	CO 3	T1: 10.2
21	YACC-automatic parser generator.	CO 3	T1:10.1-10.2 T1:10.4,9.9
22	Syntax-Directed Translation: Syntax directed definitions, construction of syntax trees	CO 4	T1: 9.1-9.2
23	S-attributed and L- attributed definitions; Syntax Directed Translation schemes.	CO 4	T1: 9.3 R1:7.6
24	Intermediate code generation: Intermediate forms of source	CO 4	T1: 9.4
25	programs– abstract syntax tree, polish notation and three address code,	CO 4	T1:9.6-9.7 R1:8.1-8.8
26	Types of three address statements and its implementation	CO 4	T1: 9.8
27	syntax directed translation into three-address code	CO 4	T1: 9.1-9.2
28	translation of simple statements, Boolean expressions	CO 4	T1: 9.1-9.2
29	Flow-of- Control statements.	CO 4	R1:8.1-8.8
30	Type checking: Definition of type checking,	CO 5	R1:8.1-8.8
31	type expressions, type systems, static and dynamic checking of	CO 5	T1: 9.4
32	specification of a simple type checker	CO 5	T1: 9.1-9.2
33	Run time environments: Source language issues,	CO 5	T1: 9.1-9.2
34	Types Storage organization	CO 5	T1: 9.1-9.2
35	storage-allocation strategies,	CO 5	T1: 9.1-9.2
36	access to nonlocal data on the stack,	CO 5	T1: 9.1-9.2
37	Garbage collection, symbol tables.	CO 5	T1: 9.1-9.2
38	Code optimization: The principle sources of optimization	CO 6	T1: 9.1-9.2
39	optimization of blocks	CO 6	T1:10.1-10.2 T1:10.4,9.9
40	loops in flow graphs	CO 6	T1: 10.2

41	peephole optimization	CO 6	T1: 9.1-9.2
42	Code Generation: Issues in the Design of a Code Generator	CO 6	T1: 9.1-9.2
43-44	The Target Language, addresses in the Target Code,	CO 6	T1:10.1-10.4
45-46	Basic Blocks and Flow Graphs	CO 6	T1: 9.1-9.2
47	Optimization of Basic Blocks	CO 6	T1: 9.1-9.2
48	A Simple Code Generator	CO 6	T1:9.6-9.7 R1:8.1-8.8
49	register allocation and assignment	CO 6	T1:9.6-9.7
50-52	DAG representation of basic blocks.	CO 6	R1:8.1-8.8
PROBLEM SOLVING/ CASE STUDIES			
1	Consider the following fragment of C code: float i, j; i = i*70+j+2; Construct the output at all phases of the compiler for above C code	CO 1	T1:1.1-1.5 R1:1.1
2	For the following expression total = count + rate * 5 Construct the output after each phase of compiler?	CO 1	T1:1.1-1.5 R1:1.1
3	Convert NFA with ϵ to equivalent NFA M=({q0,q1,q2},{0,1,2}, δ, q0, {q2}) where δ is given by [δ (q0,0)={q0}, δ (q0,1)=ϕ, δ (q0,2)=ϕ, δ(q0, ϵ)=q1] [δ (q1,0)=ϕ, δ (q1,1)=q1 , δ (q1,2)=ϕ ,δ (q1, ϵ)=q2] [δ (q2,0)=ϕ, δ (q2,1)= ϕ , δ (q2,2)= {q2},δ (q2, ϵ)= ϕ]	CO 2	T1:1.1 R1:1.6
4	Describe a DFA for the following language L={w/|w | mod5=0,w belongs to (a,b)*} L={w/|w | mod5=1,w belongs to (a,b)*}	CO 2	T1:1.1 R1:1.6
5	Describe the DFA Transition diagram for equivalent Regular expression (ab+a) *(aa+b)	CO 2	T1:3.8-4.3 R1:3.1-3.3
6	Construct the FIRST and FOLLOW sets for following grammar S$\rightarrow$ aBDh , B $\rightarrow$ cC , C $\rightarrow$ bC / ϵ , D $\rightarrow$ EF , E $\rightarrow$ g / ϵ , F $\rightarrow$ f / ϵ	CO 3	T1: 4.9
7	Construct SLR parsing table for the below grammar? E $\rightarrow$ E+T |T T $\rightarrow$ T*F | F F$\rightarrow$ (E) |id.	CO 3	T1: 7.6-7.7
8	Outline the CLR Parsing model and write the CLR parsing algorithm for constructing the parsing table	CO 3	T1: 10.2

9	Construct production rules and semantic actions for the following grammar along with annotated parse tree for the expression: "int a, b, c"? D →T L T →int T → float; L→ L1,id L → id	CO 4	T1: 9.1-9.2
10	Construct the three address code and draw the abstract tree for the following expressions? a) (x-y)*z+m-n b) a+(b-c)+(b+c)*(a*e)	CO 4	T1: 9.1-9.2
11	Translate the expression – (a + b) * (c + d) + (a + b +c) into a) quadruples b) triples	CO 4	T1: 9.8
12	Explain briefly about Activation record with block diagram	CO 5	T1: 9.1-9.2
13	Explain the specification of a simple type checker	CO 5	R1:8.1-8.8
14	Construct the code sequence generated by the simple code generation algorithm for x*y+(m-k)-(g+b)	CO 6	T1:9.6-9.7 R1:8.1-8.8
15	Explain the concept of Function-Preserving Transformations	CO 6	T1:10.1-10.2 T1:10.4,9.9
DISCUSSION ON DEFINITION AND TERMINOLOGY			
1	Definition of compiler, interpreter and its differences, the phases of a compiler	CO 1	T1:1.1-1.5 R1:1.1
2	LR grammars, LR parsers-simple LR,CLR ,LALR	CO 3	T1: 7.6-7.7
3	Syntax directed definition, construction of syntax trees, S-attributed and L- attributed definitions	CO 4	T1: 9.1-9.2
4	Storage organization, storage- allocation strategies, access to nonlocal names	CO 5	T1: 9.1-9.2
5	optimization of basic blocks, loops in flow graphs, peephole optimization; Code generator	CO 6	T1:10.1-10.2 T1:10.4,9.9
DISCUSSION ON QUESTION BANK			
1	Describe how various phases could be combined as a pass in compiler	CO 1	T1:1.1-1.5 R1:1.1
2	Identify whether the following grammar is CLR or not with reasons? S→ AA , A →aA | b	CO 3	T1: 7.6-7.7

3	Construct production rules and semantic actions for S-attributed grammar for the following grammar along with syntax tree and annotated parse tree for the given string a*b-c/d+e? L$\rightarrow$E E$\rightarrow$ E+T | E-T|T T$\rightarrow$ T*F | T/F |F F$\rightarrow$ P-F | P P$\rightarrow$(E) P$\rightarrow$ID	CO 4	T1: 9.1-9.2
4	Explain briefly about stack storage allocation with block diagram.	CO 5	T1: 9.1-9.2
5	Identify the register descriptor target code for the source language Statement and its cost. (a-b) + (a-c) + (a-c)	CO 6	T1:10.1-10.2 T1:10.4,9.9

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Ms. I Sumalatha, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
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Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI & ML)
COURSE DESCRIPTION

Course Title	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS**				
Course Code	ACAC06				
Program	B.Tech				
Semester	V	CSE(AI &ML)			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Chief Coordinator	Dr M.Nagaraju, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHSC02	I	Linear Algebra and Calculus
UG	AHSC08	II	Probability and Statistics
UG	ACSC08	III	Data Structures
UG	ACSC13	IV	Design and Analysis of Algorithms

II COURSE OVERVIEW:

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. In artificial intelligence, an expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if-then rules rather than through conventional procedural code. Artificial intelligence (AI) is a study field that examines how to achieve intelligent human behaviors on a computer. Driven by the combination of increased access to data, computational power, and improved sensors and algorithms, Artificial Intelligence (AI) technologies are entering the mainstream of technological innovation. These technologies include search, machine learning, natural language processing, robotics and image processing. An ultimate objective of AI is to make a PC that can learn, plan, and take care of issues independently.The computer-implemented in some cases with AI technology can be even cleverer than us. Presentation of artificial intelligence is though, ideas and methods to familiarize the student with the basic programs in the field and their underlying theory. Students will explore this through problem-solving paradigms, logic and theorem proving, language and image understanding, search and control methods and learning.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Artificial Intelligence and Expert Systems	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question. The expected percentage of cognitive level of the questions is broadly based on the criteria given in the below Table. 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
16.6%	Remember
50 %	Understand
16.6 %	Apply
16.6 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

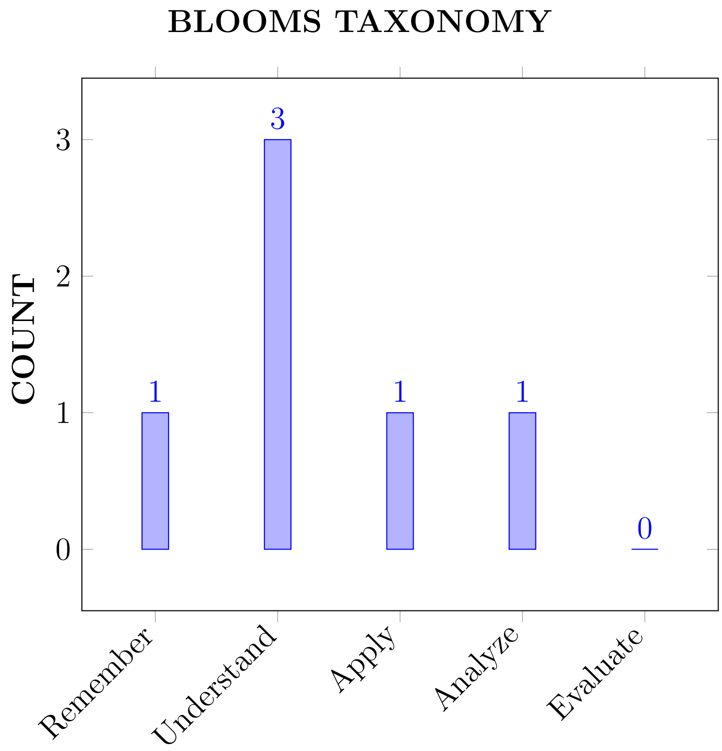
I	The historical perspective of AI and its foundations.
II	The basic principles of AI toward problem solving, inference, knowledge representation, and learning.
III	The investigation of AI techniques in applications like intelligent agents, expert systems, artificial neural networks and other machine learning models.
IV	The experience of AI development tools such as Prolog (AI language), expert system shell, and/or data mining tool.
V	The current scope, potential, limitations, and implications of intelligent systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** knowledge representation and issues in AI and Related fields.	Understand
CO 2	**Demonstrate** knowledge reasoning with predicate logic and inference rules in the presence of incomplete and/or uncertain information.	Understand
CO 3	**Choose** Heuristic, Adversarial search and game playing algorithms for addressing a particular AI problem and implement the selected strategy.	Remember
CO 4	**Experiment with** uncertainty issues by using statistical and symbolic reasoning approaches.	Apply
CO 5	**Analyze** the various algorithms used in the prediction and perception of things in an intelligent environment.	Analyze
CO 6	**Demonstrate** knowledge representation with the help of AI languages and tools.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis**: Identity, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	SEE/CIE/AAT
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE/CIE/AAT
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	SEE /CIE, AAT
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	SEE/CIE/AAT
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	SEE/CIE/AAT

PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE/CIE/AAT
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Tech Talks/Open Ended Experiments
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	1	Tech Talks/Open Ended Experiments
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	Tech Talks/Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		✓	-	-
CO 2	-	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	✓	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Learn definition of AI and its underlying assumptions. The approaches also evolved from the foundation of AI algorithms to the paradigm slot in symbolic algorithms and expert system development, Machine learning and Deep learning to support study of their own engineering discipline applying mathematical and scientific principles.	3
	PSO 1	Understand Early works in AI to design System Software and make use of these in the areas related to Web design, Machine learning and Networking.	4
CO 2	PO 3	Relate Knowledge and understand approaches to knowledge representation in commercial and economic context of engineering process to Various problems, customer and user needs, cost effective and creative solutions, design process and Management techniques.	7
	PSO 2	Understand Issues in Knowledge Representation in improving Software reliability, security and information retrieval systems.	2
CO 3	PO 1	Compare procedural and declarative knowledge in solving complex engineering problems.	3
	PSO 1	Demonstrate algorithms for solving logic programming.	4
CO 4	PO 1	Recall steps of algorithm to convert casual forms with scientific principles and mathematical principles.	2
	PSO 1	Make use of algorithms to convert casual forms relating formula in proof.	4
CO 5	PO 1	Explain axioms and rules of inference in nonmonotonic reasoning to extend some kind of numeric measure of certainty using scientific principles and mathematical principles.	2
	PO 2	Explore techniques for solving problems with incomplete and uncertain models by identifying the problem statement, information collection and develop a solution and documentation	4
	PO 3	Design solutions for uncertainty problems in any AI system that seeks to model and reasoning by investigating, identifying constraints to establish innovative solutions evaluate outcomes and promote sustainability.	5
	PO 10	Understand the techniques for solving problems and communicate effectively with the engineering community and with society at large.	3
	PSO 2	Understand the techniques of uncertainty for improving software reliability and information retrieval.	2

CO 6	PO 1	Apply inference and resolution for conversion of facts into first order logic, statements into CNF(Conjunctive Normal form) using scientific, mathematical principles and support study of their own engineering discipline	3
	PO 2	Build refutation proofs that are proofs by contradiction by identifying, formulating and analysing complex engineering problems with the help of basic mathematics and engineering sciences.	7
	PSO 1	Make use of inference and resolution to design and analyze computer programs for converting the facts and statements	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 2	-	-	7	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 5	2	4	5	-	-	-	-	-	-	3	-	-	-	2	-
CO 6	3	7	-	-	-	-	-	-	-	-	-	-	3	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
CO 2	-	-	70	-	-	-	-	-	-	-	-	-	-	100	-
CO 3	100	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
CO 4	66.7	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
CO 5	66.7	40	50	-	-	-	-	-	-	60	-	-	-	100	-
CO 6	100	70	-	-	-	-	-	-	-	-	-	-	50	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 5	3	2	2	-	-	-	-	-	-	3	-	-	-	3	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
TOTAL	15	5	5	-	-	-	-	-	-	3	-	-	11	6	-
AVERAGE	2.5	0.83	0.83	-	-	-	-	-	-	0.5	-	-	1.8	1.0	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-	Assignments	-
Laboratory Practices	-	Student Viva	-	Certification	-	-	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION OF AI AND KNOWLEDGE REPRESENTATION**
	Definition of AI, The AI Problems, The Underlying Assumption, AI Techniques, The Level of the Model, Criteria for Success, The importance of AI, Early works in AI, AI and Related fields, The Foundations of Artificial Intelligence, The History of Artificial Intelligence. Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, Issues in the Design of Search Programs. Knowledge Representation Issues: Representations and Mappings, Approaches to Knowledge Representation, Issues in Knowledge Representation. AI Languages and Tools: Lisp, Prolog, CLIPS.
MODULE II	**FIRST ORDER LOGIC AND INFERENCE**
	Using Predicate Logic: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Properties of Wff, Clausal Forms, Conversion to clausal forms, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning, Matching, Control Knowledge.
MODULE III	**SEARCH TECHNIQUES**
	Heuristic Search Techniques: Generate-and-Test, Hill Climbing, Best-first Search, A* algorithm, AO* algorithm, Problem Reduction, And-Or search, Constraint Satisfaction, Means-ends Analysis. Adversarial Search and Game Playing: Optimal Decision in Games, The minimax algorithm, Alpha-Beta pruning, Iterative Deepening, Expectimax search.
MODULE IV	**HANDLING UNCERTANITY**
	Symbolic Reasoning Under Uncertainty: Introduction to Non monotonic Reasoning, Logics for Non monotonic Reasoning, Implementation Issues, Augmenting a Problem-solver. Statistical Reasoning: Probability and Bayes' Theorem, Certainty Factors and Rule-based Systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic.
MODULE V	**PLANNING, LEARNING AND EXPERT SYSTEMS**
	Planning: Overview, An Example Domain: The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems. Learning: What is learning, Rote learning, Learning by taking Advice, Learning from example: Induction, Explanation based learning (EBL), Discovery, Clustering, Analogy, Neural net and genetic learning, Reinforcement learning. Expert System: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition, Expert System Architectures, Rule based systems, Non production system, knowledge acquisition.

TEXTBOOKS

1. Elaine Rich, Kevin Knight, Shivashankar B Nair, "Artificial Intelligence", Tata McGraw Hill, 3rd edition, 2009.

2. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Prentice-Hall, 2007.

REFERENCE BOOKS:

1. Nils J.Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1990.

2. Stuart Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson Education, 2nd Edition, 2010.

3. VS Janakiraman K, Sarukesi Gopalakrishnan, "Foundations of Artificial Intelligence & Expert Systems", Macmillan.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	In Outcome-Based Education (OBE), we discussed about course delivery assessment that are planned to achieve stated objectives and outcomes. We will focuses on measuring student performance i.e. outcomes at different levels. Course outcomes(CO), Program Outcomes(PO)and Program Specific Outcomes(PSO) and also mapping of CO's to PO's PSO's and their attainments are discussed.		
CONTENT DELIVERY (THEORY)			
1	Definition of AI, The AI Problems, The Underlying Assumption	CO 1,	T1:1.1-1.8, 2.2
2	AI Techniques, The Level of the Model, Criteria for Success	CO 1	T1:1.10
3	The importance of AI, Early works in AI	CO 2	T2:2.7
4	AI and Related fields, The Foundations of Artificial Intelligence	CO 3	T2:2.8
5	The History of Artificial Intelligence.	CO 4	T3:2.8
6	Defining the Problem as a State Space Search.	CO 1	T2: 3.4
7	Production Systems, Problem Characteristics,	CO 4	T1:3.1-3.2
8	Production System Characteristics	CO 4	T1:4.2,7.1-7.4
9	Issues in the Design of Search Programs.	CO 5	T1:3.3-3.7
10	Representations and Mappings.	CO 5	T1:4.2,7.1-7.4
11	Approaches to Knowledge Representation	CO 1	T2:2.8
12	Issues in Knowledge Representation.	CO 4	T1:1.3 T1:1.7,7.4
13	Representing Simple Facts in Logic	CO 6	T1: 7.6 7.7, 8.9-8.10
14	Representing Instance and ISA Relationships	CO 4	T1:1.3 T1:1.7,7.4
15	Computable Functions and Predicates	CO 3	T1:1.1 T1:1.1-1.4
16	Properties of Wff, Clausal Forms, Conversion to clausal forms, Resolution	CO 5	T1: 7.6 7.7, 8.9-8.10
17	Procedural Versus Declarative Knowledge, Logic Programming	CO 4	T1:1.1-1.2 T1:1.5-1.7
18	Forward Versus Backward Reasoning	CO 1	T1:1.3 T1:1.7,7.4
19	Matching, Control Knowledge.	CO 4	T1:1.1-1.2 T1:1.5-1.7
20	Generate-and-Test, Hill Climbing	CO 1	T1:3.1-3.4 T1:2.1-2.4

21	Best-first Search,Problem Reduction	CO 5	T1:5.1-5.3 T1:2.8,3.7-3.8
22	And-Or search, Constraint Satisfaction, Means-ends Analysis.	CO 1	T1:1.1-1.2 T1:1.5-1.7
23	A* algorithm, AO* algorithm	CO 2	T1:3.3-3.5 T1:2.6
24	Optimal Decision in Games	CO 3	T1:5.1-5.3 T1:2.8,3.7-3.8
25	The minimax algorithm, Alpha-Beta pruning	CO 5	T1:3.3-3.5 T1:2.6
26	Iterative Deepening, Expectimax search.	CO 4	T1:5.1.-5.10 T1:3.6
27	Introduction to Non monotonic Reasoning	CO 4	T1:4.4-4.6 T1: 5.11 T1:3.10
28	Logics for Non monotonic Reasoning	CO 1	T1:5.1-5.3 T1:2.8,3.7-3.8
29	Probability and Bayes' Theorem	CO 5	T1:3.3-3.5 T1:2.6
30	Certainty Factors and Rule-based Systems	CO 1	T1: 5.11 T1:3.10
31	Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic	CO 2	T1:3.3-3.5 T1:2.6
32	Overview, An Example Domain: The Blocks World	CO 5	T1:6.1,6.4 T1:4.1-4.5
33	Components of a Planning System	CO 5	T1:6.3,6.10 T1:4.9-4.10
34	Goal Stack Planning, Nonlinear Planning Using Constraint Posting	CO 1	T1:5.1-5.3 T1:2.8,3.7-3.8
35	Hierarchical Planning, Reactive Systems. What is learning, Rote learning	CO 1	T1:3.3-3.5 T1:2.6
36	learning by taking Advice, learning from example	CO 5	T1:6.2-6.3,6.7 T1:4.8,4.11
37	Induction, Explanation based learning (EBL)	CO 1	T1: 7.6 7.7, 8.9-8.10
38	Discovery, Clustering, Analogy, Neural net and genetic learning, Reinforcement learning.	CO 2	T1:6.1,6.4 T1:4.1-4.5
39	Representing and Using Domain Knowledge,	CO 3	T1:5.1.-5.10 T1:3.6
40	Expert System Shells, Explanation, Knowledge Acquisition, Expert System Architectures	CO 6	T1:6.3,6.10 T1:4.9-4.10
41	Rule based systems, Non production system, knowledge acquisition	CO 1	T1:1.3 T1:1.7,7.4

PROBLEM SOLVING/CASE STUDIES			
42	Enumerate Classical “Water jug Problem”. Describe the state space for this problem and also give the solution	CO 1	T1:6.1,6.4 T1:4.1-4.5
43	Illustrate Knowledge Organization and Manipulation IN AI	CO 1	T1:6.1,6.4 T1:4.1-4.5
44	Imagine that you had been to an aquarium and seen a shark and an octopus .Describe these to a child who has never seen one. What resources and mechanisms does the child use to comprehend the nature of these marine animals?	CO 2	T1: 7.6 7.7, 8.9-8.10
45	Analyze each of them with respect to the seven problem characteristics, Chess, 8-puzzle, Missionaries and cannibals, Monkey and bananas, Tower of Hanoi, Crypt arithmetic	CO 1	T1:6.3,6.10 T1:4.9-4.10
46	Find a good state space representation for the following. Water jug, Traveling salesman, Tower of Hanoi , Crypt arithmetic, Chess , 8-puzzle.	CO 2	T1:5.1.-5.10 T1:3.6
47	Trace the operation of the unification algorithm on each of the following pairs of literals: f(Marcus) and f(Caesar) ii. f(x) and f(g(y)) f(Marcus,g(x,y)) and f(x,g(Caesar,Marcus))	CO 3	T1:6.1,6.4 T1:4.1-4.5
48	Convert the following well formed formula into clause from with sequence of steps: x: [Roman(x) Know (x,Marcus)] [hate(x, Caesar) v (y: z: hate(y,z) thinkcrazy(x,y))]	CO 4	T1: 7.6 7.7, 8.9-8.10
49	Assume the following facts: Steve only likes easy courses. Science courses are hard. All the courses in the basketweaving department are easy BK301 is a basketweaving course. Use resolution to answer the question, “What course would Steve like?”	CO 3	T1:6.2-6.3,6.7 T1:4.8,4.11
50	Imagine a Robot trying to move from one place in a city to other.It has complete knowledge of the connecting roads in the city.As it moves the road condition keep changing.If the robot is to reach its destination with in a prescribed time,Suggest an algorithm for the same [HINT:Split the roadmap into a set of connected nodes and imagine that the costs of moving from one node to another change based on sometime dependent conditions].	CO 2	T1: 7.6 7.7, 8.9-8.10
51	What are the Implementation Issues and explain about Augmenting a Problem-solver.	CO 2	T1:5.1-5.3 T1:2.8,3.7-3.8
52	Use Fuzzy logic.For example,you might want to define such fuzzy sets as honest people or greedy people and describe Abott,Babbit,and Cabot’s memberships in those sets.	CO 1	T1:6.3,6.10 T1:4.9-4.10
53	Show how a JTMS could be used in medical diagnosis. Consider rules such as, “If you have a runny nose, assume you have a cold unless it is allergy season.”	CO 4	T1:6.1,6.4 T1:4.1-4.5

54	Explain in detail about STRIPS and write the components of STRIPS for the given scenario: "Consider a flight journey in a luxurious flight fom India to US"	CO 3	T1:3.1-3.4 T1:2.1-2.4
55	Consider the problem of building a program to learn a grammar for a language such as English. Assume that such a program would be provided, as input, with a set of pairs, each consisting of a sentence and a representation of the meaning of the sentence. This is analogous to the experience of a child who hears a sentence and sees something at the same time. How could such a program be built using the techniques	CO 4	T1: 7.6 7.7, 8.9-8.10
56	Consider the problem of devising a plan for cleaning the kitchen. (a)Write a set of STRIPS-style operators that might be used. When you describe the operators, take into account such considerations as: Cleaning the stove or the refrigerator will get the floor dirty. To clean the oven, it is necessary to apply oven cleaner and then to remove the cleaner. Before the floor can be washed, it must be swept. Before the floor can be swept, the garbage must be taken out. Cleaning the refrigerator generates garbage and messes up the counters. Washing the counters or the floor gets the sink dirty. (b) Write a description of a likely initial state of a kitchen in need of cleaning. Also write a description of a desirable (but perhaps rarely obtained) goal state. (c) Show how the technique of planning using a goal stack could be used to solve this problem.	CO 3	T1:5.1-5.3 T1:2.8,3.7-3.8
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Define Artificial Intelligence	CO 1	T1:6.2-6.3,6.7 T1:4.8,4.11
58	What is a Support Vector Machine?	CO 2	T1:6.1,6.4 T1:4.1-4.5
59	What is Disjunctive normal form?	CO 4	T1: 7.6 7.7, 8.9-8.10
60	Why is Depth-first search used?	CO 2	T1:6.3,6.10 T1:4.9-4.10
61	Define the term STRIPS	CO 5	T1:6.3,6.10 T1:4.9-4.10
DISCUSSION ON QUESTION BANK			
62	Solve the Water Jug problem: you are given 2 jugs, a 4-gallon one and 3-gallon one. Neither has any measuring maker on it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallons of water into 4-gallon jug? Explicit assumptions: A jug can be filled from the pump, water can be poured out of a jug onto the ground, water can be poured from one jug to another and that there are no other measuring devices available.	CO 1	T1:5.1-5.3 T1:2.8,3.7-3.8

63	What problems would be encountered in attempting to represent the following statements in predicate logic?It should be possible to deduce the final statement from the others John only likes to see French movies. It's safe to assume a movie is American unless explicitly told otherwise The playhouse really shows the Foreign films People don't do things that will cause them to be in situations that they don't like	CO 3	T1:6.2-6.3,6.7 T1:4.8,4.11
64	The constraint satisfaction procedure we have described performs depth-first search whenever some kind of search is necessary.But depth-first search is not the only way to conduct such a search (a) Rewrite the constraint satisfaction procedure to use breadth first search (b) Rewrite the constraint satisfaction procedure to use best first search	CO 2	T1: 7.6 7.7, 8.9-8.10
65	Construct a Bayesian Network and define the necessary CPTs for the given scenario. We have a bag of three biased coins a,b and c with probabilities of coming up heads of 20	CO 4	T1:6.3,6.10 T1:4.9-4.10
66	Explain in detail about STRIPS and write the components of STRIPS for the given scenario: "Consider a flight journey in a luxurious flight fom India to US"	CO 5	T1:6.1,6.4 T1:4.1-4.5

Signature of Course Coordinator **HOD, CSE(AI & ML)**
Dr. M.Nagaraju, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering(AI&ML)**				
Course Title	**Embedded Systems**				
Course Code	AECC40				
Program	B. Tech				
Semester	V				
Course Type	Open Elective-II				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. S Lakshmanachari, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	ACSC07	III	Computer Organization and Architecture	3
B.Tech	ACSC12	IV	Operating Systems	3

II COURSE OVERVIEW:

This course allows students to learn the fundamentals of embedded system hardware and firmware design. It focusses on embedded system design process, embedded C, interfacing modules, software development tools for debugging and testing of embedded applications, ARM and SHARC processor architectures and memory organization. It provides hands-on experience on implementation of embedded application prototype design using embedded C.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Embedded Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
66.6%	Understand
16.6 %	Apply
16.6 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	AAT	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Videos	Tech-talk	Open Ended Experiment
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

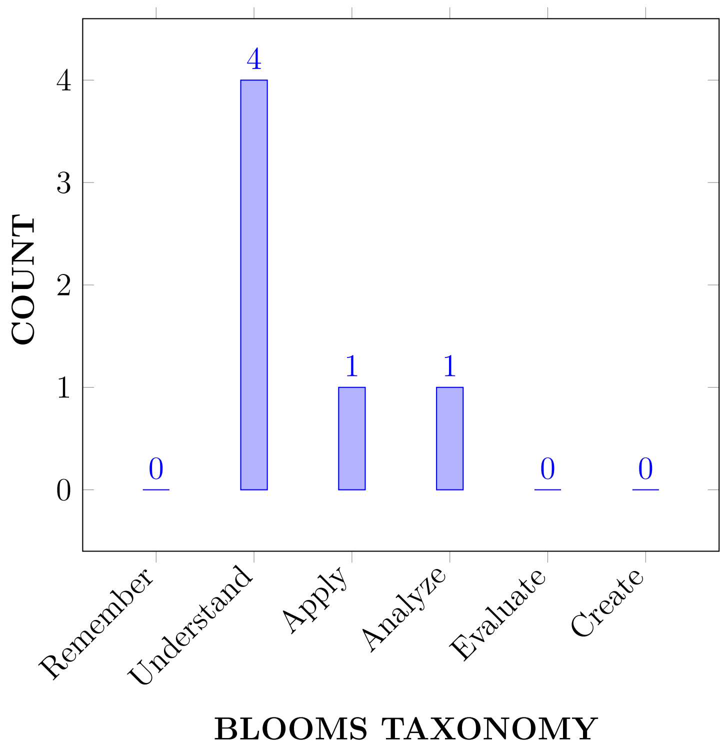
I	The concepts of embedded computing, embedded C, RTOS and embedded software tools for implementing embedded systems.
II	Embedded software development tools for debugging and testing of embedded applications, architectures of ARM and SHARC processors.
III	Interfacing with external environments using sensors, actuators and communication in distributed embedded systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the concepts of Embedded Systems and formalisms for system design with examples.	Understand
CO 2	**Examine** and write the Embedded Systems programming in C with Keil Integrated Development Environment (IDE).	Analyze
CO 3	**Demonstrate** the principles of RTOS and the methods used for saving memory and power in real time environments.	Understand
CO 4	**Make use of** embedded software development tools for debugging and testing of embedded applications.	Apply
CO 5	**Illustrate** the architecture, memory organization and instruction level parallelism of ARM and SHARC processors used in Embedded Systems.	Understand
CO 6	**Interpret** the concepts of Internet of Things used in the embedded systems applications.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	SEE/CIE/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems..	2	CIE/Quiz/ AAT

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	Illustrate the concepts (knowledge) of embedded systems using their architectures by using **mathematics, science, engineering fundamentals** to the solution of complex engineering problems.	3
	PO 10	Describe the concepts of Embedded Systems and formalisms by **giving effective presentations and take clear instructions** for system design with examples.	1
	PSO1	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	1
CO2	PO 1	Apply the integration of sensors, actuators and on-chip peripherals of microcontroller architectures for prototype design by applying **science** and **engineering fundamentals**.	2
	PO 2	Understand the given embedded application **problem statement** and finding the solution implementation and select proper language for **information and data collection** for **solution development** by writing embedded C language programming efficient and **interpretation of results**.The prototype embedded system design by analyzing complex engineering problems.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Manage the design process** and make **use of creativity to establish solutions** by selecting proper syntaxes to write the embedded C language programming by **understanding of the requirement for engineering activities to promote sustainable development** and design solutions for complex Engineering problems and design system components of embedded applications that meet the specified needs with appropriate consideration for the public **health and safety, and the cultural, societal, and Environmental considerations.**	4
CO2	PO 5	Select and apply appropriate techniques of **(Modern Tool Usage)** Keil Integrated Development Environment, for design of the basic embedded modules using different electronic circuits to provide valid conclusions.	1
	PO 10	Use Keil Integrated Development Environment by **giving effective presentations and take clear instructions** for analyzing the Embedded Systems programming in C.	1
CO3	PO 1	Demonstrate (knowledge) the principles of RTOS such as interrupt latency and context switching in hard real time environments by applying the knowledge of **mathematical model, science and engineering fundamentals**	3
	PO 10	Describe the principles of RTOS and the methods used for saving memory and power with Keil Integrated Development Environment by **giving effective presentations and take clear instructions** in real time environments.	1
	PSO1	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	1
CO4	PO 1	Make use of embedded software development tools (knowledge) for debugging and testing of embedded applications to the solution of complex engineering problems using **mathematics, science, engineering fundamentals**.	3
	PO 2	**Identify the problem** and understand the given embedded application and choose necessary hardware and software interface for **information and data collection** and **conduct experimental design** and **finding the solution implementation** of embedded applications using development tools by analyzing complex engineering problems.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Understand the customer and user needs** and select an appropriate RTOS and Software development tools by **managing the design process and evaluate outcomes** to **promote sustainable development** for data transfer between the devices using **creativity to establish innovative solutions**.	4
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering tools including prediction and modelling the embedded circuits using **Keil integrated development environment tool** to complex Engineering activities with an understanding of the limitations.	1
CO4	PO 10	Use embedded software development tools by **giving effective presentations and take clear instructions** for debugging and testing of embedded applications.	1
CO5	PO 1	Understand (knowledge) the architecture, memory management and application development using ARM and SHARC processors by applying **science and engineering fundamentals**.	2
	PO 10	Explain the architecture, memory organization and instruction level parallelism of ARM and SHARC processors by **giving effective presentations and taking clear instructions**.	1
CO6	PO 1	Model a embedded application prototype using embedded C by applying **engineering fundamentals**.	1
	PO 2	Understand the **problem statement** and **solve** embedded **prototype implementation** using the concepts of Internet Of Things **(information and data collection)** and **interpret the results** in global engineering applications in complex problem analysis using mathematics.	5
	PO 3	**Using creativity to establish innovative solutions** and **understanding of the requirement for engineering activities to promote sustainable development** for design a complex engineering problems and real time processes that meet the specified needs with appropriate consideration for the **public health and environmental considerations**.	3
	PO 10	Interpret the concepts of Internet of Things used in embedded systems applications by **giving effective presentations and taking clear instructions**.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 2	2	4	4	-	1	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 4	3	4	4	-	1	-	-	-	-	1	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	5	3	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	50	-	-
CO 2	66.6	40	40	-	100	-	-	-	-	20	-	-	-	-	-
CO 3	100	-	-	-	-	-	-	-	-	20	-	-	50	-	-
CO 4	100	40	40	-	100	-	-	-	-	20	-	-	-	-	-
CO 5	66.6	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	33.3	50	30	-	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 2	3	1	1	-	3	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 4	3	1	1	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	2	1	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	16	4	3	-	6	-	-	-	-	4	-	-	6	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
AVERAGE	2.66	1.33	1	-	3	-	-	-	-	1	-	-	2	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	AAT	✓
Quiz	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-
Seminars	-	Laboratory Practices	-		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**EMBEDDED COMPUTING**
	Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, characteristics and quality attributes of embedded systems, formalisms for system design, design examples.
MODULE II	**INTRODUCTION TO EMBEDDED C AND APPLICATIONS**
	C looping structures, register allocation, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly, portability issues; Embedded systems programming in C, binding and running embedded C program in Keil IDE, dissecting the program, building the hardware; Basic techniques for reading and writing from I/O port pins, switch bounce; Applications: Switch bounce, LED interfacing, interfacing with keyboards, displays, D/A and A/D conversions, multiple interrupts, serial data communication using embedded C interfacing.
MODULE III	**RTOS FUNDAMENTALS AND PROGRAMMING**
	Operating system basics, types of operating systems, tasks and task states, process and threads, multiprocessing and multitasking, how to choose an RTOS ,task scheduling, semaphores and queues, hard real-time scheduling considerations, saving memory and power. Task communication: Shared memory, message passing, remote procedure call and sockets; Task synchronization: Task communication synchronization issues, task synchronization techniques, device drivers.
MODULE IV	**EMBEDDED SOFTWARE DEVELOPMENT TOOLS**

	Host and target machines, linker/locators for embedded software, getting embedded software into the target system; Debugging techniques: Testing on host machine, using laboratory tools, an example system.
MODULE V	**INTRODUCTION TO ADVANCED PROCESSOR**
	Introduction to advanced architectures: ARM and SHARC, processor and memory organization and instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled systems, design example-Elevator controller.

TEXTBOOKS

1. Shibu K.V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition, 2009.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2nd Edition, 2011.
3. Andrew Sloss, Dominic Symes, Wright, "ARM System Developer's Guide Designing and Optimizing System Software", 1st Edition, 2004.

REFERENCE BOOKS:

1. Wayne Wolf, Computers as Components, Principles of Embedded Computing Systems Design, Elsevier, 2 nd Edition, 2009
2. Dr. K. V. K. K. Prasad, Embedded / Real-Time Systems: Concepts, Design & Programming, dreamtech publishers, 1 st Edition, 2003.
3. Frank Vahid, Tony Givargis, Embedded System Design‖, John Wiley & Sons, 3 rd Edition, 2006
4. Lyla B Das, "Embedded Systems" , Pearson Education, 1st Edition, 2012.
5. David E. Simon, "An Embedded Software Primer", Addison-Wesley, 1st Edition, 1999.
6. Michael J.Pont, "Embedded C", Pearson Education, 2nd Edition, 2008.

WEB REFERENCES:

1. https://www.smartzworld.com/notes/embedded-systems-es/
2. http://notes.specworld.in/embedded-systems-es/
3. http://education.uandistar.net/jntu-study-materials
4. http://www.nptelvideos.in/2012/11/embedded-systems.html

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/playercourseid = 228sectionid = 729lessonid = 7135

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&courseid=228
CONTENT DELIVERY (THEORY)			
2	Definition of embedded system, embedded systems vs. general computing systems.	CO 1	T1-1.1
3	History of Embedded systems	CO 1	T1-1.
4	Complex systems and microprocessor, classification,major application areas.	CO 1	T1-1.3
5	The embedded system design process	CO 1	T2-1.4
6	Characteristics and quality attributes of embedded systems	CO 1	T2-1.5
7	Formalisms for system design, design examples.	CO1	R2-1.2
10	Introduction to embedded C,C looping structures.	CO 2	T3-1.3
11	Register allocation, Function calls, and pointer aliasing.	CO 2	T3-2.4
12	Structure arrangement, Bit fields, unaligned data and endianness.	CO 2	T3-2.5
13	Inline functions and inline assembly, portability issues.	CO 2	T3-2.6
14	Embedded systems programming in C, binding and running embedded C program in Keil IDE	CO 2	T3-2.7
15	Embedded C program in Keil IDE, dissecting the program, building the hardware	CO 2	T3-2.8
16	Basic techniques for reading and writing from I/O port pins, switch bounce	CO 2	T3-2.9
17	Applications: Switch bounce, LED interfacing.	CO 2	R2-3.1
18	Interfacing with keyboards, displays	CO 2	R2-3.2
19	D/A and A/D conversions, multiple interrupts.	CO 2	R2-3.3
20	Serial data communication using embedded C interfacing.	CO 2	R2-3.4
28	RTOS Fundamentals, Operating system basics, types of operating systems	CO 3	R2-3.5
29	Tasks and task states, process and threads	CO 3	R2-3.6
30	Multiprocessing and multitasking, how to choose an RTOS	CO 3	R3-3.7
31	Task scheduling, semaphores and queues	CO 3	R3-3.8

32	Hard real-time scheduling considerations, saving memory and power.	CO 3	R3-4.1
33	Task communication: Shared memory, message passing	CO 3	R3-4.1
34	Remote procedure call and sockets	CO 3	R3-4.2
35	Task synchronization: Task communication synchronization issues	CO 3	R3-4.2
36	Task synchronization techniques, device drivers.	CO 3	R3-4.3
37	Host and target machines	CO 4	R3-4.3
38	Linker for embedded software	CO 4	R3-4.4
39	Locators for embedded software	CO 4	R3-4.4
40	Getting embedded software into the target system	CO 4	R3-4.5
41	Debugging techniques: Testing on host machine	CO 4	R3-4.5
44	Debugging techniques using laboratory tools, an example system.	CO 4	R3-4.5
47	Introduction to advanced architectures: ARM	CO 5	T2-8.1
48	Introduction to advanced architectures: SHARC	CO 5	T2-8.1
49	Processor and memory organization	CO 5	T2-8.2
50	Instruction level parallelism	CO 5	T2-8.2
51	Networked embedded systems: Bus protocols	CO 6	T2-8.3
52	Networked embedded systems: I2C bus and CAN bus	CO 6	T2-8.3
53	Internet-Enabled systems	CO 6	T2-8.4
54	Design example-Elevator controller.	CO 6	T2-8.4
PROBLEM SOLVING/ CASE STUDIES			
8	BMW 850i brake and stability control system	CO 1	T2-1.4
9	Design example of model train controller	CO 1	T3-2.7
21	Embedded C program for Switch bounce	CO 2	R2-3.2
22	Embedded C program for LED interface	CO 2	R3-4.5
23	Embedded C program for Interfacing with keyboards	CO 2	T2-8.2
24	Embedded C program for Interfacing with displays	CO 2	T2-1.4
25	Embedded C program for 7 Segment Display Interfacing	CO 2	T3-2.7
26	Embedded C program for ADC Interfacing with 8051 microcontroller	CO 2	R2-3.2
27	Embedded C program for DAC Interfacing with 8051 microcontroller	CO 2	R3-4.5
45	Design of Digital camera	CO 4	T2-8.2
46	Design of Microwave oven	CO 4	T2-1.4
55	Design of Elevator controller	CO 6	T3-2.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Embedded computing	CO 1	T1-1.3
57	Introduction to embedded c and applications	CO 2	T3-2.4
58	RTOS fundamentals and programming	CO 3	R3-4.2
59	Embedded software development tools	CO 4	R3-4.4
60	Introduction to advanced processors	CO 5, CO 6	T2-8.3

DISCUSSION OF QUESTION BANK			
61	Embedded computing	CO 1	T1-1.3
62	Introduction to embedded c and applications	CO 2	T3-2.4
63	RTOS fundamentals and programming	CO 3	R3-4.2
64	Embedded software development tools	CO 4	R3-4.4
65	Introduction to advanced processors	CO 5, CO 6	T2-8.3

Course Coordinator **HOD,CSE(AI&ML)**
Mr. Mr. S Lakshmanachari, Assistant Professor(CS)

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**

PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA statement / Vital features (VF)	No. of VF's
PSO 1	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	**2**
PSO 2	Focus on improving software reliability, network security or information retrieval systems.	**2**
PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	**2**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI&ML)

COURSE DESCRIPTION

Course Title	IMAGE AND SPEECH PROCESSING LABORATORY				
Course Code	ACAC11				
Program	B.Tech				
Semester	V	CSE(AI&ML)			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
		-	-	3	1.5
Course Coordinator	Dr. B Padmaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites

II COURSE OVERVIEW:

This course introduces the demonstration of operations on image and audio (speech)data using Python libraries. It focuses on image processing basics such as intensity transformations, spatial filtering, histogram equalizations etc. It also includes speech processing basics such as reading and displaying an audio file, converting speech to text and vice versa, usage of various speech APIs.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Image and Speech Processing Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	✓	Lab Worksheets	✓	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	The fundamental concepts of digital signal processing and Image processing.
II	The current applications in the field of digital image processing.
III	Different digital models for speech signals.
IV	The digital image processing techniques for edge detection.
V	The spatial domain Image enhancement techniques.

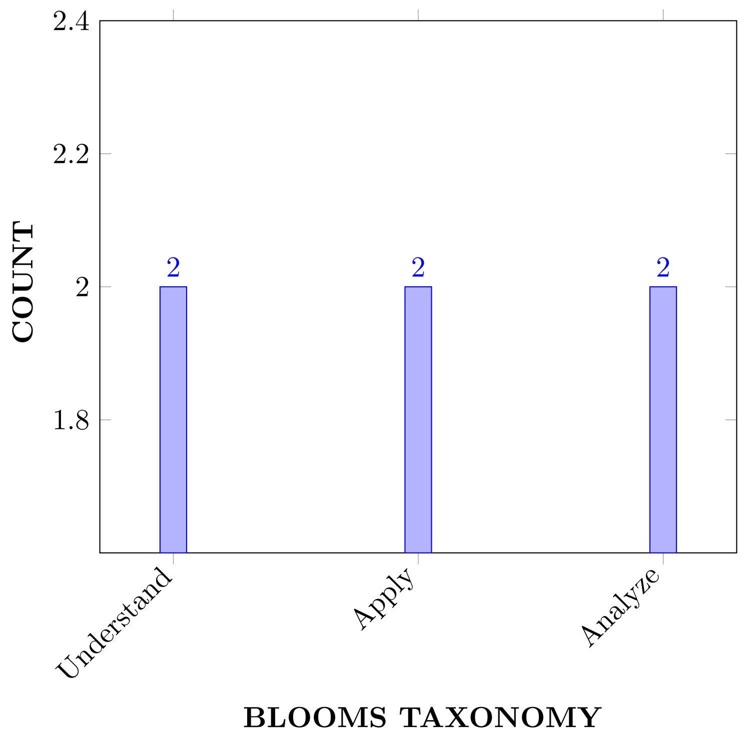
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the fundamental concepts of digital signal processing and Image processing.	Understand
CO 2	**Develop** the components in speech processing systems including speech recognition and speaker recognition, in MATLAB.	Understand
CO 3	**Construct** image intensity transformation and filtering techniques for image enhancement in the spatial and frequency domain.	Apply
CO 4	**Apply** the Edge detection technique of image processing and us identifying the points in a digital image with discontinuities.	Apply

CO 5	**Analyze** images in the frequency domain using various transforms like Fourier Transform (FT) and fast Fourier Transform (FFT) on the audio.	Analyze
CO 6	**Analyze** images in the frequency domain using Recognize speech from audio data using different APIs signal	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations

Program Outcomes	
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** UCreate, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Lab Exercises
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	-	-	-	4	-	-	-	-	-
CO 2	3	5	-	4	1	-	-	-	-	2	-	3	2	-	-
CO 3	2	2	5	7	-	-	-	-	-	4	-	6	2	-	-
CO 4	2	5	3	4	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	3	-	6	2	-	-
CO 6	3	3	-	-	-	-	-	-	-	3	-	6	2	-	-

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Illustrate the principles of the Digital Image Processing terminology . **Knowledge**for understanding image and its representation, pixel, intensity, gray level, relationship between the pixels by applying the principles of**engineering science to complex engineering problems** .	2
	PO 10	**Effective presentation and Speaking Style on**sampling and quantization and **write Subject Matter Effectively**the difference between analog and digital images.	4
CO 2	PO 1	**Develop a image with various** image transform properties types and its types using **Scientific principles and methodology fundamental mathematics.**	3
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for image transforms using **first principles of mathematics and Engineering sciences.** .	3
	PO 10	**Effective presentation and Speaking Style on**properties of transforms and **write Subject Matter Effectively** on types of transforms.	4
	PSO 1	**Build Skills to develop** Use real time data to implement machine learning basics with R programming **on image transforms with project development and execution process of** modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO 3	PO 1	**Illustrate the principles of an image find by**using engineering techniques for image enhancement by using mathematical methods.	2
	PO 2	**Illustrate** the filter processing **model translation** for spatial domain and **formulate**the time domain filter	2
	PO 3	**Develop** a histogram techniques **complex engineering problem with appropriate considerations and environmental considerations** for image enhancement	2
	PO 4	**Demonstrate** the Use image enhancement **enhancement analyze and interpretation and Ability to apply quantitative methods** for image enhancement in frequency domain processing technique to provide valid digital image	7
	PO 10	**Effective presentation and Speaking Style** on histogram processing **Write Subject Matter Effectively**on manipulation technique of an digital image	4

	PO 12	**Recognize the need for** the image segmentation in different image applications and **ability to improve**the enhancement algorithms in the broadest context of**technological advancements**	6
	PSO 1	**Build Skills to develop**on image transforms with project development and execution process of **of modern tools such as MATLAB with image processing tool box, python, CV2.** .	6
CO 4	PO 1	Distinguish the Edge detection technique of image processing and us identifying **Knowledge**the points in a digital image by applying the principles of mathematics, engineering science for complex engineering problems	2
	PO 2	Formulate and analyze **Problem analysis.**complex Engineering problems Edge detection**using first principles of mathematics and Engineering sciences**	5
	PO 3	**Develop the Edge detection technique** complex engineering problem **with appropriate considerations and environmental considerations Edge detection**	3
	PO 4	Understand the Edge detection technique of image processing and us identifying **Knowledge the points in a digital image by applying the principles of (mathematics, engineering science for complex engineering problems.**	4
CO 5	PO 1	Interpret frequency domain using various transforms to **apply Mathematical principles fundamental mathematics**.	3
	PO 2	**Apply Problem statement**the images in the frequency domain using various transforms techniques **by using principles of mathematics and formulate segmentation techniques.**.	3
	PO 10	**Effective presentation and Speaking Style and write on** frequency domain techniques	3
	PO 12	**Recognize** the need for frequency domain technique, and broadest context of technological change in digital	6
	PSO 1	**Build Skills to develop** with project development and execution frequency domain with modern tools such as tools such as MATLAB with image processing tool box, python, CV2	2
CO 6	PO 1	Interpret frequency domain using Recognize speech from audio data using different APIs signa to **apply Mathematical principles fundamental mathematics**	3
	PO 2	**Apply Problem statement** the images in frequency domain using Recognize speech from audio data using different APIs signal by using principles of mathematics frequency domain techniques	3
	PO 10	**Effective presentation and Speaking Style and write on** frequency domain using Recognize speech from audio data using different APIs signal.	3

	PO 12	**Recognize** the need for frequency domain technique, and broadest context of technological change in digital image and advanced engineering concepts	6
	PSO 1	**Build Skills to develop**with project development and execution frequency domain with modern tools such as MATLAB with image processing tool box, python, CV2	2

XV SYLLABUS:

WEEK 1	**APPLYING INTENSITY TRANSFORMATIONS, SPATIAL FILTERS**
	1. Problem Statement: An image edge-detection algorithm detects the edges in each channel of an image using differences in the intensity values of pixel neighborhoods. Given an input image the task is to prepare this image to feed it to the algorithm for execution with high accuracy and minimal computational complexity. **Solutions Expected:** a. Convert the input image to grayscale so as to reduce the number of channels of the input image while preserving the intensity data of the pixels. b. Reduce the resolution of the image so as to reduce the number of possible pixel neighborhoods. c. Apply intensity transformation operations on the input image to make the edges present in it more easy to detect. d. Apply sharpening spatial filters to the input image to correct the blurry regions of the image. e. Apply smoothing spatial filters to the input image to remove noise from the image.
WEEK 2	**ARITHMETIC OPERATIONS ON IMAGES**
	2.Problem Statement: Given multiple noisy images of the same dimensions at different time stamps generated from the same scene, the aim is to create a less noisy and enhanced image of the scene. **Solutions Expected:** a. Use addition operation to blend all the input images to create a stable image of the scene. b. Use subtraction operation to enhance the input images. c. Add/Subtract a constant image (an image consisting of the same pixel value in its matrix) from the image obtained by adding all the input images to adjust the exposure of the image.

WEEK 3	**LOGICAL OPERATIONS ON IMAGES**
	3.Problem Statement: Given colored images of the same dimensions, convert them to black and white (binary). The task is to first represent the common bright areas of the images, then the combined bright areas of the images. **Solutions Expected:** a. Use the "and" operator on all input images (converted to black and white) to represent the common bright areas of the image. b. Use the "or" operator on all input images (binary) to represent the combined bright areas of the images.
WEEK 4	**HISTOGRAM PROCESSING**
	4.Problem Statement: Given input images that are either (1) too bright or (2) too dark or have extremely (3) low or (4) high contrast. The task is to classify these images as containing one of the four described properties and then enhance them. **Solutions Expected:** a. Plot the histograms of the images to classify them as containing the described quantities. b. Perform histogram equalization on the input images to enhance based on the task.
WEEK 5	**IMAGE PROCESSING USING NOISE FILTERS**
	5.Problem Statement: Consider the Digital Image (x,y), analyze frequencies of the image and apply various filtering techniques to handle and enhance salt and pepper noise. **Solutions Expected:** a. Use the following smoothing spatial filters for reduction of blur and noise in the image. i. Linear Filter (Mean Filter) ii. Order Statistics (Non-linear) filter

WEEK 6	**WORKING WITH AUDIO FILES**
	6.Problem Statement: Given a speech signal as an audio file, the task is to analyze frequencies contained in the signal and also visualize its representations. **Solutions Expected:** a. Apply the short-time fourier transform to the speech signal to convert the signal from time domain to frequency domain and plot the resulting signal. b. Apply discrete cosine transform to the speech signal and plot the resulting signal. c. Apply the Haar transform to the speech signal and plot the resulting signal. d. Upsample or Downsample speech signal for better visualization.
WEEK 7	**PITCH PERIOD ESTIMATION OF A SPEECH SIGNAL**
	7.Problem Statement: Given a time-domain speech signal, estimate its pitch period. **Solutions Expected:** a. Pitch period estimation using parallel processing. b. Pitch period estimation using shorttime autocorrelation function. c. Pitch period estimation using autocorrelation function and AMDF (Average Magnitude Difference Function).
WEEK 8	**FILTER BANKS - 1**
	8.Problem Statement: Provided a Speech Signal to analyzer on various filters to perform splitting analysis/Visualization of the results. **Solutions Expected:** a. Perform the visualization of the results using a DCT filter bank on the speech signal by splitting into various sub-bands and also in real numbers. b. Perform the visualization of the results using a DFT filter bank on the speech signal by splitting into various sub-bands and also in complex numbers.
WEEK 9	**FILTER BANKS - 2**
	9.Problem Statement: Provided a Speech Signal to analyzer on various filters to perform splitting analysis in more discriminative at lower frequencies, less discriminative at higher frequencies and visualize the results. **Solutions Expected:** a. Use a polyphase filter bank to split the input signal into various sub-bands and visualize the results of the analysis. b. Use a mel filter bank to split the input signal in a way similar to human ear perception and visualize the results of the analysis.

WEEK 10	**LINEAR PREDICTIVE CODING**
	10.Problem Statement: Predict the future values of the signal waveform using its past values of a speech signal which is used for linear predictive coding analysis **Solutions Expected:** a. Apply the linear predictive coding on the waveform to predict the future values basing on its past values. b. Use linear predictive coding to represent the spectral envelope of the given speech signal in a compressed form. c. Visualize the prediction error of the speech signal obtained using a prediction-error filter.
WEEK 11	**TEXT TO SPEECH**
	11.Problem Statement: Given a valid string of text to convert as a speech signal and provide the detailed analysis. **Solutions Expected:** a. Use gTTs module in python to convert text to speech. b. Use APIs to convert text to speech.
WEEK 12	**SPEECH RECOGNITION**
	12.Problem Statement: Identify speech from provided input audio signal data and convert it into text which shows the following solution expected. **Solutions Expected:** a. Recognize speech using the google api. b. Recognize speech using the wit api. c. Recognize speech using the houndify api.

TEXTBOOKS

1. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson, 2002.
2. Lawrence R. Rabiner, Ronald W. Schafer, ”Digital Processing of Speech Signals”, Pearson Education, 2012.

REFERENCE BOOKS:

1. R. L. Rabiner, R.W. Schafer, “Digital Processing of Speech Signals”, Pearson Education
2. B. Gold and Nelson Morgon, “Speech and audio Signal Processing”, Wiley India Edition,2006.
3. Dan Jurafsky and James H. Martin, “Speech and Language Processing”, Pearson, 2 nd Edition, 2017.

WEB REFERENCE :

1. https://nptel.ac.in/courses/106/105/106105032/
2. https://sisu.ut.ee/imageprocessing/documents
3. https://www.geeksforgeeks.org/reading-image-opencv-using-python/
4. https://tinyurl.com/yjcmyrcd
5. http://www.speech.cs.cmu.edu/15-492/

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Applying Intensity Transformations, Spatial Filters	CO 1	R1: 1
2	Arithmetic Operations On Images	CO 2	R3: 2
3	Logical Operations On Images	CO 2	R1: 7
4	Histogram Processing	CO 3	R1: 8
5	Image Processing Using Noise Filters	CO 4	R1: 2.4
6	Working With Audio Files	CO 5	R1: 9
7	Pitch Period Estimation of A Speech Signal	CO 6	R1: 10
8	Filter Banks - 1	CO 6	R3: 15
9	Filter Banks - 2	CO 2	R1: 9
10	Linear Predictive Coding	CO6	R1: 10
11	Text To Speech	CO 6	R4:7
12	Speech Recognition	CO 6	R4:10

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Convert the input image to grayscale so as to reduce the number of channels of the input image while preserving the intensity data of the pixels.
2	Use addition operation to blend all the input images to create a stable image of the scene .
3	Use the "and" operator on all input images (converted to black and white) to represent the common bright areas of the image.
4	Plot the histograms of the images to classify them as containing the described quantities.

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Dr. B Padmaja, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI&ML)
COURSE DESCRIPTION

Course Title	**Programming in Logic Laboratory**				
Course Code	ACAC012				
Program	B.Tech				
Semester	V	CSE(AI&ML)			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	0	0	0	3	1.5
Course Coordinator	Dr. M.Nagaraju, Assistant Professor CSE(AI&ML)				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming
B.Tech	ACAC06	V	Artificial Intelligence and Expert Systems

II COURSE OVERVIEW:

This course covers fundamental concepts and underlying assumptions about intelligence. The goal is to produce programs to do intelligent things as people do. It also explains different kinds of techniques useful for solving AI problems. It gives an insight to model human intelligence. Different Heuristic approaches are explored to measure how far a node in a search tree seems to be from a goal. Intelligence requires knowledge. Defining the problem accurately and segregating the background knowledge needed in the solution of the problem are clearly stated and implemented.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Programming in Logic Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

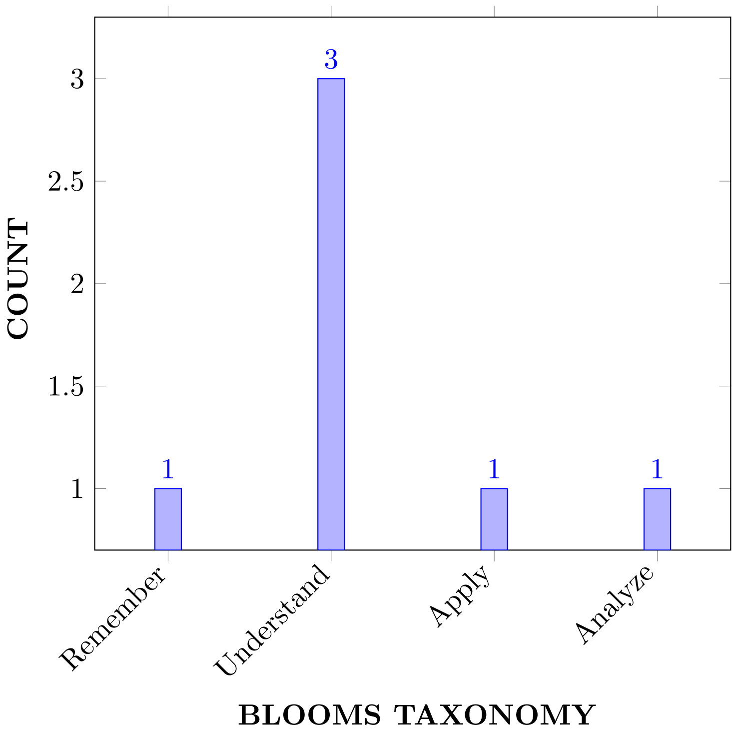
I	The basic concepts of Artificial Intelligence and Expert systems.
II	The designing of Prolog programs to represent the knowledge in terms of facts and rules.
III	The identification and applying of different search techniques and algorithms to solve real world problems. The designing of Python programs for various Learning algorithms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** knowledge representation and issues in AI and Related fields.	Understand
CO 2	**Demonstrate** knowledge reasoning with predicate logic and inference rules in the presence of incomplete and/or uncertain information.	Understand
CO 3	**Choose** Heuristic, Adversarial search and game playing algorithms for addressing a particular AI problem and implement the selected strategy.	Remember
CO 4	**Experiment with** uncertainty issues by using statistical and symbolic reasoning approaches.	Apply
CO 5	**Analyze** the various algorithms used in the prediction and perception of things in an intelligent environment.	Analyze
CO 6	**Demonstrate** knowledge representation with the help of AI languages and tools.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises

PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** UCreate, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	Lab Exercises
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Courses Outcomes	Program Outcomes				Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	1	-	-
CO 2	-	-	7	-	1	2	-
CO 3	3	-	-	-	4	-	-
CO 4	2	1	-	1	4	-	-
CO 5	2	4	5	-	-	2	-
CO 6	3	7	-	-	3	-	-

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**Water Jug Problem**
	1. Problem Statement: Given two jugs, a 4-gallon one and a 3-gallon one. Neither has any measuring markers on it. There is a pump that can be used to fill the jugs with water. How can we get exactly 2 gallons of water into the 4-gallon jug? **Solutions Expected:** a. Describe the state space as a set of ordered pairs of integers. b. Generate production rules and perform basic operations to achieve the goal. c. Initialize the start state and apply the rules iteratively until the goal state is reached. d. Generate a search tree (Depth-First Search / Breadth-First Search)
WEEK 2	**Monkey Banana**
	2. Problem Statement: Imagine a room containing a monkey, chair and some bananas that have been hanged from the center of ceiling. If the monkey is clever enough, he can reach the bananas by placing the box directly below the bananas and climb on the chair .The problem is to prove whether the monkey can reach the bananas. The monkey wants it, but cannot jump high enough from the floor. At the window of the room there is a box that the monkey can use. The monkey can perform the following actions:- 1) Walk on the floor. 2) Climb the box. 3) Push the box around (if it is beside the box). 4) Grasp the banana if it is standing on the box directly under the banana. **Solutions Expected:** a. Write down the initial state description and action schemes. b. Prepare all the required predicates that will make the monkey to perform some action and move from one state to the other until the goal state is reached. c. Set the initial position of the monkey (initial state) and raise questions to whether the knowledge represented can make the monkey get the banana. d. Trace the flow of actions from initial state to goal state.

WEEK 3	**8-Puzzle Problem**
	3. Problem Statement: The 8-puzzle, consists of a 3×3 board with eight numbered tiles and a blank space. A tile adjacent to the blank space can slide into the space. The task is to reach a specified goal state, such as the one shown on the right of the figure. The objective is to place the numbers on tiles to match the final configuration using the empty space. You can slide four adjacent (left, right, above, and below) tiles into the empty space. **Solutions Expected:** a. Examine the problem, formulate all the states and actions to reach the goal. b. Prepare the production rules that initializes the problem states. c. Through iterative process determine whether the current and the destination tiles are a valid move.
WEEK 4	**The Tower of Hanoi**
	4. Problem Statement: There are three pegs, 1, 2, and 3, and three disks, a, b, and c (a being the smallest and c being the biggest). Initially, all the disks are stacked on peg 1. The problem is to transfer them all on to peg 3. Only one disk can be moved at a time, and no disk can ever be placed on top of a smaller disk. **Solutions Expected:** a. Discover the quite simple strategy which will correctly play the Towers of Hanoi game with three poles and N discs. b. Define a predicate Hanoi having one argument, such that Hanoi(N) means to print the sequence of moves when N discs are on the source pole. c. Define a predicate that can print the names of the poles that are involved in moving disc.
WEEK 5	**Blocks Rearrangement Problem**
	5. Problem Statement: The problem is to find a plan for rearranging a stack of blocks as shown below. We are allowed to move one block at a time. A block can be grasped only when its top is clear. A block can be put on the table or on some other blocks. To find a required plan, we have to find a sequence of moves that accomplish the given transformation. Think the problem as a problem of exploring among possible alternatives. **Solutions Expected:** a. Generate the rules involving to accomplish various tasks involving the blocks world. b. Formulate the more careful definitions for program and the actions. c. Present the graphical representation of the problem (state space representations) including initial state and the goal state.

WEEK 6	**Search Techniques**
	6. Problem Statement: A farmer wants to get a lion, a fox, a goose, and some corn across a river. There is a boat, but the farmer can only take one passenger in addition to himself on each trip, or else both the goose and the corn, or both the fox and the corn. The corn cannot be left with the goose because the goose will eat the corn; the fox cannot be left with the goose because the fox will eat the goose; and the lion cannot be left with the fox because the lion will eat the fox. How does everything get across the river? Assume animals do not wander off when left alone. **Solutions Expected:** a. Represent the search space by giving the starting, ending states and the operations. b. Draw the first two levels of the search graph. That's two besides the starting state. c. What is the average branching factor for these two levels? Disregard branches back to previous states. d. Give an upper bound on the size of the search space. e. Is this problem decomposable about an intermediate state?

WEEK 7	**Search Techniques**
	7. Problem Statement: Best First Search Algorithm - The Best First Search algorithm is a set of rules that work together to perform a search. It takes into account the various characteristics of a prioritized queue and heuristic search. The goal of this algorithm is to reach the state of final or goal in the shortest possible time. **Solutions Expected:** a. Perform the search process by using additional information to determine the next step towards finding the solution. b. Perform the search process using an evaluation function to decide which among the various available nodes is the most promising before traversing to that node. c. Apply priority queues and heuristic search functions to track the traversal.
WEEK 8	**Heuristic Search Techniques**
	8. Problem Statement: A* Algorithm – A square grid is composed of many obstacles that are scattered randomly. The goal is to find the final cell of the grid in the shortest possible time. Implement A* algorithm to search for the shortest path among the given initial and the final state. **Solutions Expected:** a. Initially represent the problem statement as a graph traversal problem. b. Perform the search process to obtain the shorter path first, thus making it an optimal. c. Find the least cost outcome for the problem by finding all the possible outcomes. d. Make use of weighted graph by using numbers to represent the cost of taking each path and find the best route with the least cost in terms of distance and time.
WEEK 9	**Adversarial Search**
	9. Problem Statement: AO* Algorithm – Implement the algorithm to generate AND-OR graph or tree to represent the solution by dividing the problem into sub problems and solve them separately to obtain the result by combining all the sub solutions. **Solutions Expected:** a. Follow problem decomposition approach and solve each sub problem separately and later combine all the solutions. b. Traverse the graph starting at the initial node and following the current best path, and accumulate the set of nodes that are on the path and have not yet been expanded. c. Pick one of these best unexpanded nodes and expand it. Add its successors to the graph and compute cost of the remaining distance for each of them. d. Change the cost estimate of the newly expanded node to reflect the new information produced by its successors. Propagate this change backward through the graph. Decide which of the current best path.

WEEK 10	**No Heuristic Search**
	10. Problem Statement: Depth First Search – The objective is to develop code to demonstrate the implementation of depth-first search algorithm. The concept of depth-first search is similar to that of a state-space problem. It aims to find a solution path from one node to another in the state space. The algorithm is called depth-first because of the order in which it searches for the alternatives. Whenever it is given a choice between continuing the search from multiple nodes or going deep, it always chooses the deepest one. **Solutions Expected:** a. The algorithm starts at the root node (selecting some arbitrary node as the root node in the case of a graph) and explores as far as possible along each branch before backtracking. b. Always pick the deeper branch until it reaches the solution (or it runs out of nodes, and goes to the next branch). c. Prove that DFS is complete if the search tree is finite, meaning for a given finite search tree, DFS will come up with a solution if it exists. d. Prove that DFS is not optimal, meaning the number of steps in reaching the solution, or the cost spent in reaching it is high.
WEEK 11	**Game Playing**
	11. Problem Statement: Iterative Deepening Algorithm – The goal is to prove that search is ubiquitous in artificial intelligence. The performance of most AI systems is dominated by the complexity of a search algorithm in their inner loops. Prove with an example that this algorithm gives optimal solution for exponential tree searches. **Solutions Expected:** a. Complete the search process if the branching factor is finite and there is a solution at some finite depth and obtain optimal in finding the shortest solution first. b. Avoid exploring each non-solution branch of the tree, omit cycle detection and retain completeness. c. Use additional logical features of Prolog to terminate the search process whenever if there are no solutions identified even after backtracking. d. Document the steps if the search process does not obtain optimal solution even after backtracking.

WEEK 12	**Expert Systems**
	12. Problem Statement: The goal is to create an expert system that can identify animals. We can use the rules of inference that we have learned about animals to perform this task. These rules serve as a starting point for developing an expert system, and they show the importance of having input from the users. The goal of an expert system is to provide useful information based on its users' inputs. • If it has a tawny color and has dark spots, then the animal is a cheetah. • If it has a tawny color and has black stripes, then the animal is a tiger. • If it has a long neck and has long legs, then the animal is a giraffe. • If it has black stripes, then the animal is a zebra. • If it does not fly and has long neck, then the animal is an ostrich. • If it does not fly, swims, black and white in color, then the animal is penguin. • If it appears in story ancient mariner and flys well, then the animal is albatross. **Solutions Expected:** a. Create an expert system that can identify the animal class using the inference rules. b. Utilize the user inputs and predict the animal class based on the behaviours already learned by the expert system.

TEXTBOOKS

1. Elaine Rich, Kevin Knight, Shivashankar B Nair, "Artificial Intelligence", Tata McGraw Hill, 3rd edition, 2009.
2. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Prentice-Hall, 2007.

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1. Nils J.Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1990.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson Education, 2nd Edition, 2010.
3. VS Janakiraman K, Sarukesi Gopalakrishnan, "Foundations of Artificial Intelligence & Expert Systems", Macmillan.

1. www.oikostat.ch.
2. https://learningstatisticswithr.com/
3. https://www.coursera.org/learn/probability-intro#syllabus.
4. https://www.isibang.ac.in/ athreya/psweur/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Defining the Problem as a State Space Search	CO 1	R1: 2.1 (25-30)
2	Understanding Production Systems	CO 2	R1: 2.2 (30-36)

3	Understanding Representations and Mappings	CO 2	R1: 4.1 (79-82)
4	Understanding the Problem Characteristics	CO 2	R1: 2.3 (36-43)
5	Understanding Control Strategies	CO 2	R1: 2.4
6	Implementing the Control Strategies	CO 1, CO 2, CO 3	R1: 9
7	Implementing the Heuristic Search Techniques	CO 1, CO 2, CO 3	R1: 3.1-3.6 (50-72)
8	Implementing the Problem Reduction Algorithms	CO 1, CO 2, CO 3	R1: 3.4 (64-68)
9	Implementing the Mean End Analysis	CO 1, CO 2, CO 3	R1: 3.6
10	Implementing Adversarial Search Algorithms	CO 1, CO 2, CO3	R1: 10
11	Implementing Game Playing Algorithms	CO 1, CO 2, CO 3	R1: 12.1-12.6(231-245)

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Artificial Intelligence for data consolidation, forecasting input data, and metamodeling approaches
2	AI-based forecasting methods for the assessment of the security of electricity supply
3	Design of experiments for effective scanning of the design space
4	Combine metamodeling with design of experiments

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Dr. M.Nagaraju, Assistant Professor

I A R E
EDUCATION FOR LIBERATION

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering (AI&ML)**				
Course Title	**Business Economics and Financial Analysis**				
Course Code	AHSC13				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms. D Sandhya Rani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The present course is designed in such a way that it gives an overview of concepts of Economics. Managerial Economics enables students to understand micro environment in which markets operate how price determination is done under different kinds of competitions. Financial Analysis gives clear idea about concepts, conventions and accounting procedures along with introducing students to fundamentals of ratio analysis and interpretation of financial statements. Break Even Analysis is very helpful to the Business Concern for Decision Making, controlling and forward Strategic Planning. Ratio analysis gives an idea about financial forecasting, financial planning, controlling the business and decision making.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
BEFA	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
16.67%	Remember
16.67%	Understand
16.67%	Apply
50 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

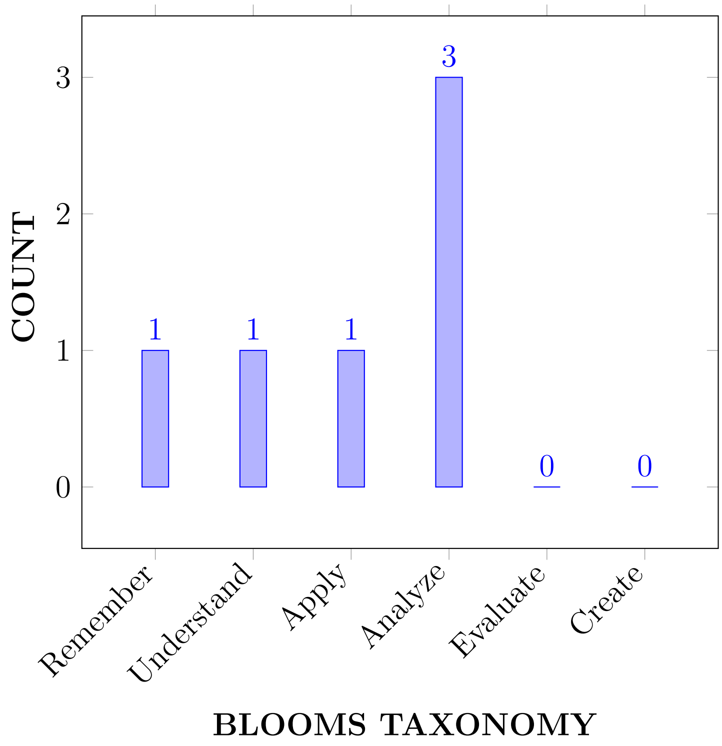
I	The concepts of business economics and demand analysis helps in optimal decision making in business environment
II	The functional relationship between Production and factors of production and able to compute breakeven point to illustrate the various uses of breakeven analysis.
III	The features, merits and demerits of different forms of business organizations existing in the modern business environment and market structures.
IV	The concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems for project management.
V	Various accounting concepts and different types of financial ratios for knowing financial positions of business concern.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**List** the basic concepts of managerial economics and analysis, measurement of demand and its forecasting to know the current status of goods and services.	Remember
CO 2	**Examine** to know the current status of goods and services. to know the economies and diseconomies of scale in manufacturing sector.	Analyze
CO 3	**Summarize** the four basic market models like perfect competition, monopoly, monopolistic competition, and oligopoly to know the price and quantity are determined in each model.	Understand
CO 4	**Compare** various types of business organizations and discuss their implications for resource allocation to strengthen the market environment.	Analyze
CO 5	**Analyze** different project proposals by applying capital budgeting techniques to interpret the solutions for real time problems in various business projects.	Analyze
CO 6	**Develop** the ability to use a basic accounting system along with the application of ratios to create (record, classify, and summarize) the data needed to know the financial position of the organization.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
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PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
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Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	1	Seminar/ Conferences
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Assignments/ Discussion
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO 6	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Recall** (knowledge) the scientific fundamentals of economic activities performed by the businessmen in the business for profit earning.	2
	PO 2	**Interpret** and identify the demand and its analysis with the mathematical and natural principles of demand forecasting methods.	6
	PO 8	**Define** (knowledge) the responsibilities of the engineering practices by knowing the best economical practices.	1
	PO 9	**Match** (knowledge) the economical implication to effectively function as a team member, and as a member or leader in diverse teams.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Relate** (knowledge) the knowledge and understanding of the economic principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	6
CO 2	PO 1	**Recall** (Knowledge) the knowledge of mathematics, science in the production function through Different Combination of variable inputs with Economies of Scale.	2
	PO 2	**Demonstrate** the different cost concepts and determine the significance of Break Even Analysis.	5
	PO 8	**Relate** (Knowledge) (Knowledge) the ethical principles and commit to professional ethics and responsibilities and norms of the production management	2
	PO 9	**Show** (Fundamentals) the production function implications for effective implementation of gang compositions in a team work and in multidisciplinary settings.	6
	PO 11	**Define** the economies of scale in production function and Break Even Analysis knowledge applied in one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	5
CO 3	PO 8	**List** (Knowledge) (Knowledge) different structures of market and how price is determined under different market structures commit to professional ethics and responsibilities and norms of the engineering practice.	2
	PO 9	**Match** the market structures and the market entry strategies as an individual, and as a member in diverse teams.	6
CO 4	PO 8	**Categorize** the ethical principles and commit to professional ethics and responsibilities belongs to different forms of business organizations existing in the modern business.	2
	PO 9	**Classify** various business organizations and their functioning as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	6
CO 5	PO 1	**Explain** the ethical issues involved in the allocation of funds under the concept of capital budgeting.	1
	PO 11	**Summarize** the concept of capital budgeting and allocations of the resources through capital budgeting methods of the management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	8
CO 6	PO 2	**Explain** the GAAP principles and ratios to analyse complex engineering problems reaching substantiated conclusions using first principles of accounts and profitability and efficiency of the organization.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Illustrate**the accounting methods and procedures and accounting principles to manage the financial aspects in a project.	8

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	6	-	-	-	-	-	1	5	-	6	-	-	-	-
CO 2	2	5	-	-	-	-	-	2	6	-	5	-	-	-	-
CO 3	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	8	-	-	-	-
CO 6	-	2	-	-	-	-	-	-	-	-	8	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	60.0	-	-	-	-	-	33.3	41.6	-	50.0	-	-	-	-
CO 2	66.7	50.0	-	-	-	-	-	66.7	50.0	-	41.6	-	-	-	-
CO 3	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 5	33.3	-	-	-	-	-	-	-	-	-	75.0	-	-	-	-
CO 6	-	20.0	-	-	-	-	-	-	-	-	75.0	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	1	2	-	2	-	-	-	-
CO 2	3	2	-	-	-	-	-	3	2	-	2	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-
TOTAL	7	7	-	-	-	-	-	10	8	-	-	-	-	-	-
AVERAGE	2.3	2.3	-	-	-	-	-	2.5	2	-	2.5	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION&DEMAND ANALYSIS**
	Introduction to Business Economics: Definition, Nature and Scope of Managerial Economics – Demand Analysis: Demand Determinants, Law of Demand and its exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Factors governing demand forecasting, methods of demand forecasting
MODULE II	**PRODUCTION & COST ANALYSIS**
	Theory of Production and Cost Analysis: Production Function – Iso-quants and Iso-costs, MRTS, Least Cost Combination of Inputs, Cobb-Douglas Production function, Laws of Returns, Internal and External Economies of Scale. Cost Analysis: Cost concepts; Break-even analysis, Determination of Break – Even point (Simple Problems) , Managerial Significance of BEA.
MODULE III	**MARKETS & NEW ECONOMIC ENVIRONMENT**
	LMarket structures: Types of competition, Features of perfect competition, Monopoly and monopolistic competition. Price determination & Price Statistics: Price Output determination in case of perfect competition and monopoly. Features and evaluation of different forms of Business organization: Sole proprietorship, partnership, Joint Stock Company, public enterprises and their types.
MODULE IV	**CAPITAL BUDGETING**
	Capital and its significance, types of capital, estimation of fixed and working capital requirements, methods and sources of raising capital- Trading Forecast, Capital budget, Cash Budget. Features of capital budgeting proposals, methods of capital budgeting – payback method, Accounting rate of return(ARR), Net Present Value Method (simple problems).

MODULE V	**INTRODUCTION TO FINANCIAL ACCOUNTING AND FINANCIAL ANALYSIS**
	Financial accounting objectives, functions, importance; Accounting concepts and accounting conventions - double-entry book keeping, journal, ledger, trial balance; Final accounts: Trading account, profit and loss account and balance sheet with simple adjustments; Financial analysis: Analysis and interpretation of liquidity ratios, activity ratios, capital structure ratios and profitability ratios (simple problems), Du Pont chart.

TEXTBOOKS

1. Aryasri, "Managerial Economics and Financial Analysis", TMH publications, 4thEdition,2012.
2. M. KasiReddy, Saraswathi, "Managerial Economics and Financial Analysis", PHI Publications, New Delhi, 2ndEdition,2012.
3. Varshney, Maheswari, "Managerial Economics", Sultan Chand Publications, 11thEdition,2009.

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1. D.N. Dwivedi, "Managerial Economics", Vikas Publication House Pvt.Ltd, 2ndEdition,2012.
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9. https://opentextbc.ca/principlesofaccountingv1openstax/chapter/prepare-a-trial-balance/
10. https://caknowledge.com/how-to-prepare-final-accounts/
11. https://corporatefinanceinstitute.com/resources/knowledge/finance/ratio-analysis/

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=publicprofile&id=5201

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Course Outcomes and how these COs mapped with POs and PSOs.		
CONTENT DELIVERY (THEORY)			
2	Concept of managerial economics according to the business	CO 1	T1- 1.3-1.8 R1-1.5-1.7
3	Nature and scope of business economics.	CO 1	T1- 1.3-1.8 R1-1.5-1.7
4	Meaning of demand analysis, Demand determinants and demand Function.	CO 1	T1-2.2-2.11 R1-3.3-3.20
5	Law of Demand and Exceptions of Law of Demand.	CO 1	T1-2.2-2.11 R1-3.3-3.20
6	Understand elasticity of the demand of the product and different types of Elasticity of Demand.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
7	Measurement of Elasticity of Demand and Factors influencing on Elasticity of Demand.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
8	State different methods of Demand Forecasting and the factors governing Demand Forecasting.	CO 1	T1-4.6-4.19
9	Demonstrate the Production function, features of Iso-Quants and Iso-Costs.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
10	Cobb-Dougles production function.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
11	Economies of Scale and Types of Economes of Scale.	CO 2	T1- 5.3-5.18
12	External and Internal Economies with appropriate examples.	CO 2	T1- 5.3-5.18
13	Advantages and Disadvantages of Economies.	CO 2	T1- 5.3-5.18
14	Illustrate different types of costs	CO 2	T1- 5.29-6.8
15	Marginal cost equation	CO 2	T1- 5.29-6.8
16	Explain the Significance and Limitations of Break-Even Analysis	CO 2	T1- 7.13-7.14
17	Profit-Volume Ratio	CO 2	T1- 7.13-7.14
18	Calculate Break-Even Point (Simple Problems)	CO 2	T1- 7.1-7.12
19	Calculate Margin of safety and P/E Ratio (Simple Problems)	CO 2	T1- 7.1-7.12
20	Illustrate the features, price-output determination under Perfect Competition.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
21	Monopoly and Monopolistic competition Markets.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
22	Demonstrate the price-output determination under perfect competition.	CO 3	T1- 8.21-8.25
23	Price-output determination under monopoly business.	CO 3	T1- 8.21-8.25
24	Illustrate the concept of Oligopoly and Duopoly with suitable examples.	CO 3	T1- 8.21-8.25
25	Describe Features of business, Definitions of Various forms of Business Units.	CO 4	T1-9.3-9.15

26	Features of Partnership and types of partners.	CO 4	T1-9.3-9.15
27	State the Merits & Demerits of Sole Proprietorship.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
28	Features of Joint Stock Company.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
29	Importance of Cooperative societies .	CO 4	T1-9.2-10.23 R1- 8.21-8.25
30	Significance and types of Capital.	CO 5	T1-9.2-10.23 R1- 8.21-8.25
31	Methods and Sources of Raising Finance.	CO 5	T1-9.2-10.23
32	Estimation of fixed and working capital requirements.	CO 5	T1-9.2-10.23
33	Demonstrate the concept of capital budgeting and allocations of the resources through capital budgeting methods.	CO 5	T1-11.3-11.5 R2-12.3-12.5
34	Illustrate the Significance of Financial Accounting, Double Entry book keeping.	CO 6	T1-11.3-11.5 R2-12.3-12.5
35	Accounting Concepts and Conventions	CO 6	T1-12.1-12.26
36	Journal Entries of business transactions	CO 6	T1-12.1-12.26
37	Ledger posting	CO 6	T1-12.1-12.26
38	Explain the meaning, advantages and Limitations of Trial Balance and Final Accounts and Solve simple Problems.	CO 6	T1-13.4-13.15 R2-11.3-11.5
39	Describe Meaning, Definitions and Limitations of Ratio Analysis .	CO 6	T1-13.4-13.15 R2-11.3-11.5
40	Compute different types of Financial Ratios (Problems) .	CO 6	T1-13.4-13.15 R2-11.3-11.5
PROBLEM SOLVING/ CASE STUDIES			
41	Problems relating to Demand elasticty measurement and Forecasting	CO 1	T1: 1.1 - 2.8, R1:2.1
42	Problems relation to Break Even Point	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
43	Problems in determining the price in different types of markets	CO 3,4	T3: 6.0 to 6.4, R1:5.1
44	Problems relating to Pay back period	CO 5	R2:7.5
45	Problems relating to Accounting Rate of Return	CO 5	R2:7.5
46	Problems relating to Net Present Value	CO 5	R2:7.5
47	Problems relating to Internal Rate of Return	CO 5	R2:7.5
48	Problems relating to Profitability Index	CO 5	R2:7.5
49	Problems relating to Journal Entries	CO 6	R3: 4.1
50	Problems relating to Ledger posting	CO 6	R3: 4.1
51	Problems relating to Trial Balance	CO 6	R3: 4.1
52	Problems relating to P& L Account	CO 6	R3: 4.1
53	Problems relating to Balance Sheet	CO 6	R3: 4.1
54	Problems relating to Profitability Ratios	CO 6	R3: 4.1
55	Problems relating to Liquidity Ratios	CO 6	R3: 4.1

DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Demand Forecasting	CO 1	T1: 1.1 - 2.8, R1:2.1
57	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
58	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
59	Capital Budgeting	CO 5	R2:7.5
60	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1
DISCUSSION OF QUESTION BANK			
61	Introduction and Demand Analysis	CO 1	T1: 1.1 - 2.8, R1:2.1
62	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
63	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
64	Capital Budgeting	CO 5	R2:7.5
65	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1

Signature of Course Coordinator **HOD,MBA**
Ms. D Sandhya Rani, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI&ML)
COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING (AI&ML)				
Course Title	NATURAL LANGUAGE PROCESSING				
Course Code	ACAC13				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. M. Nagaraju, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming
B.Tech	AHSC08	II	Probability and Statistics

II COURSE OVERVIEW:

This course is study of computing systems that can process, understand, or communicate in human language. The primary focus of the course will be on understanding various NLP tasks and algorithms for effectively solving these problems, and methods for evaluating their performance. This course is intended as a theoretical and methodological introduction to a the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Natural Language Processing	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage

in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
20%	Remember
30%	Understand
50%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

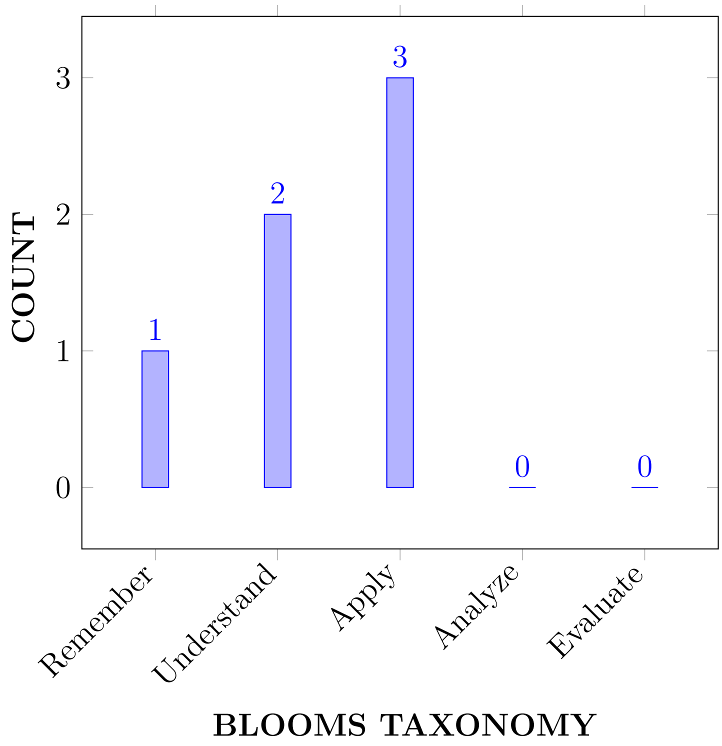
I	The concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS
II	The mathematical foundations, Probability theory with Linguistic essentials such as syntactic andsemantic analysis of text.
III	The applications of statistical learning methods and cutting-edge research models from deep learning.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Remember** the knowledge of complex language behaviour in terms of phonetics, morphology etc	Remember
CO 2	**Understand** the semantics and pragmatics for text processing	Understand
CO 3	**Apply** the CORPUS linguistics to compile and analyze the texts based on digestive approach (Text Corpus Method)	Apply
CO 4	**Understand** various statistical approaches to machine translation for a given natural language	Understand
CO 5	**Apply** Part-of-speech (POS) tagging for a given natural language and suitable modeling technique based on the structure	Apply
CO 6	**Apply** the state of the art algorithms and techniques for text-based processing of natural language with respect to morphology	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE/Quiz/ AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	CIE/Quiz/ AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		✓	-	-
CO 2	-	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓	-
CO 3	✓	-	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 5	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	✓	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Learn the definition of NLP and its underlying assumptions. The approaches also evolved to understand the properties of natural languages, its algorithms for processing linguistic information in various tasks such as Machine translation, Information extraction and retrieval, and Speech Technology.	3

	PSO 1	Demonstrate the capability to create simple AI applications using Natural Language Processing, machine learning and statistical languages.	4
CO 2	PO 2	Explore different NLP techniques to extract data from text.	3
	PO 3	Relate Knowledge and current approaches to natural language processing are based on deep learning, a type of AI that examines and uses patterns in data to improve a program's understanding. Deep learning models require massive amounts of labeled data for the natural language processing algorithm to train on and identify relevant correlations, and assembling this kind of big data set is one of the main hurdles to natural language processing.	7
	PO 5	Modern tool usage: Create, select, and apply to start NLP development is by using ready-made toolkits i.e. the Natural Language Toolkit (NLTK) with Python and different APIs. Pretrained on extensive corpora and providing libraries for the most common tasks, these platforms help kickstart your text processing efforts, especially with support from communities and big tech brands.	1
	PSO 3	Understand Issues and investigates this by demonstrating how several natural language phenomena, such as definite reference, ambiguity, ellipsis, ill-formed input, figures of speech, and vagueness, require diverse knowledge sources and reasoning.	4
CO 3	PO 1	To extract text from CORPUS linguistics i.e. a collection of authentic text or audio organized into datasets.	3
	PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods like Natural Language Understanding (NLU) are constantly growing in huge leaps and bounds with their ability to compute words and text, human language is incredibly complex, fluid, and inconsistent and presents serious challenges to solve.	7
	PO 5	Modern tool usage: Create, select, and apply to start NLP development is by using ready-made toolkits i.e. the Natural Language Toolkit (NLTK) with Python and different APIs. Pretrained on extensive corpora and providing libraries for the most common tasks, these platforms help kickstart your text processing efforts, especially with support from communities and big tech brands.	1
	PSO 1	Demonstrate corpus linguistics to see how language is used today and how that language is used in different contexts, enabling us to teach language more effectively.	4

	PSO 2	Understand Issues and investigates this by demonstrating how several natural language phenomena, such as definite reference, ambiguity, ellipsis, ill-formed input, figures of speech, and vagueness, require diverse knowledge sources and reasoning.	2
CO 4	PO 1	Recall steps of Statistical NLP that comprises all quantitative approaches to automated language processing, including probabilistic modeling, information theory, and linear algebra.	2
	PSO 1	Demonstrate the capability to create Statistical Modeling in NLP to extract tests from handwriting with the lexical acquisition, create auto-completes, Recognize speech, and caption images and detect correct spelling errors.	4
CO 5	PO 1	Explain how to categorize words in a text (corpus) in correspondence with a particular part of speech, depending on the definition of the word and its context.	2
	PO 2	Explore suitable modeling techniques for given natural language for extracting text and create POS tags that are used to describe the lexical terms that we have within our text to simply it.	4
	PO 3	Perform POS tagging, it's often the case that our tagger will encounter words that were not within the vocabulary that was used. Consequently, augmenting your dataset to include unknown word tokens will aid the tagger in selecting appropriate tags for those words.	5
	PO 5	Modern tool usage: Create, select, and apply Hidden Markov models (HMMs) a type of statistical model and trained it on a large annotated corpus of text to learn the patterns and characteristics of different parts of speech.	1
	PO 10	Understand the POS tagging techniques that is concentrated on standardized texts for many years and now used for social media texts.	3
	PSO 2	Understand the purpose of POS tags in information retrieval i.e noun, verb and adjective retrieval with its different forms..	2
CO 6	PO 1	Apply NLP and its techniques for different applications in various fields such as machine translation, email spam detection, information extraction, summarization, medical, and question answering etc.	3
	PO 2	Natural Language Understanding and Natural Language Generation are used to generate the text and solve it in the smallest units of meaning ie. Morphemes.	7
	PSO 1	Demonstrate the capability to create distinguish orthographic rules and morphological rules from morphenes.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 2	-	3	7	-	1	-	-	-	-	-	-	-	-	2	-
CO 3	3	-	-	7	1	-	-	-	-	-	-	-	4	2	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 5	2	4	5	-	1	-	-	-	-	3	-	-	-	2	-
CO 6	3	7	-	-	-	-	-	-	-	-	-	-	3	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
CO 2	-	33.3	70	-	100	-	-	-	-	-	-	-	-	100	-
CO 3	100	-	-	66.6	100	-	-	-	-	-	-	-	66.7	100	-
CO 4	66.7	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
CO 5	66.7	40	50	-	100	-	-	-	-	60	-	-	-	100	-
CO 6	100	70	-	-	-	-	-	-	-	-	-	-	50	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	-	1	3	-	3	-	-	-	-	-	-	-	-	3	-
CO 3	3	-	-	3	3	-	-	-	-	-	-	-	3	3	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 5	3	2	2	-	3	-	-	-	-	3	-	-	-	3	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
TOTAL	15	6	5	3	9	-	-	-	-	3	-	-	9	11	-
AVERAGE	3.0	2.0	2.5	3.0	3.0	-	-	-	-	3.0	-	-	3.0	2.75	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**CLASSICAL APPROACH TO NLP**
	Introduction to NLP, The classical tool kit, Knowledge in Speech and Language processing, ambiguity and models and algorithm, language and understanding, brief history.
MODULE II	**REGULAR EXPRESSIONS, TEXT NORMALIZATION**
	Regular Expressions, patterns, words, Corpora, Text normalization, Minimum edit distance, Regular Language and FSAs, Raw Text Extraction and Tokenization, Extracting Terms from Tokens, Normalization.
MODULE III	**N-GRAM LANGUAGE MODELS**
	N-grams, Evaluating language models, Generalization and zeros, smoothing, kneser-Ney smoothing, huge language models and stupid back off. Perplexity's relation to entropy. Inflection, Derivational Morphology, Finite-State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Combining FST Lexicon and rules.
MODULE IV	**WORD SENSE DISAMBIGUATION**
	Methodological Preliminaries, Supervised Disambiguation: Bayesian classification, An information theoretic approach, Dictionary-Based Disambiguation: Disambiguation based on sense, Thesaurus based disambiguation, Disambiguation based on translations in a second-language corpus.
MODULE V	**MARKOV MODEL AND POS TAGGING**
	Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging.

TEXTBOOKS

1. Christopher D. Manning and Hinrich Schutze, " Foundations of Natural Language Processing" , 6th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003.

2. Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.

REFERENCE BOOKS:

1. Nitin Indurkhya, Fred J. Damerau "Handbook of Natural Language Processing", Second Edition, CRCPress,2010.
2. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012.
3. Chris Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing",2nd edition, ITPress Cambridge, MA, 2003.

WEB REFERENCE

1. https://www.academia.edu/7452675/Foundations_of_Statistical_Natural_Language_Processing.
2. https://www.mygreatlearning.com/blog/natural-language-processing-tutorial/
3. https://pub.towardsai.net/natural-language-processing-nlp-with-python-tutorial-for-beginners-1f54e610a1a0
4. https://www.analyticsvidhya.com/blog/2021/02/basics-of-natural-language-processing-nlp-basics/

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
Discussion on subject CO-PO mapping			
CONTENT DELIVERY (THEORY)			
1	Introduction to NLP	CO 1	T1:1.1
2	The classical tool kit, Knowledge in Speech and Language Processing	CO 1	R1:1.2
3	Ambiguity and models and algorithm	CO 1	R1: 2.2.1, 4.1, 4.3
4	Language and understanding	CO 1	R1: 1.2, 1.3, 1.5
5	Brief History	CO 1	R1:, 1.1, 2.1, 3.1, 4.1, 5.1, 6.1
6	Regular Expressions	CO 2	T2: 2.1
7	Patterns	CO 2	T2: 2.1
8	Words	CO 2	T2: 2.1
9	Corpora	CO 2	T2: 2.1, R1:7.1,
10	Text Normalization	CO 2	T2: 2.1, R1:7.1
11	Minimum Edit Distance	CO 2	T2: 2.1, R1:7.1
12	Regular Language and FSA's	CO 2	T2: 2.1, R1:7.1
13	Raw Text Extraction and Tokenization	CO 2	T2: 2.1, R1:7.1

14	Extracting Terms from Tokens	CO 2	T2: 2.1, R1:7.1
15	Normalization	CO 2	T2: 2.1
16	N-grams	CO 3	T2:3.1, T1:6.1
17	Evaluating language models	CO 3	T2:3.1
18	Generalization and zeros	CO 3	T2:3.1
19	Smoothing	CO 3	T2:3.1
20	Kneser-Ney smoothing	CO 3	T2:3.1
21	Huge Language Models and Stupid Back Off	CO 3	T2:3.1
22	Perplexity's Relation to Entropy	CO 3	T2:3.1
23	Inflection	CO 3	T2:3.1
24	Derivational Morphology	CO 1	T1:3.1
25	Finite-State Morphological Parsing	CO 3	T1:3.1
26	The Lexicon and Morphotactics	CO 3	T1:3.1
27	Morphological Parsing with Finite State Transducers	CO 4	T1:3.1
28	Combining FST Lexicon and rules	CO 4	T2:25
29	Methodological Preliminaries	CO 4	T1:7.1
30	Supervised Disambiguation: Bayesian Classification	CO 4	T1:7.2
31	An information Theoretic Approach	CO 4	T1:7.2.2
32	Dictionary-Based Disambiguation: Disambiguation Based on Sense	CO 4	T1:7.3
33	Thesaurus based Disambiguation	CO 4	T1:7.3.2
34	Disambiguation based on Translations in a Second-Language Corpus	CO 4	T1:7.3.3
35	Markov Model: Hidden Markov model	CO 4	,T1: 9.1, 9.2, T2: Appendix-A
36	Fundamentals, Probability of properties	CO 5	T1:9.3, 9.4
37	Parameter Estimation and Variants, Multiple Input Observation	CO 5	T1:9.3.3
38	The Information Sources in Tagging: Markov Model Taggers	CO 5	T1:10.1
39	Viterbi Algorithm, Applying HMMs to POS Tagging	CO 5	10.2, 10.2.1, 10.3, 10.3.1
40	Applications of Tagging	CO 5	T1:10.6.2
PROBLEM SOLVING/CASE STUDIES			
41	Write an FSA for time-of-day expressions like eleven o'clock, twelve-thirty, midnight, or a quarter to ten and others.	CO 1	-
42	Implement one of the steps of the Porter Stemmer as a transducer.	CO 1	-
43	Write a program that takes a word and, using an on-line dictionary, computes possible anagrams of the word.	CO 2	-

44	Write the algorithm for parsing a finite-state transducer, using the pseudo-code. You should do this by modifying the algorithm nd-recognize	CO 1	-
45	Write an FST which correctly pronounces strings of dollar amounts like $45, $320, and $4100. If there are multiple ways to pronounce a number you may pick your favorite way.	CO 2	-
46	Write an FST which correctly pronounces 7-digit phone numbers like 555-1212, 555-1300, and so on. You should use a combination of the paired and trailing unit methods of pronunciation for the last four digits.	CO 2	-
47	Write two-level rules for the Yawelmani Yokuts phenomena of Harmony, Shortening, and Lowering introduced on page 110. Make sure your rules are capable of running in parallel	CO 2	-
48	Find 10 stress-neutral name suffixes (look in a phone book) and sketch an FST which would model the pronunciation of names with or without suffixes	CO 2	-
49	Implement the Forward algorithm..	CO 3	-
50	Now imagine a version of English that was written without spaces. Apply your segmentation program to this 'compressed English'. You will need other programs to compute word bigrams or trigrams.	CO 3	-
51	Run your N-gram program on two different small corpora of your choice (you might use email text or newsgroups). Now compare the statistics of the two corpora. What are the differences in the most common unigrams between the two? How about interesting differences in bigrams?	CO 4	-
52	Implement the Stack decoding algorithm of Figure 7.14 on 254. Pick a very simple h* function like an estimate of the number of words remaining in the sentence.	CO 4	-
53	Implement the TBL algorithm in Figure 8.10. Create a small number of templates and train the tagger on any POS-tagged training set you can find.	CO 5	-
54	Write rules expressing the verbal subcategory of English auxiliaries; for example you might have a rule can ! verb-with-bare-stem-VP-complement.	CO 5	-
55	Write an algorithm for converting an arbitrary context-free grammar into Chomsky normal form.	CO 5	-
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	MODULE-I: Classical Approach to NLP	CO 1	-
57	MODULE-II: Regular Expressions, Text Normalization	CO2	-
58	MODULE-III: N-Gram Language Model	CO 3	-
59	MODULE-IV: Word Sense Disambiguation	CO 4	-
60	MODULE-V: Markov Model and POS Tagging	CO 5	-

DISCUSSION OF QUESTION BANK			
61	Perform the following operations using Library: nltk, string: a) Lowercase the text to reduce the size of the vocabulary of our text data b) Remove numbers or convert the numbers into their textual representations c) Remove punctuations so that we don't have different forms of the same word. If we don't remove the punctuation, then been. been, been! will be treated separately. d) Use the join and split function to remove all the white spaces in a string.	CO 1	-
62	Remove the numbers with Inflect Library and Lemmatization and perform the below: a) Convert the numbers into words. This can be done by using the inflect library. b) Use the WordNetLemmatizer to get the lemmas of words and also need to provide a context for the lemmatization. So, that add part-of-speech as a parameter.	CO 2	-
63	Perform the conversion of text to speech in NLP using categorized CORPUS and implement the conversion of text to speech and text data categorization.	CO 3	-
64	Implement the concept of Combining NGRAM Taggers and implement the using of Unigram, Bigram, and Trigram tagger, backoff_tagger function for Unigram, Bigram and Trigram tagger and print proof as TRUE.	CO 4	-
65	Apply Parts-of-Speech (POS) with Inflect Library and Lemmatization and implement: a) Use part of speech tagging to mark a word to its part of speech tag based on its context in the data. It is also used to extract relationships between words. b) On top of Part of Speech tagging. It groups word into "chunks", mainly of noun phrases. Chunking is done using regular expressions.	CO 5	-

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Dr. M.Nagaraju, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI&ML)**				
Course Title	**OBJECT ORIENTED SOFTWARE ENGINEERING**				
Course Code	ACSC19				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr.Bhukya Mohan, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	**Course Code**	**Semester**	**Prerequisites**
-	-	-	-

II COURSE OVERVIEW:

This course presents the concepts, methods and techniques necessary to efficiently capture software requirements in use cases and transform them into detailed designs. It combines instruction on the Unified Software Development Process (UP), object-oriented methodologies and the Unified Modeling Language. In this course, students learn how to apply the UML notation in the context of an iterative, use case-driven, architecture-centric process. They are also exposed to an advanced CASE tool that allows the rapid development of UML diagrams and promotes an agile workflow by synchronizing changes in the various models and the code.

III MARKS DISTRIBUTION:

Subject	**SEE Examination**	**CIE Examination**	**Total Marks**
Object Oriented Software Engineering	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could

be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
60 %	Understand
20%	Apply
10%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

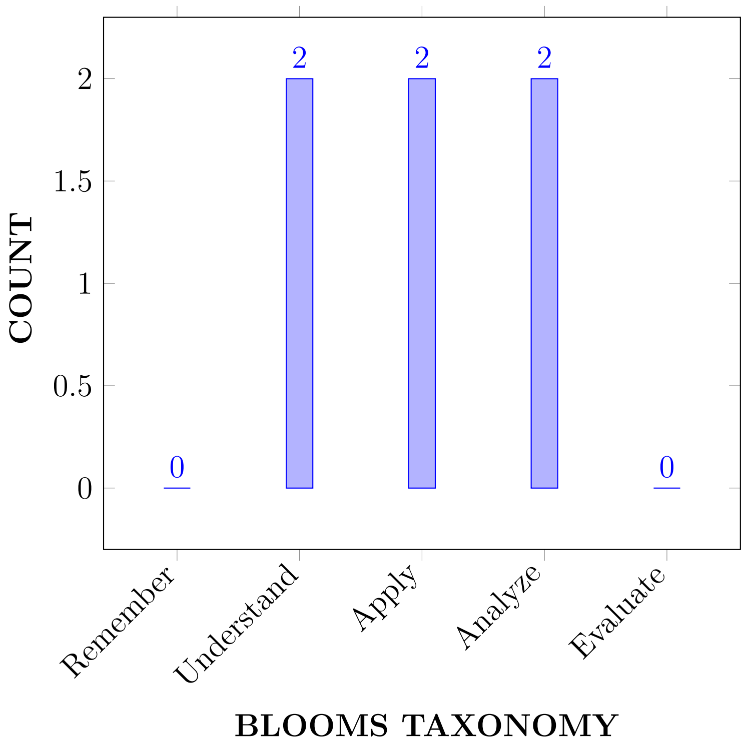
I	The object-oriented concepts along with their applicability contexts.
II	The different phases in software development life cycle .
III	To learn various modeling techniques to model different perspectives of object oriented software design (UML)
IV	To learn software architecture and design patterns.
V	The knowledge of testing methods and comparison of various testing techniques.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** software process software development process models and applications, to manage a software project.	Understand
CO 2	**Outline** the software requirements prototyping scheduling estimation models to prepare the software requirement specifications document.	Understand
CO 3	**Make use of** discrete modelling techniques to conduct structured object -oriented and domain analysis.	Apply
CO 4	**Utilize** the object -oriented analysis process and explore different design models with UML.	Apply
CO 5	**Explain** the design concept principles and various design approaches.	Understand
CO 6	**Summarize** the approaches used for object-oriented implementation testing and maintenance of a software product.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE / CIE / AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	SEE / CIE / AAT
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction analysis and interpretation of data, and synthesis of the information to provide valid conclusions and modeling to complex engineering activities with an understanding of the limitations.	3	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	2	SEE / CIE / AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	1	SEE/AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	SEE/AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	SEE/AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-
CO 2	-	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	✓
CO 3	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	✓
CO 4	✓	-	✓	-	-	-	-	-	-	✓	-	✓	-	✓	✓
CO 5	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
CO 6	-	-	-	-	✓	-	-	-	-	✓	-	✓	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Usage of basic engineering tools will help to understand the problem definition and provide knowledge on IT tools.	1
	PO 5	Use of Modern tools can availthe facility to upgrade software models and designs to improve efficiency of the tools and techniques.	1
	PSO1	Apply differnt process models leads to have better solution models and upgraded designs to slove computing problems.	1
CO 2	PO 2	By identifying and analysing engineering problem can avail better project planning activities to schedule the project planning.	3
	PO 10	Software models can effectively communicate engineering problems and solutions and used to make effective reports in the project planning.	4
	PO 12	Using lifelonglearning new methodlogies will impart effective models and designs in project planning activities and schedules.	1
	PSO 3	Use of new technologies and innovation will improve the project planning and selection of protfolios.	2
CO 3	PO 1	Applying engineering knowledge will improve the performance of software models and can analyze the advantages by comparing with current and basuc models in software development.	1
	PO 3	Usage of models is to design solutions to complex software problems and helps to design system commponents acrroding to customer requirements.	7
	PSO 3	Following new trends will help to create effective software models in the context of technological change.	1
CO 4	PO 1	Using engineering basic prinicples of software design models will be able to build software architechture of the system.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Design solutions for simple and complex problems by Defining problem, understand customer requirements, identifying basic building blocks to draw UML diagrams.	6
	PO 10	Communicate with structural and behavioral design patterns effectively on complex engineering activities with the engineering community and give and receive clear instructions.	4
	PSO 3	Make use of computational and advanced CASE tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	1
CO 5	PO 1	Apply Architectural and domain model Engineering knowledge and modelling principles, in identifying basic building blocks for visualizing artifacts of system.	1
	PO 3	Design representation of Next gen POS system for simple and complex problems by Defining problem, understand customer requirements, identifying basic building blocks to draw UML diagrams.	6
	PO 5	Communicate static and dynamic aspects of the system using using system sequence and use case diagrams. For specifying structure and interaction of objects during runtime	2
	PSO 3	Formulate and Evaluate engineering concepts to Design next-generation computer systems by using advanced building blocks of UML.	1
CO 6	PO 5	Usage of modern tools of testing and software quality will improvethe standards of verification and validation of the system.	1
	PO 10	Verification and validation willcommunicate the effectiveness of the system in real - world environment before deploying the project.	4
	PO 12	In the changing technological context life- long learning will enable to adopt changes in new verification and validation methods.	1
	PSO 3	Usage of innovative verification and validation tools will improve the quality of designs amd models in creating components of system architechture.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	1	-	-	-	-	-	-	-	2	-	-
CO 2	-	3	-	-	-	-	-	-	-	4	-	1	-	-	2
CO 3	1	-	7	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	1	-	6	-	-		-	-	-	4	-	-	-	-	1
CO 5	1	-	6	-	1	-	-	-	-	-	-	-	-	-	2
CO 6	-	-	-	-	1	-	-	-	-	4	-	1	-	-	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0
CO 2	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0	0.0	12.5	0.0	0.0	50.0
CO 3	33.0	0.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
CO 4	33.0	0.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0	0.0	0.0	0.0	0.0	25.0
CO 5	33.0	0.0	60.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0	50.0	50.0
CO 6	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	80.0	0.0	12.5	0.0	50.0	25.0

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $< C \leq 40\%$ – Low/ Slight

2 - 40 % $< C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	3	-	-	-	-	-	-	1	1	-	-
CO 2	-	1	-	-	-	-	-	-	-	3	-	1	-	-	2
CO 3	1	-	3	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	1	-	3	-	-	-	-	-	-	3	-	-	-	-	1
CO 5	1	-	3	-	3	-	-	-	-	-	-	-	-	-	2
CO 6	-	-	-	-	3	-	-	-	-	3	-	1	-	-	1
TOTAL	4	1	12	-	9	-	-	-	-	9	-	3	1	-	7
AVERAGE	1.0	1.0	3.0	-	3.0	-	-	-	-	3.0	-	1.0	1.0	-	2.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO SOFTWARE ENGINEERING**
	Introduction to software engineering, software development process models, agile development, project and process, project management, process and project metrics, object-oriented concepts, principles and methodologies.
MODULE II	**PLANNING AND SCHEDULING**
	Software requirements specification, software prototyping, software project planning, scope, resources, software estimation, empirical estimation models, planning, risk management, software project scheduling, object-oriented estimation and scheduling.
MODULE III	**ANALYSIS**
	Analysis modeling, data modeling, functional modeling and information flow, behavioral modeling, structured analysis, object-oriented analysis, domain analysis. Object-oriented analysis process, object relationship model, object behaviour model, design modeling with UML
MODULE IV	**DESIGN**
	Design concepts and principles, design process, design concepts, modular design, design effective modularity, introduction to software architecture, data design, transform mapping, transaction mapping, object-oriented design, system design process, object design process.
MODULE V	**IMPLEMENTATION, TESTING AND MAINTENANCE**
	Top-down, bottom-up, object-oriented product implementation and integration. Software testing methods, white box, basis path, control structure, black box, unit testing, integration testing, validation and system testing, testing tools, software maintenance and reengineering.

TEXTBOOKS

1. Ivar Jacobson, —Object Oriented Software Engineering: A Use Case Driven Approach, Pearson India, 1st Edition, 2002.

2. Bernd Bruegge, Allen H. Dutoit, —Object-Oriented Software Engineering: Using UML, Patterns and Java, Pearson New International Edition, 3rd Edition, 2013.

REFERENCE BOOKS:

1. Roger. S. Pressman and Bruce R. Maxim, —Software Engineering – A Practitioner‘s Approach, McGraw Hill, 7th Edition, 2015.

2. Craig Larman, —Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Pearson Education, 3rd Edition, 2008.

WEB REFERENCES:

1. https://www.cse.iitb.ac.in/ sunita/cs725/calendar.html

2. https://ece.iisc.ac.in/ parimal/2019/ml.html

3. https://www.springer.com/gp/book/9780387848570

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms .iare.ac.in/ index ?route =course/details & course id=137
CONTENT DELIVERY (THEORY)			
1	Introduction to software engineering.	CO 1	T1:1.1
2	software development process models.	CO 1	T1:1.2
3	agile development	CO 1	T1:1.3-1.4
4	project and process,project management	CO 1	T1:2.3
5	process and project metrics	CO 1	T1:2.4
6	object-oriented concepts, principles and methodologies.	CO 1	T1:2.5
7	Software requirements specification	CO 2	T1:4.1
8	software prototyping	CO 2	T1:5.1
9	software project planning scope, resources.	CO 2	T1:6,1
10	software estimation.	CO 2	T1:7.1
11	empirical estimation models,	CO 2	T1:7.1.1
12	planning.	CO 2	T1:8.1
13	risk management,	CO 2	T1:8.1.1
14	software project scheduling,	CO 2	T1:8.1.2
15	object-oriented estimation and scheduling.	CO 2	T1:11.4
16	Analysis modeling,	CO 3	T1:11.4.1
17	data modeling,	CO 3	T1:11.4,2
18	functional modeling.	CO 3	T1:12.5
19	information flow	CO 3	T1:13.1
20	behavioral modeling.	CO 3	T1:13.1
21	structured analysis, object-oriented analysis, domain analysis.	CO 3	T1:14.1

22	Object-oriented analysis process,	CO 4	T2: 5.1
23	object relationship model, object behaviour mode,	CO 4	T2: 5.2
24	design modeling with UML	CO 4	T1:16.1
25	Design concepts and principles,	CO 4	T2:16.3
26	design process,	CO 5	T1:16.4
27	design concepts,	CO 5	T1:16.5
28	modular design,	CO 5	T1:20.4
29	design effective modularity	CO 5	T1:20.4
30	introduction to software architecture,	CO 5	T1:20.5
31	data design.	CO 5	T1:21.4
32	transform mapping, transaction mapping.	CO 5	T1:22.1
33	object-oriented design, system design process, object design process	CO 6	T1:22.4
34	Top-down, bottom-up, object-oriented product implementation	CO 6	T1:22.7
35	integration..	CO 6	T1:29.1
36	Software testing methods, white box, basis path, control structure, black box.	CO 6	T1:29.3
37	unit testing, integration testing, validation and system testing	CO 6	T1:30.1
38	testing tools, software maintenance and reengineering.	CO 4	T1:30.7
39	Case Study: The Unified Library Application.	CO 4	T1:30.9
40	Case Study: Real-Time applications.	CO 6	T1:30.9
PROBLEM SOLVING/ CASE STUDIES			
1	Build a class hierarchy to organize the following drink classes: Mineral water, alcoholic, nonalcoholic, grape juice and soda.	CO 1	T2:2.1
2	Classify and describe four fundamental process activities which are common to all software processes.	CO 2	T2:2.3
3	List four facts which indicate that the requirement capture and analysis process to be very difficult.	CO 2	T2:2.3.1
4	Construct an object diagram that contains a three-level hierarchy of objects.	CO 6	T2:7.2,7.3
5	Assume that you wise to buy a car. Identify all the attributes and methods of the car object. Write a short description of services that each will provide. Create a class hierarchy of the “car” class.	CO 6	T2:10.3.1

6	Build basic class diagrams (of your choice) to identify and describe key concepts like classes, types in the system and their relationships.	CO 4	T2:13.3
7	Draw and model the activity diagrams to display either business flows or like flow charts. (Example: ATM system)	CO 4	T2:17.1.1, 17.1.3
8	Construct an activity diagram the shows flow of control from activity to another by modeling a credit card validation system with swim lanes.	CO 4	T2:18.1, 18.2.1
9	Develop the activity diagram for the process sale and specify actor, use case and scenario with swim lanes.	CO 4	T2:18.3.4, 18.3.4.1
10	Model a state machine for the controller of a home security system, which is responsible for monitoring various sensors around the perimeter of the house.	CO 6	T2:22.12, 19.1.2
11	Develop a state chart diagram of an ATM system.	CO 4	T2:18.4, 18.4.3
12	Develop a state chart diagram for the case study on the Next Gen POS system with suitable examples.	CO 6	T2:19.2, 18.4.4
13	Construct UML deployment and component diagrams for ATM system.	CO 1	T2:23.1.1, 23.1.3
14	Consider the Hospital Management System application with the following requirements i. System should handle the in- patient, out-patient information through receptionist. ii. Doctors are allowed to view the patient history and give their prescription iii. There should be a information system to provide the required information Construct the component and deployment diagram	CO 5	T2:18.3.4, 18.3, 4.1
15	Explain in detail about the notations of a sequence diagram with neat sketch.	CO 4	T2:24.2,28.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
1	Software engineering models, project and process management	CO 1	T2:18.3.4, 18.3.4.1
2	Software Requirement specification,project planning and scheduling	CO 2	T2:22.12, 19.1.2
3	software modelling, design and analysis	CO3, CO 4	T2:18.4, 18.4.3
4	Design concepts and principles	CO 5	T2:19.2, 18.4.4
5	Software testing and validation	CO 6	T2:23.1.1, 23.1.3
DISCUSSION ON QUESTION BANK			
1	Introduction to software engineering	CO 1	T2:18.3.4, 18.3.4.1
2	Project planning and scheduling	CO 2	T2:22.12, 19.1.2

3	architectural modeling, Advanced Behavioral Modeling	CO3,CO4	T2:18.4, 18.4.3
4	Design concepts and principles	CO 5	T2:19.2, 18.4.4
5	Software testing and validation	CO 6	T2:23.1.1, 23.1.3

Signature of Course Coordinator **HOD,CSE (AI&ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE and ENGINEERING(AI & ML)				
Course Title	PRINCIPLES OF IoT				
Course Code	ACIC10				
Program	B. Tech				
Semester	VI				
Course Type	Professional Elective				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms. D Sreelakshmi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC06	V	Computer Networks

II COURSE OVERVIEW:

The course aims to deliver a sound understanding of the design and analysis of Internet of Things through lectures and practice. The lectures provide the foundational knowledge in sensors and actuators, fusion of data from multiple sensors, sensor data calibration and topics in sensor data analytics: pre-processing and extraction of features in time, series sensor data, and classification methods. The students conduct a major piece of coursework working in pairs to develop an IoT application using the Orient speck platform. Students will experience all the stages in the design and implementation of a complex system, from its specification to the demonstration of a working prototype. They will be exposed to aspects of embedded systems programming, networking algorithms, wireless protocols, user interface design, system integration and testing.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Principles of IoT	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
45 %	Understand
18 %	Apply
27 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

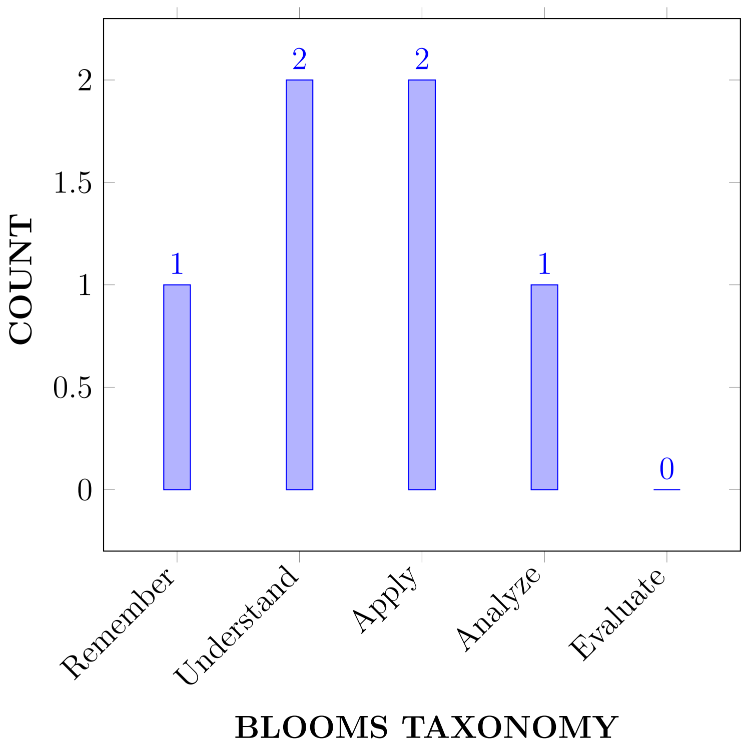
I	The IoT value chain structure (device, data cloud), application areas and technologies involved.
II	The IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules.
III	Market forecast for IoT devices with a focus on sensors.
IV	Explore and learn about Internet of Things with the help of preparing projects designed for Raspberry Pi.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Relate** the characteristics and appropriate levels of IoT for reusing of deployed IoT resources across application domains.	Remember
CO 2	**Identify** the necessity of communication models, protocols and API's for accessing data from sensors and actuators to overcome issues like failure of any connected devices.	Apply
CO 3	**Compare** Machine to Machine with IoT and identifying the role of SDN,NFV, NETCONFG-YANG for data exchange between devices and management on network.	Understand
CO 4	**Select** an appropriate sensor to make sensitive measurements of physical parameters.	understand
CO 5	**Choose** raspberry Pi device and set up the environment for connecting other devices/sensors to communicate with raspberry pi using Python language.	Apply
CO 6	**Analyze** different cloud storage models and protocols that are scalable & available on demand for designing IoT applications.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Seminar/ Conferences/ Workshops
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Seminar/ Conferences/ Workshops
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Assignments/ Discussion
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	Seminars/ Workshops/ Short term courses
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	Seminars/ Workshops/ Short term courses
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	Seminars/ Workshops/ Short term courses

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	2	Research papers/ Group discussion
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1	Seminar/ Assign-ments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	-	✓	✓	-	-	✓	-	-	✓	-	✓	✓	-	✓
CO 2	-	✓	-	✓	-	-	-	-	-	-	-	-	✓	✓	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	-	-		✓	-	-
CO 5	-	-	✓	✓	✓	-	-	-	-	✓	-	✓	✓	-	-
CO 6	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 3	Relate the characteristics and appropriate levels of IoT for **designing solutions** for **complex engineering problems** and reusing of deployed IoT resources **in design system components or processes** that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations across **application domains.**	4

	PO 4	Use **research-based knowledge** and **research methods** including **design of experiments** for reusing of **deployed IoT resources** across **application domains.**	5
	PO 7	Relate the characteristics and appropriate levels of IoT in the impact of the **professional engineering solutions in societal and environmental contexts** and **demonstrate the knowledge** of deployed IoT resources across application domains for sustainable development.	2
	PO 10	The characteristics and appropriate levels of IoT are used in deployed IoT resources across application domains to **Communicate effectively** on **complex engineering activities** with the **engineering community** and **with society at large.**	4
	PO 12	Recognize the need for characteristics and appropriate levels of IoT for reusing of deployed IoT resources across application domains in **life-long learning** in the **broadest context of technological change**.	2
	PSO1	Relate the **characteristics and appropriate levels** of IoT for **designing next-generation computer systems.**	2
	PSO3	Relate the characteristics and appropriate levels of IoT for **practical experience** in **shipping real world software** reusing of deployed IoT resources across application domains.	2
CO 2	PO 2	Identify the necessity of communication models, protocols and API's and **analyze complex engineering problems** reaching **substantiated conclusions** using **engineering sciences**.	3
	PO 4	Identify the **necessity of communication models**, protocols and **API's for accessing data from sensors** and actuators in the **design of experiments**, **analysis** and **interpretation of data.**	5
	PSO 1	Identify the necessity of communication models, protocols and API's for **designing next-generation computer systems.**	2
	PSO 2	Identify the necessity of communication models, protocols and API's for accessing data from sensors and actuators and learn the **emerging technologies and frameworks in demand with employers** and **contemporary challenges.**	2
CO 3	PO 1	**Apply** the **knowledge of engineering fundamentals** for identifying the role of SDN,NFV, NETCONFG-YANG for data exchange between devices and management on network to the **solution of complex engineering problems.**	3

	PO 2	Identifying the role of SDN,NFV, NETCONFG-YANG for data exchange between devices and management on network and **analyze complex engineering problems** reaching **substantiated conclusions** using **engineering sciences.**	3
	PO 3	Use either Machine to Machine or IoT to **design solutions** for **complex engineering problems** that meet the specified needs with **appropriate consideration** for the public health and safety, and the cultural, societal, and **environmental considerations.**	4
	PO 10	**Communicate effectively** on **complex engineering activities** using Machine to Machine with IoT and identifying the role of SDN, NFV, NETCONFG-YANG for data exchange between devices **with the engineering community** and **with society at large**.	4
	PO 12	Recognize the need for Machine to Machine with IoT and identifying the role of SDN,NFV, NETCONFG-YANG for data exchange between devices and management on network for **life-long learning** in the **broadest context of technological change.**	2
	PSO 1	Compare Machine to Machine with IoT and identify the role of SDN,NFV,NETCONFG-YANG for **designing next- generation computer systems.**	2
CO 4	PO 1	**Apply the knowledge** of **engineering fundamentals** to relate the architectural reference model and state of the art methodologies in IoT application domains for the **solution of complex engineering problems.**	3
	PO 2	Identify state of the art methodologies in IoT application domains for managing access control of IoT devices and **analyze complex engineering problems** using **principles of engineering sciences.**	3
	PO 3	**Design solutions** for **complex engineering problems** by relating architectural reference model and state of the art methodologies in **IoT application domains** for managing access control of IoT devices.	3
	PO 4	Use **research methods** including **design of experiments**, and **analyze** state of the art methodologies in **IoT application domains** for managing **access control of IoT devices.**	5
	PSO 1	Relate **architectural reference model** and state of the art methodologies in IoT application domains for **designing next-generation computer systems** and use the data for **knowledge discovery tools.**	3

CO 5	PO 3	**Design solutions** for **complex engineering problems** using raspberry Pi device and set up the environment for connecting other devices/sensors **to communicate specified needs** with **appropriate consideration** for the public health and safety, and the cultural, societal, and environmental considerations.	4
	PO 4	Use **research-based knowledge** and **research methods** including **design of experiments** using raspberry Pi device and **set up the environment** for connecting other devices/sensors **to communicate** with raspberry pi using Python language.	5
	PO 5	Select and apply appropriate techniques to set up the environment for connecting other devices/sensors to communicate with raspberry pi using Python language for **modeling to complex engineering activities.**	1
	PO 12	Recognize the need for raspberry Pi device and the environment for connecting other devices/sensors to communicate with raspberry pi using Python language in **life-long learning** in the broadest context of **technological change**.	2
	PSO 1	Choose raspberry Pi device and **set up the environment** for **designing next-generation computer systems** to connect other devices/sensors to communicate with raspberry pi using Python language.	3
CO 6	PO 1	**Apply the knowledge** of different cloud storage models and protocols that are scalable & available on demand for designing IoT applications and an **engineering specialization** to the **solution of complex engineering problems.**	3
	PO 2	**Identify** different cloud storage models and protocols that are scalable & available for **complex engineering problems** reaching **substantiated conclusions** using **principles of engineering sciences** for **designing IoT applications.**	5
	PO 3	**Design solutions** for **complex engineering problems** using different cloud storage models and protocols that are scalable & available on demand for **designing IoT applications** for the public health and safety, and the cultural, societal, and **environmental considerations.**	4
	PO 4	Use **research-based knowledge** and **research methods** including **design of experiments, analysis** and **interpretation of data** for using different cloud storage models and protocols that are scalable & available on demand for **designing IoT applications.**	6
	PO 5	Select, and apply appropriate cloud storage models and protocols that are scalable & available on demand for **modeling to complex engineering activities.**	1

	PO 10	Analyze different cloud storage models and protocols that are used to **Communicate effectively** on **complex engineering activities** with the **engineering community** and **with society at large** for designing IoT applications.	4
	PO 12	Recognize the need for different cloud storage models and protocols in **life-long learning** in the **broadest context of technological change** for designing IoT applications.	2
	PSO 1	**Analyze** different cloud storage models and protocols that are scalable & available on demand for **designing next-generation IoT applications.**	2
	PSO 3	Analyze different cloud storage models and protocols that are scalable & available on demand for designing IoT applications for **practical experience in shipping real world software using industry standard tools and collaboration techniques.**	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	8	6	2	3
CO 1	0	0	4	5	0	0	1	0	0	4	0	2	2	0	2
CO 2	0	3	0	5	0	0	0	0	0	0	0	0	2	2	0
CO 3	3	3	4	0	0	0	0	0	0	4	0	2	2	0	0
CO 4	3	3	3	5	0	0	0	0	0	0	0	0	3	0	0
CO 5	0	0	4	5	1	0	0	0	0	0	0	2	3	0	0
CO 6	3	5	4	6	1	0	0	0	0	4	0	2	2	0	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	8	6	2	3
CO 1	0	0	40	45.5	0	0	43.3	0	0	80	0	25	34	0	100
CO 2	0	30	0	45.5	0	0	0	0	0	0	0	0	34	100	0
CO 3	100	30	40	0	0	0	0	0	0	80	0	25	34	0	0
CO 4	100	30	30	45.5	0	0	0	0	0	0	0	0	50	0	0
CO 5	0	0	40	45.5	100	0	0	0	0	0	0	25	50	0	0
CO 6	100	50	40	55	100	0	0	0	0	80	0	25	34	0	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 $<C \leq$ 40% – Low/ Slight
2 - 40 % $<C<$ 60% –Moderate
3 - 60% $\leq C<$ 100% – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	8	6	2	3
CO 1	-	-	1	2	-	-	2	-	-	3	-	1	1	-	3
CO 2	-	1	-	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	1	1	-	-	-	-	-	-	3	-	1	1	-	-
CO 4	3	1	1	2	-	-	-	-	-	-	-	-	2	-	-
CO 5	-	-	1	2	3	-	-	-	-	-	-	1	2	-	-
CO 6	3	2	1	2	3	-	-	-	-	3	-	1	1	-	3
TOTAL	9	5	5	10	6		2			9		4	8	3	6
AVERAGE	3.0	1.25	1.0	2.0	3.0		2.0			3.0		1.0	1.33	3.0	3.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO INTERNET OF THINGS (IoT)**
	Introduction to Internet of Things, definition and characteristics of IoT, physical design of IoT, IoT protocols, IoT communication models, IoT communication APIs, IoT enabled ttechnologies, wireless sensor networks, cloud computing, big data analytics, communication protocols, embedded systems, iot levels and templates; Domain Specific IoTs: Home, city, environment, energy, retail, logistics, agriculture, industry, health and lifestyle.
MODULE II	**IoT NETWORKS AND MANAGEMENT**
	IoT and M2M – Software defined networks, network function virtualization, difference between SDN and NFV for IoT. Basics of IoT System Management with NETCOZF, YANG, NETCONF, YANG, SNMP NETOPEER.

MODULE III	**CONTROLLING HARDWARE AND SENSORS**
	Controlling Hardware, Connecting LED, buzzer, switching high power devices with transistors, controlling AC power devices with relays, controlling servo motor, speed control of DC motor, unipolar and bipolar stepper motors Sensors, Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, temperature and humidity sensor DHT11, motion detection sensors, wireless bluetooth sensors, level sensors, USB Sensors, embedded sensors, distance measurement with ultrasound sensor.
MODULE IV	**IOT PHYSICAL DEVICES AND ENDPOINTS**
	Introduction to Arduino and Raspberry Pi, Installation, Interfaces (serial, SPI, I2C), Programming – Python program with RaspberryPI with focus on interfacing external gadgets, controlling output, reading input from pins.
MODULE V	**IOT PHYSICAL SERVERS AND CLOUD OFFERINGS**
	Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API.

TEXTBOOKS

1. Arshdeep Bahga, Vijay Madisetti, —Internet of Things: A Hands-on-Approach, VPT, 1st Edition, 2014.
2. Matt Richardson, Shawn Wallac, –Getting Started with Raspberry Pi, O'Reilly (SPD), 3rd Edition, 2014.
3. Simon Monk, "Raspberry Pi Cookbook-Software and Hardware Problems and Solutions", O'Reilly (SPD), 2016

REFERENCE BOOKS:

1. Peter Waher, "Learning Internet of Things", Packt Publishing, 1st Edition, 2015
2. Peter Friess, "Internet of Things – From Research and Innovation to Market Deployment", River Publishers, 2014.
3. N. Ida, "Sensors, Actuators and Their Interfaces", SciTech Publishers, 2014.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Institutions adopting OBE try to bring changes to the curriculum by dynamically adapting to the requirements of the different stakeholders like Students,Parents, Industry Personnel and Recruiters. OBE is all about feedback and outcomes.In this we will discuss about the course outcomes and program outcomes and their attainment		

CONTENT DELIVERY (THEORY)			
1	Understanding the basics concepts of IoT	CO1	T1:19-22
2	Motivations of IoT and various Applications of IoT	CO1	T1:22-24
3	Describe the Things of IoT and characteristics of IoT	CO1	T1:24-26
4	Analysis and Design of IoT in physical view	CO2	T1:26-30
5	Analysis and Design of IoT in physical view	CO2	T1:26-30
6	Analysis and Design of IoT in physical view	CO2	T1:26-30
7	Understanding the working of IoT protocols	CO2	T1:31-34
8	Understanding the working of IoT protocols	CO2	T1:31-34
9	Describing various communication models and IoT enabling technologies	CO2	T1:34-49
10	Analysing the IoT levels and templats	CO2	T1:34-49
11	Identifying specific Domains IoTs and its applications	CO1	T1:53-72
12	Identifying specific Domains IoTs and its applications	CO1	T1:53-72
13	Understanding the basic differences between IoT and M2M	CO3	T1: 72-80
14	Implementation of SDN and NFV architecture in IoT	CO3	T1:80-85
15	Identifying IoT system management with NETCONF-YANG	CO3	T1:91-92
16	Uses of SNMP in IoT protocols	CO3	T1:93-94
17	Implementation of NETCONF-YANG by using Python	CO3	T1:96-97
18	Implementation of NETCONF-YANG by using Python	CO3	T1:96-97
19	Understanding the functions of components used in IoT	CO4	T3:170-186
20	Understanding the connections of LED	CO4	T3:170-186
21	Understanding the connections of Buzzer	CO4	T3:170-186
22	Analyzing to control high power devices through transistors	CO4	T1:141-150
23	Analyzing to control high power devices through relays	CO4	T1:141-150
24	Analyzing to control servo motors	CO4	T1:141-150
25	Analyzing to speed control of DC motor	CO4	T1:141-150
26	Analyzing working of unipolar and bipolar stepper mortors	CO4	T1:141-150
27	Identifying various sensors working and its application	CO4	T1:141-150
28	Describe the physical endpoints used in IoT	CO5	T1:186-196
29	Understanding the working of Arduino,installation	CO5	T1:186-196
30	Understanding the working of Raspberry Pi, installation	CO5	T1:186-196
31	Analyse the concept of interfacing	CO5	T1:186-196
32	understand the python programming with raspberry Pi	CO5	T1:186-196
33	Study the interfacing of external gadgets	CO5	T1:186-196
34	Analyze to control output of an applilcation	CO5	T1:186-196
35	Understand the concept of reading input from pins	CO5	T1:186-196
36	Iot application with Raspberry Pi	CO6	T1:197-198
37	introduction to cloud storage modles	CO6	T1:197-198
38	Introduction to cloud storage models	CO6	T1:197-198

39	Introduction to communication APIs webserver	CO1& 6	T1:254-264
40	Webserver for IoT	CO1& 6	T1:254-264
41	Webserver for IoT	CO1& 6	T1:254-264
42	Real time applications of IoT with clout for IoT	CO1& 6	T1:254-264
43	Python web application framework	CO1&6	T1:254-264
44	Python web application framework	CO1& 6	T1:254-264
45	Designing a RESTful web API	CO1&6	T1:254-264
PROBLEM SOLVING/ CASE STUDIES			
1	Write the following details regarding Raspberry Pi 3(a) Technical Specifications SoC, RAM, I/O, No of I/O,I2C, SPI etc.(b) GPIO pins and pin modes(c) Network Connectivity Options available in RPi3(d) Design a simple loT application using Digital I/0 to blink a LED in RPi3with suitable connection diagram. Write a sample python script for the same.	CO2	T1:19-72
2	Design a simple application of an breathing LED using PWM in Raspberry piwith suitable connection diagram. Write the python script for the same	CO2	T1:19-72
3	Explain domain specific home automation of IoT	CO1,CO6	T1:19-72
4	Write a Python program for controlling an LED with a switch.	CO5	T1:141-150
5	Write a Python program for switching LED/Light based on reading LDR reading.	CO5	T1:141-150
6	Implement the air pollution monitoring system using the webSocket approach.	CO1,CO2	T1:24
7	Design and discuss the levels of IoT in smart Irrigation.	CO2	T1:24
8	Draw a neat diagram and explain the design of an IoT working prototype forinterfacing Arduino UNO with DHT11 sensor to send the temperature andhumidity data to ThingSpeak cloud server using ESP8266.	CO5	T1:141-150
9	Explain about IoT cloud with home automation.	CO6	T1:197-198
10	What are the impacts that can be observed in implementing internet of Things on Agriculture sector?	CO1	T1:254-264
11	Write a Python program for blinking LED with Raspberry Pi?	CO5	T1:141-150
12	Discuss about the analysis of IoT with smart environment.	CO1,CO6	T1:254-264
13	What Impacts will the Internet Of Things have on infrastructure and smart cities sector?	CO6	T1:254-264
14	Write a Python program for sending an email on a switch press.	CO5	T1:141-150
15	Extend the functionality of the home intrusion detection IoT system by interfacing a webcam. Implement a function in the controller to capture an image from the webcam and send it as an attachment in the email alert when an intrusion is detected.	CO1,CO6	T1:254-264
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	List out the four V's in Big Data?	CO1	T1:19

2	Summarize the benefits of SoC	CO5	T1:19
3	Differentiate Raspberry with Arduino.	CO2	T1:19
4	Which protocols provide connectivity between M2M nodes within an M2M area network?	CO3	T1: 72-80
5	List out the steps used in internet gateway device.	CO3	T1:91-92
DISCUSSION OF QUESTION BANK			
1	Explain various protocols used in each layer.	CO 1,CO 2	T1:19-72
2	Describe devices data and steps in acquiring and storing data for an application service or business process.	CO 3	T1:74-97
3	Explain 5 different sensors with examples?	CO 4	T1:70-140
4	Describe the basic structure of Arduino programming with an eaxmple?	CO 5	T1:186-198
5	How Rasberry Pi different from a desktop computer? Justify your answer with an illustration.	CO 6	T1:254-264

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Ms. D Sreelakshmi, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

COURSE DESCRIPTION

Course Title	DISASTER MANAGEMENT				
Course Code	ACEC31				
Program	B.Tech				
Semester	VI				
Course Type	Open Elective				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms. Patnala V S Neelima, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	-	-	-

II COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Disaster Management	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
17%	Remember
83 %	Understand
0%	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. **Alternative Assessment Tool (AAT)**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	**Tech-talk**	**Complex Problem Solving**
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

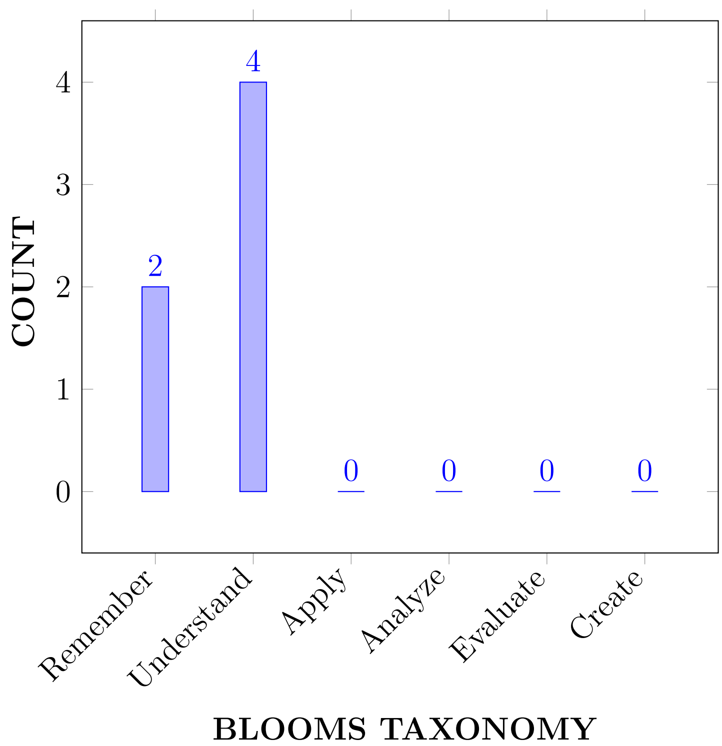
I	The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II	The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III	The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV	The immediate response and damage assessment with information reporting and monitoring tools.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** Environmental hazards for developing modern disaster management system.	Remember
CO 2	**Illustrate** various approches for reducing the level of risk associated with Disasters.	Understand
CO 3	**Compare** natural and manmade disasters for finding out intensity of damage loss occurred by them.	Understand
CO 4	**List** various hazards and their effects for evaluating their impact on society and Environment.	Remember
CO 5	**Outline** human adjustments and perception towards hazards for mitigation of disasters.	Understand
CO 6	**Summarize** disaster phenomenon and its different contextual aspects for implementing the Disaster Risk Reduction Strategy.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/SEE/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/SEE/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 2	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge and principals of mathematics to engineering problems in determining an area enclosed by irregular boundary line using the knowledge of **mathematics and science fundamentals**	2
	PO 7	Understand the disaster management by considering Environmental impacts on the livelihood and their effect on Socio economic issues for sustainable development.	2
CO 2	PO 1	Apply the knowledge on various disaster mitigation approaches in **engineering disciplines** and and use their application in geographical researches.	1
	PO 6	Apply the engineering knowledge in disaster management to **promote sustainable development** and build **Awareness on health, safety,** and **risk issues** associated with Disasters.	4
CO 3	PO 6	Identify **engineering activities including personnel, health, safety, and risk and effective disaster management strategies** for implementing, analyzing disaster impacts on human life and environment.	4
	PO 7	Understand intensity of disasters and their impact on **environment** and influence on **socio economic** parameter for assessment of intensity of risk.	2
CO 4	PO 6	Identify **engineering activities including personnel, health, safety, and risk** for analyzing hazard impacts on environment.	4
	PO 7	Identify the impact of various hazards in **socio economic and environmental** aspects for developing modern disaster management system.	2

CO 5	PO 1	Understand the **methodology and scientific principal towards** hazards for human adjustments and perception by sharing technological knowledge from **other engineering branches.**	2
	PO 6	Understanding of the need for a **high level of professional and ethical conduct in engineering** for human adjustments, perception with effective **management strategies**for disaster mitigation.	4
CO 6	PO 1	Understand the **knowledge of scientific principal and methodology** in disaster phenomenon for minimizing impact by implementing the Disaster Risk Reduction Strategy.	2
	PO 6	**Appropriate management strategies** are to be applied to reduce the level of risk in disaster mitigation.	1
	PO 9	Apply disaster risk reduction strategy using vrious organizations and **work effetively as an individual** and **as a member** or **a leader** are to be applied to reduce the level of risk in disaster mitigation.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	2	-	-	-	-	-	2	-	-	-	-		-	-	-
CO 2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	4	2	-	-	-	-		-	-	-
CO 4	-	-	-	-	-	4	2	-	-	-	-	-	-		-
CO 5	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	1	-	-	3	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	33.3	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	80	66.6	-	-	-	-	-	-		-
CO 4	-	-	-	-	-	80	66.6	-	-	-	-	-	-	-	-
CO 5	66.6	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	20	-	-	25	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - 0≤ C≤ 5% – No correlation
1 - 5≤ C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	3	3	-	-	-	-	-	-		-
CO 5	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	1	-	-	1	-	-	-	-	-	-
TOTAL	10	-	-	-	-	13	9	-	1	-	-	-	-	-	-
AVERAGE	3	-	-	-	-	3	3	-	1	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	-
Assignments	-	Mini project	-	Tech Talk	✓

XVII ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of mini projects by Experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ENVIRONMENTAL HAZARDS AND DISASTERS**
	Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.
MODULE II	**TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS**
	Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE III	**ENDOGENOUS HAZARDS**
	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India,human adjustment, perception and mitigation of earthquake.
MODULE IV	**EXOGENOUS HAZARDS**
	Exogenous hazards/disasters, infrequent events, cumulative atmospheric hazards/disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation); Droughts:Impacts of droughts, drought hazards in India, drought control measures,extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.
MODULE V	**EMERGING APPROACHES IN DISASTER MANAGEMENT**
	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness) 2. Emergency Stage 3. Post Disaster stage, Rehabilitation.

TEXTBOOKS

1. PardeepSahni, "Disaster Mitigation: Experiences and Reflections", PHI Learning Pvt. Ltd., 1 st Edition, 2001.
2. J.Glynn, GaryW.HeinKe, "Environmental Science and Engineering",Prentice Hall Publishers, 2 nd Edition, 1996.

REFERENCE BOOKS:

1. R.B.Singh (Ed), "Environmental Geography", 2nd Edition, 1990.
2. R.B. Singh (Ed), "Disaster Management", 2nd Edition, 2006.
3. Donald Hyndman "Natural Hazards and Disasters" - 5th edition, 2017.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be a changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Objectives, Course Outcomes, Program Outcomes, CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Classify Environmental Hazards & Disasters	CO 1	T2:26.3, R2: 3.1
3	Understand the Meaning of Environmental Hazards	CO 1	T2:2.2.2
4	Understand Environmental Stress	CO 1	T2:2.2.2, R3:3.7
5	Understand Environmental stress.	CO 2	T2:2.2.2
6	Obtain knowledge on Concept of Environmental Hazards	CO 2	T1:8.1
7	Capacity to analyze Environmental stress & Environmental Disasters	CO 2	T1:7.1, R2: 1.2
8	Capacity to analyze Ecology concept	CO 2	T2:3.2.3, R2: 1.3
9	Understand Different Approaches	CO 3	T2:4.2.3
10	Understand Landscape Approach -.	CO 3	T2:4.5.2
11	Explain Ecosystem approach -Perception approach.	CO 3	T2:4.7.9
12	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
13	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
14	Understand Types of Environmental hazards & Disasters	CO 4	T2:5.4
15	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
16	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
17	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
18	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
19	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
20	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
21	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
22	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2

23	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
24	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
25	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
26	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
27	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
28	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
29	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
30	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
31	Distribution of earthquakes - Hazardous effects of - earthquakes - Earthquake Hazards in India	CO 4	T2:8.9.2
32	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
33	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
34	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
35	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
36	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
37	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
38	Analyze the Tropical cyclones and Local storms	CO 5	T2:9.6.2, R3: 8.5
39	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
40	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
41	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
42	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
43	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4

44	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
45	Analyze the Exogenous hazards/ disasters - Infrequent events- Cumulative atmospheric hazards/ disasters	CO 6	T2:9.5.6
PROBLEM SOLVING/ CASE STUDIES			
1	Case study on modern disaster management system	CO 1	T2:2.2.2
2	Case study on natural disaster	CO 2	T2:2.2.2
3	Case study on manmade disaster	CO 3	T2:2.2.2
2	Case study on Latur earthquake	CO 4	T2:2.2.2
4	Case study on Fukushima Nuclear disaster	CO 4	T2:2.2.2, R3:3.7
5	Case study on tsunami occurred in Japan	CO 5	T2:2.2.2
6	Case study on Hiroshima and Nagasaki	CO 4	T1:8.1
7	Case study on Russian Siberia oil spill	CO 4	T1:7.1, R2: 1.2
8	Case study on Hudhud Cyclone 2014	CO 5	T2:3.2.3, R2: 1.3
9	Case study on South India Floods 2015	CO 5	T2:4.2.3
10	Case study on Bihar Heat Wave 2019	CO 5	T2:4.5.2
11	Case study on Bihar Floods 2019	CO 5	T2:4.7.9
12	Case study on Oil Spillage in Russia 2020	CO 4	T2:5.4
13	Case study on Yellow River Flood in china	CO 4	T2:5.5.3
14	Case study on Bhola Cyclone Bangladesh	CO 5	T2:6.2.2
15	Causes of wildfires and effects	CO 4	T2:9.5.4
16	pre-disaster activities to reduce the impact of cyclones	CO 5	T2:9.5.4
17	Tectonic plate theory	CO 4	T2:9.5.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach	CO 1	T2:2.2.2
2	Natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards	CO 2	T2:2.2.2, R3:3.7
3	Effects of volcanic eruptions, environmental impacts of volcanic eruptions	CO 3, CO 4	T2:2.2.2
4	Lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters:	CO 5	T1:8.1
5	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness), 2. Emergency Stage ,3. Post Disaster stage, Rehabilitation.	CO 6	T1:7.1, R2: 1.2

DISCUSSION OF QUESTION BANK			
1	Environmental hazards and disasters	CO 1	R1:2.1
2	Types of environmental hazards and disasters	CO 2	T4:7.3
3	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, and their environmental impacts.	CO 3, CO 4	R2:5.1
4	Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.	CO 5	T1:7.5
5	Emerging approaches in disaster management	CO 6	T1: 4.1

Signature of Course Coordinator **HOD,CE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI &ML)**				
Course Title	**SOFT SKILLS AND INTERPERSONAL COMMUNICATION**				
Course Code	AHSC15				
Program	B.TECH				
Semester	VI				
Course Type	OPEN ELECTIVE				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3		3	-	-
Course Coordinator	Mr. P. Sunil Solomon, Assistant Professor				

I COURSE PREREQUISITES

Level	Course Code	Semester	Prerequisites
IB.Tech	AHSC01	I,II	Basic principles of soft skills and concepts of functional syntacticalities.

II COURSE OVERVIEW

The objectives of Soft Skills and Interpersonal Communication Skills are to give each student a realistic perspective of work and work expectations. It helps formulate problem solving skills and also it guides students in making appropriate responsible decisions. Besides, it creates a desire to fulfill individual goals, and to educate students about productive thinking, self-defeating emotional impulses, and self- defeating behaviors.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Soft Skills and Interpersonal Communication	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with" either" or" choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question. The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
80%	Understand
20%	Apply
0 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 50 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

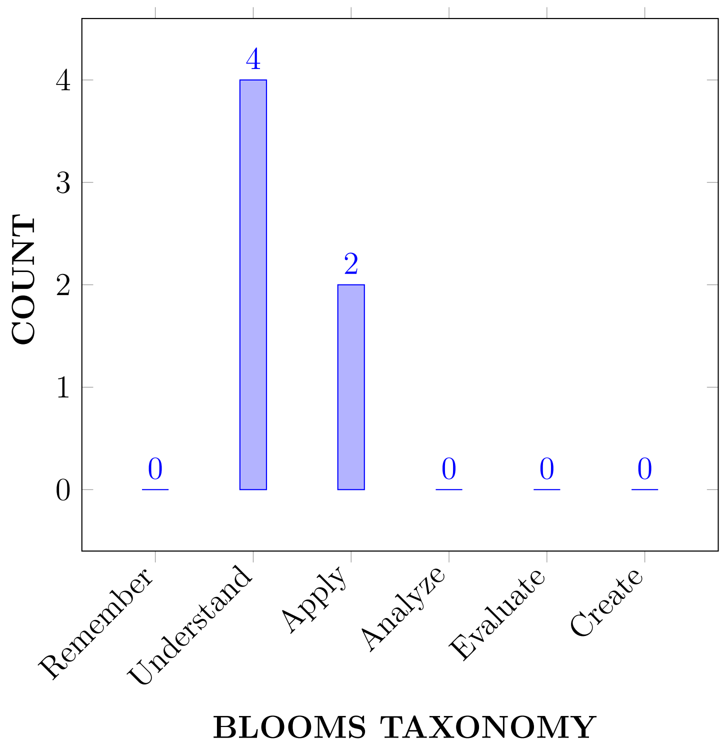
I	Communication skills effectively in both spoken and written languages.
II	All-round personalities with a matured outlook to function effectively in different formal and informal situations. .
III	Self-confidence by mastering inter-personal skills, team management skills, and leadership skills. .
IV	Effective presentation skills which give an edge while interacting with people at all levels.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** soft skills in the development of personality and use them in their daily life.	Apply
CO 2	**Relate** how to listen actively and respond productively to others.	Understand
CO 3	**Classify** the correct usage of English grammar in writing and speaking.	Understand
CO 4	**Demonstrate** the significance of verbal and non-verbal communication in academic and non-academic platforms.	Understand
CO 5	**Explain** some of the strategies and challenges for effective speaking skills and make use of prereading skills to understand the content of advanced level text books.	Understand
CO 6	**Develop** various written communication strategies of cover letter writing, resume writing, E-mail writing and report writing.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

<table>
<tr><th colspan="2">PROGRAM OUTCOMES</th><th>Strength</th><th>Proficiency Assessed by</th></tr>
<tr><td>PO8</td><td>Communication:Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (Ethics).
1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior.
2. Stood up for what they believed in
3. High degree of trust and integrity</td><td>3</td><td>Seminar/ Conferences/ Quiz/ AAT Assignments/ Discussion</td></tr>
</table>

<table>
<tr><th colspan="2">PROGRAM OUTCOMES</th><th>Strength</th><th>Proficiency Assessed by</th></tr>
<tr><td>PO9</td><td>Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and Teamwork).

1. Independence
2. Maturity – requiring only the achievement of goals to drive their performance
3. Self-direction (take a vaguely defined problem and systematically work to resolution)
4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects.
5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen - week design project.
6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference.
7. Teamwork is important not only for helping the students know their classmates but also in completing assignments.
8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade.
9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation.
10. Ability to work with all levels of people in an organization
11. Ability to get along with others
12. Demonstrated ability to work well with a team</td><td>12</td><td>Seminar / Conferences /Quiz / AAT / Assignments / Discussion</td></tr>
</table>

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. 1. **Clarity (Writing) Style (Oral)** 2. **Grammar/Punctuation (Writing)** 3. **References (Writing)** 4. **Speaking** 5. **Subject Matter (Oral)**	5	Seminar/ Conferences/ Quiz/ AAT Assignments/ Discussion

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	✓	✓	✓	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 8	Demonstrate the basic **professional ethics** of ethical choices, codes of ethics, professional practice, and ethical behaviour with special respect to the usage of soft skills and personality development. Besides, students are designed to **stand up for what they believed in** and they are encouraged to maintain a **high degree of trust and integrity.**	3
CO 2	PO 10	Explain with **clarity** on listening an audio clip and also maintain appropriate oral presentation skills with proper **grammatical** skills in both writing and **speaking** situations.	5
CO 3	PO 10	Describe the usage of **grammatical** knowledge in **writing** and **speaking** areas and also discuss the apt applicability of different grammar rules in **oral** presentations with **clarity.**	5
CO 4	PO8, PO 9, PO10	Illustrate **ethical choices knowledge of professional codes of ethics** and also **evaluates the ethical dimensions of professional practice** and demonstrates **ethical behaviour**. Besides, **stood up for what they believe in** and moreover **discover high degree of trust and integrity. Apply the knowledge with independence and maturity to achieve desired goals and also maintain self-direction method to lead the team members while designing the projects. Moreover, it is observed to build an effective teamwork with an appropriate textbook for reference. Besides, explain the significance of teamwork to complete assignments. And also, interpret the complex concepts with subjective evidence to develop ability to work with all levels of people. Therefore, summarize demonstrated ability to work well with a team.** At the same time, extend the knowledge on **subject matter** with appropriate **clarity** using with proper **grammatical** structures in both areas of **speaking** and **written** communication practices.	20

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO8 PO 10	Interpret **ethical choices and knowledge of professional codes of ethics and also evaluates ethical dimensions of professional practice and demonstrates ethical behaviour** at workplace. Besides, illustrates how to **stand up for what they believed in.** Furthermore, **practice high degree of trust and integrity.** Choose appropriate **reading** strategies in order to understand with proper **clarity.** Moreover, predict **syntactical** structures used in **spoken** communication and **written communication.**	8
CO 6	PO 10	Classify different **oral** and **written** communication strategies through systematic order and also recognize appropriate method in order to understand the writer's point of view with **clarity** while **reading** and practices proper **grammatical** functionalities to understand different **subject matters.**	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	3	12	5	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	3	-	5	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	100	0.0
CO 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0
CO 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0
CO 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	100	100	0.0	0.0	00	100	0.0
CO 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100	0.0	0.0	0.0	0.0	0.0
CO 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
CO 3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0
CO 5	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0
CO 6	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
TOTAL								9		15			0	0	0
AVERAGE								3		3				0	0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	✓	10 Minutes Video	✓	Open Ended Experiments	✓
Assignments	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback
✓	Early Semester Feedback		

XVIII SYLLABUS:

MODULE I	**SOFT SKILLS**
	Soft Skills: An Introduction – Definition and significance of soft skills; Process, Importance and application of soft skills, discovering the self; setting goals; positivity and motivation: developing positive thinking and attitude
MODULE II	**EFFECTIVENESS OF SOFT SKILLS**
	Developing interpersonal relationships through effective soft skills; Define Listening, Speaking, Reading and Writng skills; Barriers to Listening, Speaking, Reading and Writing; Essential formal writing skills; Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.

MODULE III	**ORAL AND AURAL SKILLS**
	Sounds of English vowels sounds and consonant sounds, Word Accent and connected speech- contractions, questions tags, Listening for information, Taking notes while listening to lectures (use of Dictionary). Group Discussion: Importance, Planning, Elements, Skills, Effectively disagreeing, Initiating
MODULE IV	**VERBAL AND NON-VERBAL COMMUNICATION**
	Interpersonal communication-verbal and nonverbal etiquette; Body language, grapevine, Postures, Gestures, Facial expressions, Proximity; Conversation skills, Critical thinking, Teamwork, Group Discussion, Impact of Stress; Measurement and Management of Stress
MODULE V	**WRITTEN COMMUNICATION**
	Significance; Effectiveness of writing; Organizing principles of Paragraphs in documents; Writing introduction and conclusion; Techniques for writing precisely; Letter writing; Formal and Informal letter writing; E-mail writing, Report Writing.

TEXTBOOKS

1. Raman Meenakshi, Upadhyay Shalini (2017). Soft Skills: Key to Success in Workplace and Life. Cengage India Private Limited, Noida.
2. Handbook of English for Communication (Prepared by Faculty of English, IARE)

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1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Klaus, Peggy, Jane Rohman & Molly Hamaker. —The Hard Truth about Soft Skill, London: HarperCollins E-books, 2007.
3. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
4. Stein, Steven J. & Howard E. Book. —The EQ Edge: Emotional Intelligence and Your Success Canada: Wiley & Sons, 2006
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1. http://bookboon.com/en/communication-ebooks-zip
2. http://www.bloomsbury-international.com/images/ezone/ebook/writing-skills-pdf.pdf

3. http://learningenglishvocabularygrammar.com/files/idiomsandphraseswith meaningsandexamplespdf.pdf

4. http://www.robinwood.com/Democracy/General Essays/CriticalThinking.pdf

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Discussion on mapping COs with POs (OBE)		T1:06.06
CONTENT DELIVERY (THEORY)			
2	Introduction of soft skills	CO1	T1:06.09
3	Significance of soft skills..	CO1	T1:09.10
4	Process, importance and application of soft skills..	CO1	T1:08:05
5	Discovering one's self-qualities.	CO1	T1:06:02
6	Setting up goals	CO1	T1:04:74
7	Positivity and motivation.	CO1	T1:01:08
8	Developing one's positive thinking and attitude	CO 1	T1:03:01
9	Developing interpersonal relationships through soft skills..	CO2	T1:06:05
10	Significance of listening skills.	CO 2	T1:02:09
11	Significance of speaking skills.	CO 4	T1:26:11
12	Significance of reading skills..	CO 5	T1:46:08
13	Significance of writing skills.	CO 6	T1:16:20
14	Barriers to listening and speaking.	CO 2	T1:13:43
15	Barriers to reading and writing.	CO 5	T1:40:51
16	Essentials of formal writing skills.	CO 6	T1:19:07
17	Developing public speaking skills.	CO4	T1:69:62
18	Methods, strategies of public speaking..	CO 4	T1:5:05
19	Essential tips for effective public speaking.	CO4	T1:46:05
20	Introduction to sounds of vowels and consonants.	CO 4	T1:09:18
21	Contractions and questions tags.	CO 3	T1:07:14
22	Listening for information.	CO 1	T1:32:96
23	Taking notes while listening to lectures.	CO 3	T1:55:21
24	Group discussion and its importance.	CO 2	T1:14:25
25	Planning, elements, skills, effectively, disagreeing, initiating.	CO 2	T1:08:08
26	Developing interpersonal communication skills.	CO4	T1:22:74
27	The role of verbal and nonverbal etiquettes in one's career.	CO1	T1:32:36
28	Significance of body language,	CO 1	T1:78:12
29	Grapevine communication.	CO4	T1:01:08
30	Developing critical thinking.	CO4	T1:04:18
31	Conversation skills at formal and informal situations. .	CO4	T1:06:08
32	The power of group discussion and the role of a team work.	CO4	T1:03:22

33	Impact of stress; measurement and management of stress.	CO4	T1:89:01
34	Significance and effectiveness of writing.	CO 6	T1:01:04
35	Organizing principles of paragraphs in documents;	CO 4	T1:74:32
36	Writing introduction and conclusion	CO 1	T1:25:10
37	Techniques for writing precisely;	CO 6	T1:09:07
38	Letter writing; Formal and Informal letter writing;	CO 6	T1:60:31
39	Rules of E-mail writing.	CO 6	T1:22:12
40	Strategies of report writing.	CO 6	T1:01:01
PROBLEM SOLVING/ CASE STUDIES			
1	Soft skills can help someone come out of difficult situations and ensure reassurance along with reliability. think critically and answer	CO 1	R2:7.5
2	Will not hard skills suffice the requirement needed in a corporate setup without soft skills?	CO 1	R2:7.5
3	Do you think soft skills are communication skills? If so, give your reasons	CO 1	R2:7.5
4	Describe the way interpersonal communication can influence the psychological health of individuals with examples.	CO 1	R2:7.5
5	What do you mean by ‘assumption’ in the communication process and explain with a real -life example?	CO 1	R2:7.5
6	Explain with examples the self-fulfillment and happiness of productive interpersonal communication skills.	CO 1	R2:7.5
7	Explain the importance of learning the sounds of English language for fluent and confident communication.	CO 3	R2:7.5
8	Mispronunciation of English words may lead to miscommunication and misconception. Elaborate with the help of an example.	CO 3	R2:7.5
9	Throw light on word stress which is pivotal for proper differentiation of sounds.	CO 3	R2:7.5
10	Differentiate between verbal and non-verbal communication	CO 4	R2:7.5
11	Classify non-verbal skills and explain the various skills that are important	CO 4	R2:7.5
12	Write down advantages of non-verbal skills	CO 4	R2:7.5
13	What is the meaning of thesis focus? Explain in detail.	CO 6	R2:7.5
14	What do you understand by organization?	CO 6	R2:7.5
15	Support and Elaboration is an extension and development of the topic/subject/ thesis. Comment.	CO 6	R2:7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
41	Definition and terminology of soft skills	CO 1	T1:69:08
42	Definition and terminology of contractions	CO 3	T1:65:66
43	Definition and terminology of question tags	CO 3	T1:42:03
44	Definition and terminology of verbal and nonverbal communication	CO 4	T1:78:78
45	Definition and terminology of self discovery	CO 1	T1:09:01
DISCUSSION OF QUESTION BANK			
1	Module I - Soft skills and interpersonal communication	CO 1, 2	R4:2.1

2	Module II - Effectiveness of soft skills	CO 2, 3	T4:7.3
3	Module III - Oral and aural skills	CO 4	R4:5.1
4	Module IV - Verbal and nonverbal communication	CO 5	T1:7.5
5	Module V - Interpersonal communication	CO 6	T1: 4.1

Signature of Course Coordinator **HOD**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**COMPUTER SCIENCE AND ENGINEERING (DS)**				
Course Title	**Natural Language Processing Laboratory**				
Course Code	ACAC15				
Program	B.Tech				
Semester	VI	CSE(AI&ML)			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	0	0	0	3	1.5
Course Coordinator	Dr. M.Nagaraju, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming

II COURSE OVERVIEW:

This course is study of computing systems that can process, understand, or communicate in human language. The primary focus of the course will be on understanding various NLP tasks and algorithms for effectively solving these problems, and methods for evaluating their performance. This course is intended as a theoretical and methodological introduction to a the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Natural Language Processing Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIE Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

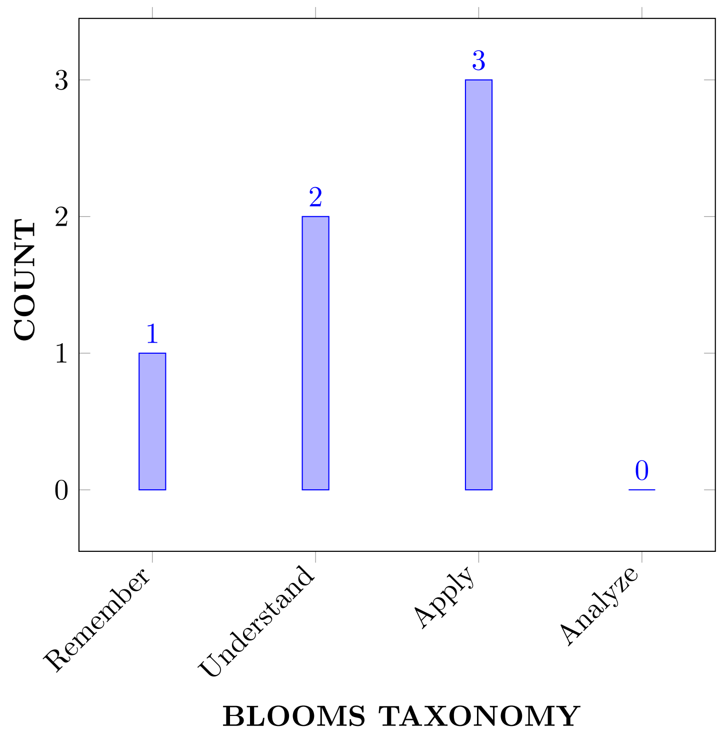
I	The concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
II	The mathematical foundations, probability theory with linguistic essentials such as syntactic and semantic analysis of text.
III	The Statistical learning methods and cutting-edge research models from deep learning.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Remember** the knowledge of complex language behaviour in terms of phonetics, morphology etc	Remember
CO 2	**Understand** the semantics and pragmatics for text processing	Understand
CO 3	**Apply** the CORPUS linguistics to compile and analyze the texts based on digestive approach (Text Corpus Method)	Apply
CO 4	**Understand** various statistical approaches to machine translation for a given natural language	Understand
CO 5	**Apply** Part-of-speech (POS) tagging for a given natural language and suitable modelling technique based on the structure	Apply
CO 6	**Apply** the state of the art algorithms and techniques for text-based processing of natural language with respect to morphology	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises

PO 5	**Modern tool usage:** UCreate, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build suitable statistical models, tools and techniques to analyse large data sets for visualization and interpretation.	3	Lab Exercises
PSO 2	Focus on improving software reliability, network security or information retrieval systems.	3	Lab Exercises
PSO 3	Make use of computing theory, mathematics, statistical methods and the principles of optimization techniques in data analytics for providing solutions.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO's
	PO 1	PO 3	PO 5	PSO 3
CO 1	✓	-	-	✓
CO 2	-	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	-	-	✓
CO 5	✓	✓	✓	✓
CO 6	✓	-	-	✓

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**TEXT PREPROCESSING IN PYTHON**
	Problem Statement: Prepare the text data for the NLP model building and perform the text pre-processing. Use the required pre-processing steps based on the dataset prepared and understand the steps involved in Text Pre-processing. **Solutions Expected:** Implement the following text pre-processing operations. a) Lowercase the text to reduce the size of the vocabulary of our text data b) Remove numbers or convert the numbers into their textual representations c) Remove punctuations so that we don't have different forms of the same word. If we don't remove the punctuation, then been. been, been! will be treated separately. d) Use the join and split function to remove all the white spaces in a string.
WEEK II	**TEXT PREPROCESSING IN PYTHON**
	Problem Statement: Explore the basics of NLP and present how they can be useful for text processing tasks using NLTK libraries. Implement the essential methods of NLP with their respective coding in python. **Solutions Expected:** a) Open the text file for processing and perform the file read operation. b) Import the required libraries and get the text as sentences and words using tokenizing. c) Find the frequency distribution of words in a particular text and plot the frequency graph. d) Remove the punctuation marks from the actual text, make a new list and plot the graphs with and without punctuation marks. e) Import the list of stopwords, code to remove the stopwords, display the final frequency distribution of the most common words found.
WEEK III	**LEMMATIZATION**
	Problem Statement: Remove Numbers with INFLECT Library and develop the code to implement LEMMATIZATION. **Solutions Expected:** a) Convert the numbers into words. This can be done by using the inflect library. b) Use the WordNet Lemmatizer to get the lemmas of words and also need to provide a context for the lemmatization. So, that add part-of-speech as a parameter.
WEEK IV	**TEXT-TO-SPEECH CONVERSION**
	Problem Statement: Using categorized CORPUS implement the code to perform the conversion of text to speech using gTTS library. **Solutions Expected:** a) Develop the code that converts text to speech. b) A large number of text data, then one can categorize it to separate sections Using these two files(movie_pos.txt and movie_neg.txt), and have two categories – pos and neg.

WEEK V	**N-GRAM LANGUAGE MODELS**
	Problem Statement: Suppose we didn't use the end-symbol. Train an unsmoothed bigram grammar on the following training corpus without using the end-symbol: <s> a b <s> b b <s> b a <s> a a **Solutions Expected:** a) Demonstrate that your bigram model does not assign a single probability distribution across all sentence lengths by showing that the sum of the probability of the four possible 2 word sentences over the alphabet a,b is 1.0, and the sum of the probability of all possible 3 word sentences over the alphabet { a,b} is also 1.0.
WEEK VI	**N-GRAM LANGUAGE MODELS**
	Problem Statement: Analyze different types of n-grams on the given text data and decide which n-gram works better for your data. **Solutions Expected:** a) Implement the code by combining ngram taggers collectively using Unigram, Bigram and, Trigram tagger. b) Implement the code using backoff_tagger function for Unigram, Bigram and, Trigram tagger and print proof as TRUE.
WEEK VII	**PEARSON'S CHI-SQUARE TEST**
	Problem Statement: Compare the observed and expected results using chi-square statistical test and identify whether a disparity between an actual and predicted data is due to chance or to a link between the variables under consideration. **Solutions Expected:** a) Perform the test using a mathematical approach and then using Python's SciPy module with statistical hypothesis is a test for independence between categorical variables. b) Get the chi-square distribution and return the scalar numpy array by using this method.
WEEK VIII	**PART OF SPEECH TAGGING AND CHUNKING**
	Problem Statement: Understand how POS tagging process the words classification into their parts of speech and labelling them accordingly. Implement the code to understand how POS tagging is so important in understanding the meaning of a sentence or to extract the relationship and build a knowledge graph. **Solutions Expected:** a) Use part of speech tagging to mark a word to its part of speech tag based on its context in the data. It is also used to extract relationships between words. b) On top of Part of Speech tagging. It groups word into "chunks", mainly of noun phrases. Chunking is done using regular expressions.

WEEK IX	**PART OF SPEECH TAGGING**
	Problem Statement: Use Natural Language Toolkit (NLTK) and build programs to perform text analysis. Demonstrate how NLTK is implemented as POS Tagging with stop words. **Solutions Expected:** a) Implement the code based on text that contain stop words like 'the', 'is', 'are'. Stop words can be filtered from the text to be processed. There is no universal list of stop words in nlp research, however the nltk module contains a list of stop words. Hint: Update the stop word file depends on your language which one you are using. Here we are using english (stopwords.words('english')).
WEEK X	**MARKOV MODEL PROCESS**
	Problem Statement: Find the probability of a state at a given time in a Markov chain by using dynamic programming and depth-first search (DFS) to solve the problem. **Solutions Expected:** a) Consider the state and the time as the two DP variables and observe that the probability of going from state A to state B at time t is equal to the product of the probability of being at A at time $t-1$ and the probability associated with the edge connecting A and B. b) Prove that the probability of being at B at time t is the sum of this quantity for all A adjacent to B.
WEEK 11	**WORD SIMILARITY**
	Problem Statement: Examine how Word Similarity is used to determine how semantically two words are close to each other. Find the similarity between the word vectors in the vector space using spaCy NLP library. **Solutions Expected:** a) Find word similarity: using context-sensitive tensors. b) Determine the type of an image in Python using imghdr.
WEEK XII	**POS TAGGING**
	Problem Statement: Learn how POS tagging works by describing words in their parts of speech and help you understand the meaning of sentences and develop a knowledge graph. **Solutions Expected:** a) Implement the code to identify words as nouns, verbs, adjectives, adverbs, etc. b) Use part of speech tagging to mark a word to its part of speech tag based on its context in the data. It is also used to extract relationships between words. c) On top of Part of Speech tagging. It groups word into "chunks", mainly of noun phrases. Chunking is done using regular expressions.

TEXTBOOKS

1. Christopher D. Manning and Hinrich Schutze, " Foundations of Natural Language Processing" , 6th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003

2. Daniel Jurafsky and James H. Martin “Speech and Language Processing”, 3rd edition, Prentice Hall, 2009.

REFERENCE BOOKS:

1. Nitin Indurkhya, Fred J. Damerau “Handbook of Natural Language Processing”, Second Edition, CRCPress,2010.
2. James Allen “Natural Language Understanding”, Pearson Publication 8th Edition. 2012.
3. Chris Manning and Hinrich Sch¨utze, “Foundations of Statistical Natural Language Processing”,2nd edition, ITPress Cambridge, MA, 2003.

1. https://www.geeksforgeeks.org/natural-language-processing-overview/
2. https://www.geeksforgeeks.org/python-word-similarity-using-spacy/?ref=rp
3. https://pub.towardsai.net/natural-language-processing-nlp-with-python-tutorial-for-beginners-1f54e610a1a0
4. https://www.analyticsvidhya.com/blog/2021/02/basics-of-natural-language-processing-nlp-basics/
5. https://towardsdatascience.com/free-hands-on-tutorials-to-get-started-in-natural-language-processing-6a378e24dbfc

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Understand the process of text preprocessing	CO 1	R1: 2.1 (25-30)
2	Explore the basics of NLP and present how it is suitable for text processing tasks	CO 2	R1: 2.2 (30-36)
3	Understanding the Inflect library and Implement Lemmatization	CO 2	R1: 4.1 (79-82)
4	Perform categorization using CORPUS and perform text-to-speech conversion	CO 2	R1: 2.3 (36-43)
5	Understanding and implement various N-gram language models	CO 2	R1: 2.4
6	Implementing different n-grams and perform analysis to decide the best among all	CO 1, CO 2, CO 3	R1: 9
7	Implementing the Pearson's Chi-Square test for statistical analysis	CO 1, CO 2, CO 3	R1: 3.1-3.6 (50-72)
8	Understand and Implement how POS Tagging is used to perform the words classification	CO 1, CO 2, CO 3	R1: 3.4 (64-68)
9	Implementing the use of NLTK and develop programs to perform text analysis	CO 1, CO 2, CO 3	R1: 3.6
10	Implementing the Markov Model process to find the probabilities	CO 1, CO 2, CO3	R1: 10
11	Implementing the POS tagging to examine the word similarity	CO 1, CO 2, CO 3	R1: 12.1-12.6(231-245)

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Understand how NLP powers modern applications
2	Explore key NLP techniques to build your natural language vocabulary
3	Transform text data into mathematical data structures and learn how to improve text mining models
4	Discover how various neural network architectures work with natural language data
5	Get the hang of building sophisticated text processing models using machine learning and deep learning
6	Check out state-of-the-art architectures that have revolutionized research in the NLP domain

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Dr. M.Nagaraju, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING(AI&ML)

COURSE DESCRIPTION

Course Title	OBJECT ORIENTED ANALYSIS AND DESIGN LABORATORY				
Course Code	ACAC14				
Program	B.Tech				
Semester	VI	CSE(AI&ML)			
Course Type	CORE				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr.Bhukya Mohan Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC02	III	Object Oriented Programming with objects.

II COURSE OVERVIEW:

This Laboratory course introduces the Unified Modeling language for visualizing, specifying, constructing and documenting in preparing blueprint of a software intensive system. This lab covers Static and Dynamic aspects of the System with illustrations of Class,Object,Component, Deployment Use case, State chart, sequence, activity, collaboration Diagrams. These diagrams are used to create low level and high level design documents of the software system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Object Oriented Analysis Design Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

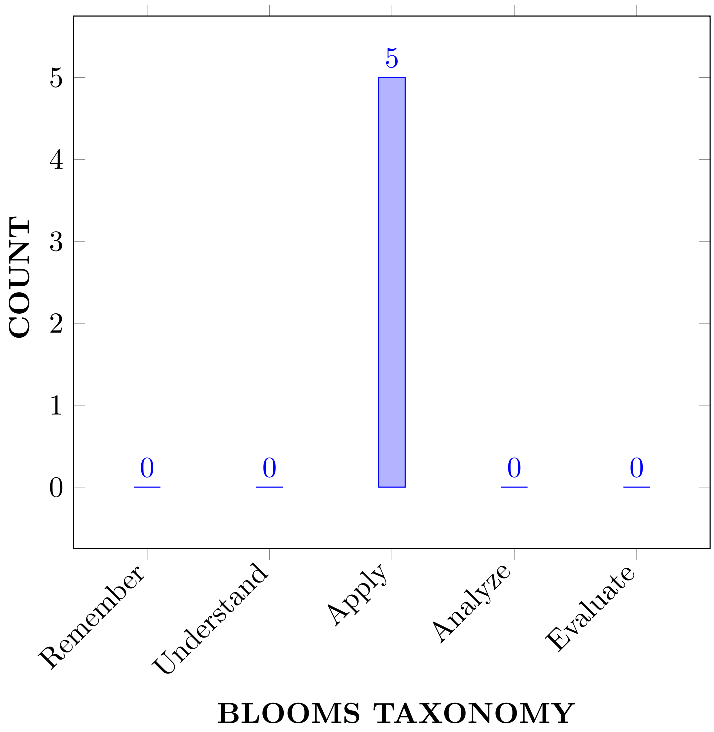
I	The need for requirement analysis in designing real time applications.
II	The implementation of Architectural views for different case studies.
III	The case studies for analyzing modeling techniques.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the requirements specification for an intended software system.	Apply
CO 2	**Make use of** UML notations to represent requirements of the software systems.	Apply
CO 3	**Build** a structural model of the software system using UML notations.	Apply
CO 4	**Design** a behavioral model of the software system with the help of UML structural diagrams.	Apply
CO 5	**Develop** a design model for different real time applications.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Exercise, CIE, SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercise, CIE, SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab Exercise, CIE, SEE

PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercise, CIE, SEE
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	2	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 2	**Analyze** features of software by **identifying, formulating, reviewing** complex engineering problems there by reaching to conclusion by following principles of SDLC.	6
	PO 3	**Design the solution** of software or system components by following designed guidelines.	10
	PO 4	**Identify the problems** and advantages for managing software requirement specifications.	5
	PSO 2	Compare process models, approaches and techniques to manage a given software development process by using the **mathematical principles and computer science Methodologies**	2
	PSO 3	**Formulate and Evaluate engineering concepts** to Design next-generation computer systems for modeling simple to complex engineering activities with understanding requirements and limitations of user.	2
CO 2	PO 2	Make use of UML notations to identify the **problem statement** and to define **model translation.**	2
	PO 3	Ensure the UML notation fits the purpose of all aspects of problem and **assists the design process** thereby achieving the engineering objectives.	3

	PO 4	Make use of building blocks for creating architectural view of system using UML by **communicating effectively to engineering community**	2
	PO 5	Make use of appropriate design techniques and **modern Engineering IT tools** for modelling the UML to represent complex engineering requirements.	1
	PSO 2	Design the software UML by identifying the **requirement activities like defining various problems, customer and user needs, cost effective and creative solutions, design process.**	2
	POS 3	Creation of UML to identify and **improve the software** eliability issues, analyze the data / Information.	2
CO 3	PO 2	**Understand** the given problem and **Design the software by making sure it fits for purpose for all aspects of the problem including**.	4
	PO 3	**Design** the software by making sure it fits for purpose for all aspects of the problem including**CASE tool** for modeling simple to complex engineering activities with understanding requirements and limitations of user.	1
	PO 4	**Understand** the given problem and **system definition, problem formulation, collecting data, modelling, solution development** for specifying structure and interaction of objects during runtime.	1
	PO 5	Translation of UML design notations that represent the requirement to actual implementation by **adopting techniques, resources and modern engineering tools..**	1
	PO 12	Classify the key issues in terms of **defining various problems, customer and user needs, cost effective and creative solutions, design process, economiccontext and management techniques.**	1
	PSO 2	Recognize the need and develop suitable building blocks using UML diagrams for **future advancement and lifelong learning.** eliability issues, analyze the data / Information.	1
	POS 3	Creation of UML to identify and **improve the software** eliability issues, analyze the data / Information.	2
CO 4	PO 2	Classify the key issues in terms of**defining various problems, customer and user needs, cost effective and creative solutions, design process.**	5
	PO 3	**Communicate** effectively in orally and written by comprehend and write effective **reports and design documentation**	6
	PO 4	Design solutions for simple and complex problems by **Defining problem, understand customer requirements, identifying** basic building blocks to draw UML diagrams.	1

	PO 5	Understand the **problem and develop solutions using different data technologies and document the results for interpretation.**	1
	PO 12	**Improve the software**reliability issues, analyze the data / Information.	1
	PSO 2	Identify the need and implement suitable building blocks using UML diagrams for **future advancement and lifelong learning.**	1
	PSO 3	Make use of **computational and advanced CASE tools** for creating innovative career paths, to be an entrepreneur and desire for higher studies.	2
CO 5	PO 2	**Understand** the given problem and system **definition, problem formulation, collecting data, modelling, solution development** definition, problem formulation, collecting data, modelling, solution development and documentation for design solution by using advanced building blocks of UML.	5
	PO 3	**Design** the software by making sure it fits for purpose for all aspects of the problem including **production, operation and maintenance by applying innovative solutions.**	5
	PO 4	Understand the **experimental designs** and development of project analysis and development of software requirement Specifications.	5
	PO 5	Translation of UML design notations that represent the requirement to actual implementation by **adopting techniques, resources and modern engineering tools.**	1
	PSO 2	Creation of UML to identify and **improve the software**reliability issues, analyze the data / Information.	2
	PSO 3	Make use of modern computer tools to **identify the technical skills necessary of reliable engineering practices..**	2

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Outcomes	Program Outcomes					Program Specific Outcomes	
	PO 2	PO 3	PO 4	PO 5	PO12	PSO 2	PSO 3
CO1	3	3	3	-	-	2	2
CO2	2	2	2	1	-	2	2
CO3	3	3	1	1	3	1	2
CO4	3	3	2	2	1	1	2
CO5	3	3	3	3	2	2	2

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	REQUIREMENT DEVELOPMENT
	Problem statement: Requirement engineering produces a specification of what a system should do. The intention of requirement engineering is to provide a clear definition of requirement of the systems. This phase is a very important phase because, if the customer requirements are not clearly understood, the ambiguity can get into the other phase of the development. To avoid such issues, requirement has to be elicited using the right elicitation techniques, to be analyzed effectively, specified clearly and verified thoroughly. All activities are collectively termed as requirement development activities. **Solutions expected:**Identify the requirement development activities associated with each of the following scenarios: a. Joe is creating an online survey questionnaire for requesting user feedback on the desired features of the application to be developed. b. Mark is preparing a formal document which includes all of the desired features identified by the survey. c. Jack identified an incomplete requirement statement d. Jones is identifying all security related requirement and separating them from the performance related requirements e. Merlin a team member is sent to client to observe the business case and collect typical user requirements. g. Leo is team member is working on requirement and ensuring that requirement collected should not be vague and unclear. h. Lee is conducting a facilitated meeting with the stakeholder to capture the requirements. i. Amit a team member is distributing questionnaires to stack holder for gathering user requirements.

WEEK II	**ANALYSIS OF SYSTEM USING UML NOTATIONS**
	Problem Statement Demonstrate the Classes, relationships, common mechanisms. Create SRS for Recruitment System. **Solutions expected:** a. Demonstrate the Classes, relationships, common mechanisms. b.Illustrate the differences between functional and non-functional requirements.. c.Create SRS for Recruitment System
WEEK III	**DESIGN OF SYSTEM USING STRUCTURAL DIAGRAMS**
	Problem statement: Design and illustrate the static part of the system using the UML structural diagrams (Object, and Class diagrams). **Solutions expected:** a. Demonstrate differences between static and dynamic diagrams b. Develop a design model using Class diagrams library management c. Model a view using Object diagram for order management
WEEK IV	**DESIGN OF SYSTEM USING STRUCTURAL DIAGRAMS**
	Problem statement: Design and illustrate the static part of the system using the UML structural diagrams (Component and Deployment diagrams). **Solutions expected:** a. Demonstrate Components in Component diagram and Components in Deployment diagrams b. Develop a design model using Component and Deployment diagrams with an example c. Model a view using Component and Deployment diagrams for Hospital management system.
WEEK V	**DESIGN OF SYSTEM USING BEHAVIORAL DIAGRAMS**
	Problem statement: Design and illustrate the static part of the system using the UML behavioral diagrams (Use Case, Sequential and Collaboration). **Solutions expected:** a. Describe modelling techniques of Use case, Sequential and Collaboration diagrams b. Develop a design model using Use case, Sequential and Collaboration diagrams with an example. c. Model a view using Usecase diagrams for a parking lot

WEEK VI	**DESIGN OF SYSTEM USING BEHAVIORAL DIAGRAMS**
	Problem statement: Design and illustrate the static part of the system using the UML behavioral diagrams (Activity and State chart). **Solutions expected:** a. Describe in detail Activity and State chart diagrams b. Develop a design model using Activity and State chart diagrams with an example c. Model a view using Activity and state chart diagrams for movie ticket booking system.
WEEK VII	**EXAM REGISTRATION SYSTEM**
	Problem statement: Exam Registration system is used in the effective dispatch of registration form to all of the students. This system adopts a comprehensive approach to minimize the manual work and schedule resources, time in a cogent manner. The core of the system is to get the online registration form (with details such as name, reg.no etc.,) filled by the student whose testament is verified for its genuineness by the Exam Registration System with respect to the already existing information in the database. **Solutions expected:** a. Demonstrate modelling techniques of Class diagram for Exam Registration b. Develop a design model using Sequence diagrams for Exam Registration System c. Model a view using Collaboration diagram for Exam Registration System
WEEK VIII	**STOCK MAINTENANCE**
	Problem statement: The stock maintenance system must take care of sales information of the company and must analyze the potential of the trade. It maintains the number of items that are added or removed. The salesperson initiates this Use case. The salesperson is allowed to update information and view the database. **Solutions expected:** a. Develop a design model using Usecase diagrams for Stock Maintenance b. Develop a design model using Class diagrams for Stock Maintenance c. Model a view using using Sequence diagram for Stock Maintenance

WEEK IX	**PASSPORT PROCESS**
	Problem statement: Passport Automation System is used in the effective dispatch of passport to all of the applicants .This system adopts a comprehensive approach to minimize the manual work and schedule resources, time in a cogent manner. The core of the system is to get the online registration form (with details such as name, address etc.,) filled by the applicants whose testament is verified for its genuineness by the Passport Automation System with respect to the already existing information in the database. **Solutions expected:** a. Elaborate modelling techniques of Deployment diagrams b. Design model using Deployment diagrams for Passport Process c. Model a view using Activity diagram for Passport Process
WEEK X	**E-BOOK MANAGEMENT SYSTEM**
	Problem statement: An E, Book lends books and magazines to member, who is registered in the system. Also it handles the purchase of new titles for the Book Bank. Popular titles are brought into multiple copies. Old books and magazines are removed when they are out or date or poor in condition. A member can reserve a book or magazine that is not currently available in the book bank, so that when it is returned or purchased by the book bank, that person is notified. The book bank can easily create, replace and delete information about the tiles, members, loans and reservations from the system **Solutions expected:** a. Define modelling techniques of Collaboration diagrams b. b. Design model using Deployment diagrams for E-book Management system c. Model a view using Use Case diagram for Passport Process
WEEK XI	**RECRUITMENT PROCESS**
	Problem statement: The recruitment system allows the job seekers to enroll their names through the process of registration. The employee also can get the list of available candidates and shortlist for their company requirement. Once the applicant enrolls he receives an id, which helps him in further Correspondence. A fees amount is received from the job seekers for enrollment. This system makes the task of the job seeker easier rather than waiting in queue for enrollment. This also reduces the time consumption for both for the job seeker and employee.. **Solutions expected:** a. Define modelling techniques of Sequence diagrams b. Design model using Sequence diagrams for Recruitment system process c.Model a view using Use Case diagram for Recruitment system process

WEEK XII	**ATM TRANSACTION**
	Problem Statement: ATMs are omnipresent these days, at least in major cities and towns. It is an empowering technology, as one can withdraw or transfer money any time they want. Now the enrolment for bank accounts is on the rise, which will include many illiterate or old people also. Is the current ATM experience good enough for them to use it? How can the experience be enhanced for them? **solutions expected:** a. Demonstrate modelling techniques of Activity diagrams b. Design a model using Activity diagram for ATM Transaction c. Model a view using Use Case diagram for ATM Transaction
WEEK XIII	**CONFERENCE MANAGEMENT SYSTEM**
	Problem Statement: The process of the candidates is to login the conference system and submit the paper through online. Then the reviewer reviews the paper and sends the acknowledgement to the candidate either paper selected or rejected. This process of on conference management system are described sequentially through following steps: • The candidate login to the conference management system. • The paper title is submitted. • The paper is been reviewed by the reviewer. • The reviewer sends acknowledgement to the candidate. • Based on the selection, the best candidate is selected. Finally, the candidate registers all details. **Solutions expected:** a. Illustrate modelling techniques of Use Case diagrams b. Design a model using Use Case diagram for Conference Management System c. Model a view using using Sequence diagram for library Management System.

WEEK XIV	**PERFORMANCE TESTING**
	Problem Statement: : Performance testing tests the non-functional requirements of the system. The different types of performance testing are load testing, stress testing, endurance testing and spike testing. **Solutions expected:** 1. A space craft is expected to function for nearly 8 years in space. The orbit control system of the spacecraft is a real-time embedded system. Before the launch, the embedded software is to be tested to ensure that it is capable of working for 8 years in the space. Identify the suitable performance testing category to be carried out to ensure that the space craft will be functioning for 8 years in the space as required. 2. Global Education Centre (GEC) at Infosys Mysore provides the training for fresh entrants. GEC uses an automated tool for conducting objective type test for the trainees. At a time, a maximum of 2000 trainees are expected to take the test. Before the tool is deployed, testing of the tool was carried out to ensure that it is capable of supporting 2000 simultaneous users. Indicate the performance testing category? 3. A university uses its web-based portal for publishing the results of the students. When the results of an examination were announced on the website recently on a preplanned date, the web site crashed. Which type of performance testing should have been done during web-site development to avoid this unpleasant situation? 4. During unexpected terrorist attack, one of the popular websites crashed as many people logged into the web-site in a short span of time to know the consequences of terrorist attack and for immediate guidelines from the security personnel. After analyzing the situation, the maintenance team of that website came to know that it was the consequences of unexpected load on the system which had never happened previously. Which type of performance testing should have been done during web-site development to avoid this unpleasant situation?

TEXTBOOKS

1. Grady Booch, James Rumbaugh, Ivar Jacobson, —The Unified Modeling Language User Guide‖, Pearson Education, 2ndEdition, 2004.

REFERENCE BOOKS:

1. Craig Larman, —Applying UML and Patterns: An Introduction to Object Oriented Analysis and Design and Iterative Development‖, Pearson Education, 3rd Edition, 2005.

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's
1	Requirement Development	CO 1, CO 2
2	Analysis of Systems Using UML Notations.	CO 1, CO 2
3	Design of system Using Structural Diagrams	CO 2, CO 4
4	Design of system Using Structural Diagrams	CO 2, CO 3

5	Design of System Using Behavioral Diagrams	CO 2, CO 3 CO 4
6	Design of System Using Behavioral Diagrams	CO 2, CO 4
7	Exam Registration System	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
8	Stock Maintenance	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
9	Passport Process	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
10	E-Book Management Systems	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
11	Recruitment Process	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
12	Exam Registration System	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
13	Conference Management System	CO 1, CO 2 ,CO 3 ,CO 4,CO 5
14	Performance Systems	CO 1, CO 2 ,CO 3 ,CO 4,CO 5

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Real time Online Transform** for embedded Systems considering non-functional aspects with rate-monotonic analysis.
2	Implementation of **Advanced relationships** and common mechanisms in real time applications.
3	**Reverse engineering:** Encourage students to implement model from a given input of source code.

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Mr.Bhukya Mohan, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**APPLIED NATURAL LANGUAGE PROCESSING**				
Course Code	ACAC19				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Ms.S.Viharika, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

This course examines machine learning techniques that obtain leading results on the problem of natural language processing (NLP). NLP is a critical step towards effective communication between people and machines. You will learn how to represent words and text, the use of deep recurrent models for text prediction, and issues that separate NLP from other application domains.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Foundations of Machine Learning	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	White Board	✓	Tech Talks	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Concep Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
50 %	Remember
16.66%	Understand
33.33%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

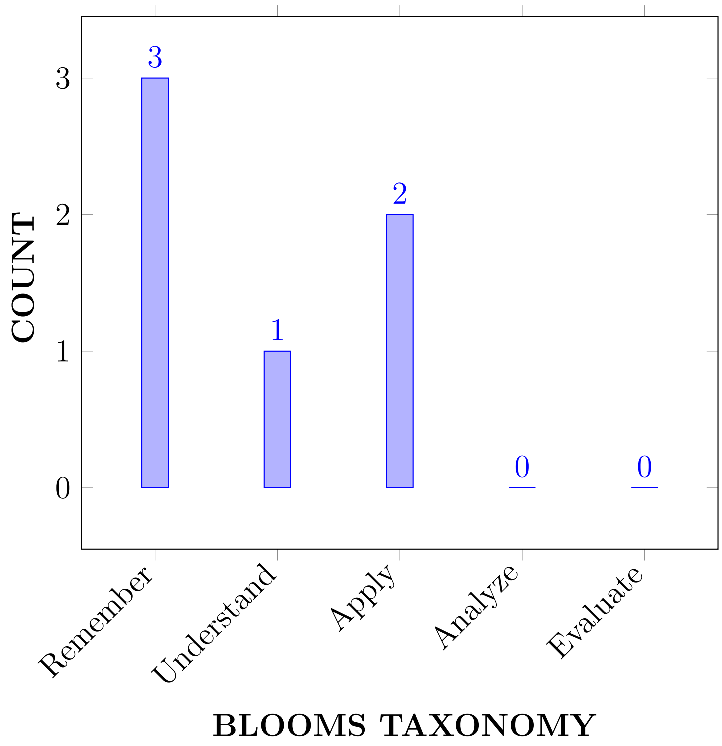
I	The basic concepts and basic algorithms of natural language processing.
II	How to use existing natural language processing tools to conduct basic natural language processing, such as text normalization, named entity extraction, or syntactic parsing.
III	The various machine learning techniques used in natural language processing.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** the concepts of NLP,machine learning and deep learning algorithms to acquire practical skills necessary to process raw text data.	Understand
CO 2	**Make use of** the NLP tokenization technique and existing libraries to perform text conversion.	Apply
CO 3	**Select the** preprocessing methods and feature extraction techniques to perform document classification.	Apply
CO 4	**illustrate the topic models,word embedding techniques** for word representation and distributed memory of paragraph vectors.	Apply
CO 5	**Demonstrate** Text Generation,machine translation tasks on sequence-to-sequence models,question and answer with neural network models of NLP.	Apply
CO 6	**Detail discussion on** Deep recurrent models for text prediction and issues to processing the natural language.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	CIE/Quiz/AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change..	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)..	3	CIE /Quiz /AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems..	2	CIE /Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	CIE /Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 2	-	-	-	✓	-	-	-	-	-	-	-	-	✓	-	✓
CO 3	-	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-
CO 4	-	-	-	✓	✓	-	-	-	-	-	-	✓	-	✓	-
CO 5	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	✓	✓	-	-	-	-	-	-	-	✓	✓	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Learn definition ofNLP,machine learning and deep learning algorithms. The approaches also evolved from the foundation of machine learning and deep learning algorithms to the paradigm slot in symbolic algorithms and expert system development, Machine learning and Deep learning to support study of their own engineering discipline applying mathematical and scientific principles.	3
	PO 2	Identify and **formulate the machine learning problem statements** by designing the models and validate their efficiency through experimental designs.	3
	PO 3	Trying to define and identify **the characteristics required to design a learning system**	3
	PO 4	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**	4
	PSO 1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems.**	4
CO2	PO 4	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**	3
	PSO1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems.**	4
	PSO3	Understand and **analyze various machine learning tools** and justify a solutiion to a real world problem.	4
CO 3	PO3	Trying to define and identify **the characteristics required to design a learning system**	2
	PSO1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems.**	2
CO 4	PO 4	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**,	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 5	Trying to determine hidden patterns of data **using Unsupervised Learning Algorithms.**	1
	PO 12	Knowledge of Bayesian Learning to find hidden patterns of data **using Unsupervised Learning Algorithms and techniques**	7
	PSO 2	Using Bayesian Learning to outline Unsupervised Learning Techniques **to determine hidden patterns of data**	4
CO 5	PO 5	Choosing Unsupervised Learning Techniques for optimizing the solution **and solving Classification and Regression Problems.**	1
CO 6	PO 3	Trying to define and identify **the characteristics required to design a learning system**	2
	PO 4	With the knowledge of Machine Learning trying to apply **to real-world problems to design a Learning System**	2
	PO 12	Identify appropriate Machine Learning Algorithms to categorize Learning Tasks **depending on the nature of the Learning System**	2
	PSO 1	Understand, design and analyze **Machine Learning Algorithms to solve real world problems.**	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	3	3	3	4	-	-	-	-	-	-	-		4	-	-
CO 2	-	-	-	3	-	-	-	-	-	-	-	-	4	-	4
CO 3	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	-	-	-	2	1	-	-	-	-	-	-	7	-	4	-
CO 5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	2	2	-	-	-	-	-	-	-	2	2	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	100	30	30	36	-	-	-	-	-	-	-		44	-	-
CO 2	-	-	-	27	-	-	-	-	-	-	-	-	44	-	66
CO 3	-	-	20	-	-	-	-	-	-	-	-	-	22	-	-
CO 4	-	-	-	18	100	-	-	-	-	-	-		-	100	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 5	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	10	18		-	-	-	-	-	-	25	22	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $<C \leq 40\%$ – Low/ Slight

2 - 40 % $<C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	3	1	1	1	-	-	-	-	-	-	-	-	2	-	
CO 2	-	-	-	1	-	-	-	-	-	-	-	-	2	-	3
CO 3	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	-	-	-	1	3	-	-	-	-	-	-	3	-	3	-
CO 5	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	1	1	-	-	-	-	-	-	-	1	1	-	-
TOTAL	3	1	3	4	6	0	0	0	0	0	0	4	6	3	3
AVERAGE	0.5	0.1	0.5	0.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.0	0.5	0.5

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	History of NLP, NLP, Machine Learning, and Deep Learning Packages with Python, Applications of Deep Learning to NLP, Popular Applications, Basic NLP, Perform NLP Tasks using spaCy, Multilayer Perceptrons and Recurrent Neural Networks.

MODULE II	**Text Preprocessing**
	Tokeninzation – A Minimal Tokenizer, Hugging Tokenizer, Building Own Tokenizer, Words – Understanding Versus Reading Text, Word Vectors, Embeddings in Practice, Embedding Things that Transformers – Building a Transformer from scratch, Attention Mechanisms, Transformers for computer .
MODULE III	**Working with Raw Text**
	Regular Expressions and Automata,Words and Transducer, N-grams. The Bag-of-Words Model, Count Vectorizer, Term Frequency Inverse Document Frequency.
MODULE IV	**Topic Modeling and Word Embeddings**
	Topic Model and Latent Dirichlet Allocation, Non-Negative Matrix Factorizaiton (NMF), Word2Vec, Continuous Bag-of-Words(CBoW), Global Vectors and Word Representation(GloVe), Distributed Memory of Paragraph Vectors(PV-DM)
MODULE V	**Text Generation, Machine Translation and other RLP Tasks**
	Text Generation with LSTMs, Bidirectional RNNs, RNNs – Vanilla RNNs, LSTM Networks, GRUs, Creating a Name Entity Recognition Tagger, Sequence-to-Sequence Models, Question and Answer with Neural Network Models.

TEXTBOOKS

1. Applied Natural Language Processing with Python by Taweh Beysolow II, Apress.
2. Applied Natural Language Processing in the Enterprise by Ankur A. Patel and Ajay Uppili Arasanipalai, O reilly.

REFERENCE BOOKS:

1. Jurafsky, David, and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Upper Saddle River, NJ: Prentice-Hall, 2000. ISBN: 0130950696.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. 1.http://www.e-booksdirectory.com/details.php?ebook=10166
2. 2. http://www.e-booksdirectory.com/details.php?ebook=7400re
3. 3. http://www.nltk.org/
4. 4. http://www.nlp.stanford.edu/
5. 5. http://www.textrazor.com

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be Covered	CO's	Reference
OBE DISCUSSION			
Discussion on Subject CO-PO Mapping			
CONTENT DELIVERY (THEORY)			
1	History of NLP	CO1	T2: 1
2	NLP	CO1	T2: 1
3	Machine Learning, and Deep Learning Packages with Python	CO1	T2: 2-6
4	Applications of Deep Learning to NLP	CO1	T2: 2-6
5	Popular Applications	CO1	R2:-21-22
6	Basic NLP	CO1	R2:-21-22
7	Perform NLP Tasks using spaCy	CO1	T2:3
8	Multilayer Perceptrons	CO1	R2:33-37
9	Recurrent Neural Networks	CO1	R2:43
10	Tokeninzation – A Minimal Tokenizer	CO2	T1: 21
11	Hugging Tokenizer	CO2	T1: 191
12	Building Own Tokenizer	CO2	T1: 191
13	Words – Understanding Versus Reading Text	CO2	T1: 191
14	Word Vectors, Embeddings in Practice,Embedding things	CO2	R2:123-126
15	Transformers – Building a Transformer from scratch	CO2	R2:123-126
16	Attention Mechanisms, Transformers for computer	CO2	R2:123-126
17	Regular Expressions and Automata	CO3	T1:423-424
18	Words & Transducer, N-grams.	CO3	T1:423-424
19	The Bag-of-Words Model	CO3	T1:427
20	Count Vectorizer	CO3	T1:62-69
21	Term Frequency Inverse Document Frequency	CO3	T1:62-69
22	Topic Model and Latent Dirichlet Allocation	CO4	T1:143-145
23	Non-Negative Matrix Factorizaiton (NMF)	CO4	T1:144-145
24	Word2Vec	CO4	T1:149,157
25	Continuous Bag-of-Words(CBoW)	CO4	T1:149,157
26	Global Vectors and Word Representation(GloVe)	CO4	T1:149,157
27	Distributed Memory of Paragraph Vectors(PV-DM)	CO4	T1:113-120,286
28	Text Generation	CO5	T1:113-120,286
29	Machine Translation and other RLP Tasks	CO5	T1:113-120,286

30	Text Generation with LSTMs	CO5	T1:113-120,286
31	Bidirectional RNNs	CO5	T1:233-245
32	RNNs – Vanilla RNNs	CO5	T1:233-245
33	LSTM Networks	CO5	T1:233-245
34	GRUs	CO5	T1:309-313
35	Creating a Name Entity Recognition Tagger	CO5	T1:309-313
36	Sequence-to-Sequence Models	CO5	T1:168-170
37	Question and Answer with Neural Network Models.	CO5	T1:171-176
PROBLEM SOLVING/ CASE STUDIES			
43	Let us say our hypothesis class is a circle instead of a rectangle. What are the parameters? How can the parameters of a circle hypothesis be calculated in such a case? What if it is an ellipse? Why does it make more sense to use an ellipse instead of a circle? How can you generalize your code to K greater than 2 classes?	CO 6	T1:43
44	Imagine our hypothesis is not one rectangle but a union of two (or m greater than 1) rectangles. What is the advantage of such a hypothesis class? Show that any class can be represented by such a hypothesis class with large enough m.	CO 6	T1:43
45	The complexity of most learning algorithms is a function of the training set. Can you propose a filtering algorithm that finds redundant instances?	CO 6	T1:43
46	For a two-class problem, generate normal samples for two classes with different variances, then use parametric classification to estimate the discriminant points. Compare these with the theoretical values	CO 6	T1:84
47	Assume a linear model and then add 0-mean Gaussian noise to generate a sample. Divide your sample into two as training and validation sets. Use linear regression using the training half. Compute error on the validation set. Do the same for polynomials of degrees 2 and 3 as well	CO 6	T1:85
48	In document clustering, ambiguity of words can be decreased by taking the context into account, for example, by considering pairs of words, as in cock tail party vs. party elections.Discuss how this can be implemented.	CO 6	T1:107
49	If we have a supervisor who can provide us with the label for any x, where should we choose x to learn with fewer queries?	CO 6	T1:43
50	One source of noise is error in the labels. Can you propose a method to find data points that are highly likely to be mislabeled	CO 6	T1:44
51	Take a word, for example, "machine." Write it ten times. Also ask a friend to write it ten times. Analyzing these twenty images, try to find features, types of strokes, curvatures, loops, how you make the dots, and so on, that discriminate your handwriting from your friend's	CO 6	T1:19

52	In basket analysis, we want to find the dependence between two items X and Y. Given a database of customer transactions, how can you find these dependencies? How would you generalize this to more than two items	CO 6	T1:18
53	Let us say we are building an OCR and for each character, we store the bitmap of that character as a template that we match with the read character pixel by pixel. Explain when such a system would fail. Why are barcode readers still used?	CO 6	T1:18
54	Imagine you have two possibilities: You can fax a document, that is, send the image, or you can use an optical character reader (OCR) and send the text file. Discuss the advantage and disadvantages of the two approaches in a comparative manner. When would one be preferable over the other?	CO 6	T1:18
55	Let us say you are given the task of building an automated taxi. Define the constraints. What are the inputs? What is the output? How can you communicate with the passenger? Do you need to communicate with the other automated taxis, that is, do you need a "language"?	CO 6	T1:18
56	In your everyday newspaper, find five sample news reports for each category of politics, sports, and the arts. Go over these reports and find words that are used frequently for each category, which may help us discriminate between different categories. For example, a news report on politics is likely to include words such as "government," "recession," "congress," and so forth, whereas a news report on the arts may include "album," "canvas," or "theater." There are also words such as "goal" that are ambiguous.	CO 6	T1:18
57	Assume we are given the task to build a system that can distinguish junk email. What is in a junk e-mail that lets us know that it is junk? How can the computer detect junk through a syntactic analysis? What would you like the computer to do if it detects a junk e-mail delete it automatically, move it to a different file, or just highlight it on the screen?	CO 6	T1:18
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	Introduction to Machine Learning	CO 1	T1:1-13
59	Supervised Learning Algorithms	CO 2	T1:21-41
60	Ensemble and Probabilistic Learning	CO 3	T1:47-69
61	Unsupervised Learning	CO 4	T1:86-123
62	Advanced Supervised Learning	CO 5	T1:125-158
DISCUSSION OF QUESTION BANK			

63	Choose one among two possibilities: You can fax a document, that is, send the image, or you can use an optical character reader and send the text file. Discuss the advantage and disadvantages of the two approaches in a comparative manner. When would one be preferable over the other?	CO 1	T1:1-13
64	Explain in detail about Empirical Risk Minimization and Discuss how it can be handled using Inductive Bias	CO 2	T1:21-41
65	How can you use this extra information to calculate which item to propose to a customer? Associated with each item sold in basket analysis, if we also have a number indicating how much the customer enjoyed the product, for example, in a scale of 0 to 10.	CO 3	T1:47-69
66	Illustrate with an example, Multi-Dimensional scaling can work as long as we have the pairwise distances between objects. We do not actually need to represent the objects as vectors at all as long as we have some measure of similarity.	CO 4	T1:86-123
67	Illustrate,in a Neural Net model the number of neurons are increased in the hidden layer from 1-2 and include the activation function like ReLU. Verify whether this model can support non-linearity and Data Modeling effectively	CO 5	T1:125-158

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Ms. S.viharika, Assistant Professor.

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**COGNITIVE SCIENCE**				
Course Code	ACAC24				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr.M.Seshanna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

Cognitive Science combines the interdiscipilnary streams of cognitive science into a unified narrative in all encompassing introduction to the field.This course presents cognitive science as a discipline in its own right,and teaches students to apply the techniques and theories of the cognitive scientist's 'toolkit'-the vast range of methods and tools that cognitive scientists use to study the mind.Thematically organized,rather than by seperate disciplines,Cognitive Science underscores the problems and solutions of cognitive science,rather than those of the subjects that contribute to it-pyschology,neuroscience,linguistics etc.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Cognitive Science	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	White Board	✓	Tech Talks	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Concep Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could

be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0 %	Remember
50%	Understand
50 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

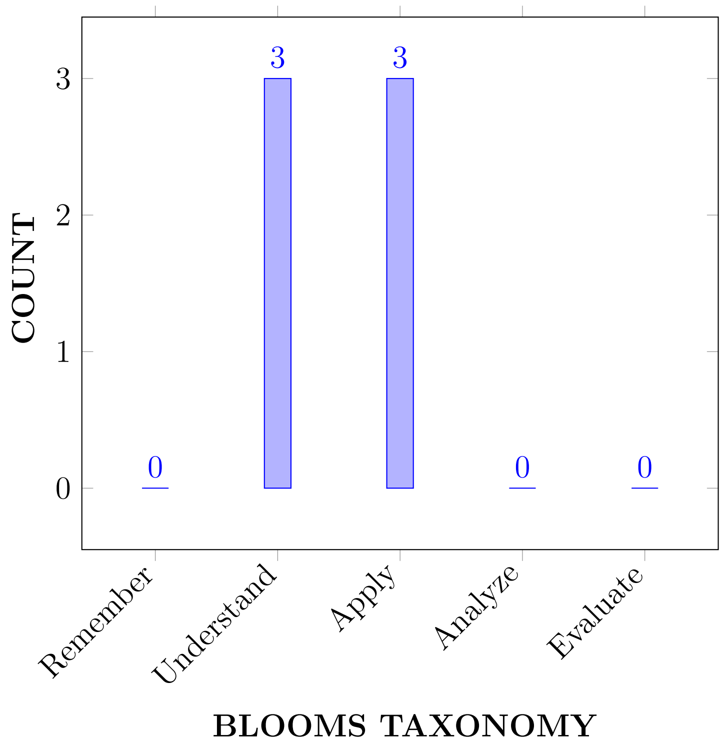
I	The basic concepts and approaches in the field of cognitive science.
II	The concepts of planning,reasoning and learning models in cognitive applications.
III	The language and semantic models of cognitive process.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Recognize** the concepts and approaches in the field of Cognitive science for Artificial intillegence to learn the basic theories and techniques.	Understand
CO 2	**Identify** the learning in cognitive systems and classification techniques for planning and learning methods in cognitive science .	Apply
CO 3	**Acquire the concept of child language learning distibuted cognization** for simple and complex decision making in Natural language Processing.	Apply
CO 4	**Compare the Reasoning methods** and ethics of learning by converting mistakes of of Artificial Intellegence for Reasoning Methods.	Understand
CO 5	**Illustrate** the classification models of Rationality and symbolic reasoning and decision making under uncertainity for paradigm of cognitive models.	Understand
CO 6	**Develop** Theory and Techniques and use different tools for cognitive disciplanes- psychology.neuro science and linguistics	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Program Outcomes	
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	CIE/Quiz/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/Quiz/AAT
PO 9	**Individual and team work:**Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	CIE /Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas..	2	CIE /Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	✓	✓	-	-	✓	✓	-	-	✓	-	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	✓
CO 3	✓	✓	-	-	✓	-	-	-	✓	-	-	-	✓	-	-
CO 4	✓	✓	-	-	✓	-	-	-	✓	-	-	-	-	-	-
CO 5	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	✓	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 1	PO 1	By understanding and applying **these concepts and approaches, engineers can develop robust and intelligent AI systems that can process complex data, understand human language, make informed decisions**, and interact with the world in a more human-like manner.	2
	PO 5	By understanding **these concepts and leveraging modern AI tools, engineers can accelerate the development process, build more sophisticated AI systems**, and harness the power of AI to solve complex real-world problems effectively..	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 6	By incorporating these concepts and approaches into AI engineering practices, engineers can contribute to the development of AI systems that align with societal values, address ethical concerns, and make a positive impact on people's lives. Balancing technical excellence with ethical considerations is key to the responsible deployment of AI in society.	3
	PO 9	Integrating these concepts and approaches from Cognitive Science **for Artificial Intelligence, individual team members can work collaboratively, share knowledge effectively, and develop AI solutions** that benefit from the collective intelligence of the team. Successful teamwork is crucial in addressing complex AI challenges and delivering high-quality results.	4
	PO10	learning and applying these concepts and approaches, **AI systems can effectively communicate with humans, enabling various applications such as virtual assistants, language translation, sentiment analysis, and more**. Effective communication between AI and humans is key to making AI technology more accessible, user-friendly, and valuable in various domains	3
	PSO 1	Understand, design and analyze **Artificial Intilligence to solve real world problems.**	4
CO2	PO 1	Incorporating these cognitive learning methods in engineering education, **students can develop a deeper understanding of concepts and enhance their problem-solving skills**, better preparing them for real-world engineering challenges.	3
	PO 2	employing these cognitive learning strategies in problem analysis, **learners can develop a structured and insightful approach to tackling complex challenges**, both in academic settings and real-world situations.	4
	PO 3	By incorporating these **cognitive learning strategies in the design and development of solutions, learners can enhance their creativity, critical thinking, and problem-solving skills. These skills are vital for engineering professionals to develop innovative and effective solutions** to complex challenges.	4
	PO 5	These cognitive learning strategies in modern tool usage, learners can develop the necessary skills to **leverage technology effectively in their respective fields** and stay updated with the ever-evolving technological landscape.	1
	PSO1	Understand, design and analyze **Cognitive learning strategies to solve real world problems.**	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO3	Understand and **analyze various Cognitive Learning tools** and justify a solutiion to a real world problem.	4
CO 3	PO 1	The concept of child language learning distributed cognization in NLP for engineering knowledge, **we can design more robust and adaptive language processing systems**. These systems can better handle both simple and complex decision-making tasks, making them more efficient and accurate in real-world applications.	3
	PO 2	Applying the concept of child language learning distributed cognization to problem analysis in NLP, **we can develop more sophisticated and context-aware systems**. These systems can effectively analyze problems, make informed decisions, and continuously improve their problem-solving capabilities through learning and interaction with users and their environment	4
	PO 5	By applying the concept of child language learning distributed cognization to modern tool usage in NLP, **we can create more advanced and adaptive NLP tools. These tools can efficiently handle both simple and complex decision-making tasks**, making them more effective and user-friendly in real-world applications.	1
	PO 9	The concept of child language learning distributed cognization to both individual and teamwork scenarios in NLP, **we can create more versatile and adaptable NLP systems.** These systems can efficiently handle simple and complex decision-making tasks, making them more effective tools for individuals and enhancing collaboration and decision-making within teams.	4
	PSO1	Understand, design and analyze **Cognitive Learning Strategto solve real world problems.**	2
CO 4	PO 1	Reasoning methods in engineering knowledge are evolving,**with AI increasingly utilizing machine learning and deep learning techniques for complex problem-solving.** However, learning from mistakes in AI can raise ethical concerns related to bias, fairness, explainability, accountability, privacy, and unintended consequences. Engineers and AI developers must prioritize ethical considerations and implement measures to address these concerns while leveraging the benefits of AI technology.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Reasoning methods in problem analysis include both **traditional human-based reasoning and AI-driven machine learning approaches. Learning from mistakes in AI for problem analysis raises ethical concerns related to bias, explainability, privacy, accountability, and unintended consequences**	4
	PO 5	Modern tools use a combination of **traditional rule-based reasoning and machine learning techniques, including deep learning**. Learning from mistakes in AI-powered modern tools raises ethical concerns related to bias, fairness, explainability, privacy, accountability, safety, and reliability.	1
	PO 9	In ethics can involve traditional ethical frameworks, machine learning approaches, and ethical heuristics. **Learning from mistakes in AI for ethical decision-making raises ethical concerns related to bias, fairness, explainability, privacy, accountability, and unintended consequences**.	5
CO 5	PO 2	Overall, the integration of classification models of **rationality and symbolic reasoning in modern tools empowers AI systems to augment human intelligence and improve the efficiency and effectiveness of decision-making and problem-solving processes..**	4
	PO 4	The application of these cognitive models in conducting investigations of **complex problems enhances the efficiency, accuracy, and reliability of the investigation process, ultimately leading to more informed and well-founded conclusions**	4
CO 6	PO 5	Integrating theoretical frameworks, computational models, and cutting-edge technologies, researchers can gain a more **comprehensive understanding of the complex interplay between psychology, neuroscience, and linguistics, ultimately contributing to the development of innovative cognitive tools and applications**	1
	PO 6	Integrating cognitive disciplines into engineering and society, we can create technologies that are more **human-centric, accessible, and user-friendly. This interdisciplinary approach can lead to innovations in human-computer interaction, healthcare, education, transportation, and other fields, benefiting individuals and society as a whole**	3
	PO 9	Integrating insights from cognitive disciplines into **individual and team work, organizations can promote a better understanding of human cognition, enhance individual cognitive capabilities, and optimize team performance.**	4

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	2	-	-	-	1	3	-	-	4	3	-	-	4	-	-
CO 2	3	4	4	-	1	-	-	-	-	-	-	-	4	-	4
CO 3	3	4		-	1	-	-	-	4	-	-	-	2	-	-
CO 4	3	4	-	-	1	-	-	-	5	-	-	-	-	-	-
CO 5	-	4	-	4	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	1	3	-	-	4	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	66				100	60	-	-	33	60	-		44	-	-
CO 2	100	40	40	-	100	-	-	-	-	-	-	-	44	-	66
CO 3	100	40	-	-	100	-	-	-	42	-	-	-	22	-	-
CO 4	100	40	-	-	100	-	-	-	-	42	-		-		-
CO 5	-	40	-	36	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	100	60	-	-	33	-	-			-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	2	-	-	-	1	3	-	-	4	3	-	-	4	-	
CO 2	3	4	4		1	-	-	-	-	-	-	-	4	-	4
CO 3	3	4	-	-	1	-	-	-	4	-	-	-	2	-	-
CO 4	3	4	-	-	1	-	-	-	5	-	-		-	-	-
CO 5	-	4	-	4	-	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 6	-	-	-	-	1	3	-	-	4	-	-		-	-	-
TOTAL	11	16	4	4	5	6	0	0	17	3	0	0	10	0.0	4
AVERAGE	1.8	2.6	0.6	0.6	0.8	1.0	0.0	0.0	2.8	0.5	0.0	0.0	1.6	0.0	0.6

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO COGNITIVE SCIENC (09)**
	Fundamental concepts of cognitive science – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation, semantic networks, frames, conceptual dependency, scripts, Ontology Understanding, Common Sense Reasoning.
MODULE II	**MODULE – II: PLANNING AND LEARNING METHODS (09)**
	Planning – Situation Logic- Learning in Cognitive Systems- Rote Learning – Learning by Examples - Incremental Concept Learning – Inductive Learning - Classification Techniques – Statistical Reasoning- Bayesian Classification- Bayesian Networks- Concept Learning- Version Spaces - Discrimination Trees.
MODULE III	**COGNITIVE MODELING (09)**
	Child concept acquisition - Child language learning, Acquisition of arithmetic skills, Distributed cognition and learning, Simple and complex decision making. Reasoning under uncertainty, Natural language understanding, Natural language processing, Automated natural language generation.
MODULE IV	**REASONING METHODS (09)**
	Reasoning by analogy, Explanation based reasoning, Case based reasoning, Constraint Satisfaction, Constraint Propagation, Temporal reasoning, Temporal Constraint Networks Spatial reasoning, Visual Spatial reasoning, Meta reasoning, Learning by correcting mistakes AI ethics.

MODULE V	**MODELING PARADIGM (09)**
	Modelling select aspects of cognition, Classical models of rationality, symbolic reasoning and decision making under uncertainty, Formal models of inductive generalization causality, Categorization and similarity analysis.

TEXTBOOKS

1. José Luis Bermúdez, "Cognitive Science: An Introduction to the Science of the Mind", Cambridge University Press, New York, 2014.
2. Mallick, Pradeep Kumar, Borah, Samarjeet," Emerging Trends and Applications in Cognitive Computing", IGI Global Publishers, 2019.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Tata McGraw-Hill Education, 3rd Edition, 2012
2. Stuart Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson Education, 2nd Edition, 2010.
3. Paul Miller, "An Introductory Course in Computational Neuroscience", MIT Press, 2018.
4. Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels(Ed), "The Oxford Handbook of Computational and Mathematical Psychology", Oxford University Press (2015).
5. Neil Stillings, Steven E. Weisler, Christopher H. Chase and Mark H. Feinstein, "Cognitive Science: An Introduction", MIT press, 2nd Edition, 1995.

WEB REFERENCES:

1. http://books.nap.edu/catalog/6160.html
2. http://www.emtech.net/links/construc.html
3. http://www.house.gov/science/research/may10/halpern.html

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be Covered	CO's	Reference
OBE DISCUSSION			
Discussion on Subject CO-PO Mapping			
CONTENT DELIVERY (THEORY)			
1	Fundamental concepts of cognitive science	CO1	T2: 1
2	Computers in Cognitive Science-Applied Cognitive Science	CO1	T2: 1
3	The Interdisciplinary Nature of Cognitive Science	CO1	T2: 2-6

4	Artificial Intelligence: Knowledge representation	CO1	T2: 2-6
5	semantic networks	CO1	R2:-21-22
6	frames	CO1	R2:21-22
7	conceptual dependency	CO1	R2:-21-22
8	scripts	CO1	R2:21-22
9	Ontology Understanding	CO1	T2:3
10	Common Sense Reasoning	CO1	R2:33-37
11	Planning – Situation Logic	CO2	T1: 21
12	Learning in Cognitive Systems- Rote Learning	CO2	T1: 191
13	Learning by Examples - Incremental Concept Learning	CO2	T1: 191
14	Inductive Learning	CO2	T1: 191
15	Classification Techniques – Statistical Reasoning	CO2	R2:123-126
16	Bayesian Classification- Bayesian Networks	CO2	R2:123-126
17	Concept Learning- Version Spaces	CO2	R2:123-126
18	Discrimination Trees	CO2	T1:423-424
19	Child concept acquisition	CO3	T1:423-424
20	Child language learning	CO3	T1:423-424
21	Acquisition of arithmetic skills	CO3	T1:427
22	Distributed cognition and learning	CO3	T1:62-69
23	Simple and complex decision making	CO3	T1:62-69
24	Reasoning under uncertainty	CO3	T1:62-69
25	Natural language understanding	CO3	R1:154-171
26	Natural language processing	CO3	R1:154-171
27	Automated natural language generation	CO3	R1:174-190
28	Reasoning by analogy	CO4	T1:143-145
29	Explanation based reasoning, Case based reasoning	CO4	T1:144-145
30	Constraint Satisfaction, Constraint Propagation	CO4	T1:149,157
31	Temporal reasoning	CO4	T1:149,157
32	Temporal Constraint Networks Spatial reasoning	CO4	T1:149,157
33	Visual Spatial reasonin	CO4	T1:113-120,286
34	Meta reasoning	CO4	T1:113-120,286
35	Learning by correcting mistakes AI ethics	CO4	T1:113-120,286
36	Modelling select aspects of cognition	CO5	T1:113-120,286
37	Classical models of rationality	CO5	T1:233-245
38	symbolic reasoning	CO5	T1:233-245

39	decision making under uncertainty	CO5	T1:233-245
40	Formal models of inductive generalization causality	CO5	T1:309-313
41	Categorization and similarity analysis	CO5	T1:309-313
PROBLEM SOLVING/ CASE STUDIES			
42	How behavior of community about COVID-19 can be interpreted in context of cognitive science?	CO 6	T1:43
43	What is functionalism and what is its relation to psychology and cognitive science?.	CO 6	T1:43
44	What is the best network based cognitive model to explain and predict political decision-making ?	CO 6	T1:43
45	In cognitive science, how are humans and computers considered similar? How are they different? In your answer, include a description of formal systems.	CO 6	T1:84
46	What is meant by rationalism and empiricism in cognitive science?l	CO 6	T1:85
47	In what ways are cognitive decoupling and meta-representational ability related to morality? How can System 1 and System 2 be considered in regards to moral reasoning?	CO 6	T1:107
48	Is a New Software Library to Simulate Natural Processes like Hunger Needed?	CO 6	T1:43
49	What are the current research trends in Cognitive Science?	CO 6	T1:44
50	Is still Cognitivism the main psychological foundation for Artificial Intelligence?	CO 6	T1:19
51	Proponents of the neural network approach argue that it provides a more natural account of many cognitive phenomena than those provided by Turing Machine/Physical Symbol System approaches. What are those cognitive phenomena? Give examples and explain whether you think that neural networks do indeed account for those phenomena in a more natural way.	CO 6	T1:18
52	Why Bayesian Cognitive Modeling?	CO 6	T1:18
53	Do you know real-world examples for cognitive assistants?	CO 6	T1:20
54	Anyone interested in contributing book chapters on Optimization and Cognitive Science?	CO 6	T1:33
55	Can Cognitive Science and AI System Engineering usefully be applied to understanding Ezra Pound's creative thought process?	CO 6	T1:45
56	What do you think about considering three basic forms of knowledge: rational knowledge, emotional knowledge and spiritual knowledge?	CO 6	T1:40
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Introduction to Cognitive Science	CO 1	T1:1-13
58	Planning and Leraning Methods	CO 2	T1:21-41
59	Cognitive Modeling	CO 3	T1:47-69
60	Reasoning Methods	CO 4	T1:86-123
61	Modeling Paradigm	CO 5	T1:125-158

DISCUSSION OF QUESTION BANK			
62	What are the main disciplines that contribute to cognitive science? Come up with at least one way each of these disciplines contributes to the field.	CO 1	T1:1-13
63	Illustrate on the' Learning in the cognitive Systems' and and 'Classification Techniques' with an examples	CO 2	T1:21-41
64	what is cognitive model.Explain the concept of ' Natural Language Processing'.	CO 3	T1:47-69
65	Explain about Reasoning Methods with an Examples.	CO 4	T1:86-123
66	summerize the Classical models of rationality,symbolic reasoning and decision making with an example.	CO 5	T1:125-158

Signature of Course Coordinator **HOD,CSE(AI & ML)**

Mr.M.Seshanna, Assistant Professor.

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING(AI & ML)				
Course Title	DEEP NEURAL NETWORKS				
Course Code	ACAC16				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. M.Nagaraju, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming
B.Tech	ACAC04	IV	Foundations of Machine Learning

II COURSE OVERVIEW:

Machine learning is a powerful set of techniques that allow computers to learn from data rather than having a human expert. Neural networks are a class of machine learning algorithms originally inspired by the brain, but which have recently seen a lot of success at practical applications. They're at the heart of production systems at companies like Google and Face book for face recognition, speech-to-text, and language understanding. This course gives an overview of both the foundational ideas and the recent advances in neural net algorithms. It covers the history of neural networks and state-of-the-art approaches to deep learning. Students will learn how to design neural network architectures, training procedures and hyperparameter tuning.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Deep Neural Networks	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage

in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
20%	Understand
70%	Apply
10 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table.

Case Studies	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

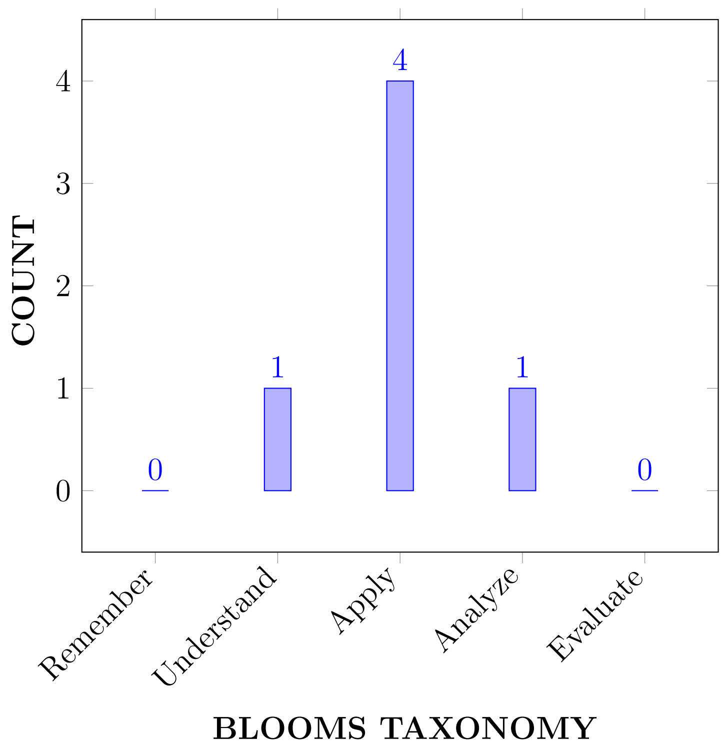
I	The theoretical foundations, algorithms and methodologies of Neural Network.
II	The design of single and multi-layer feed-forward deep networks and tune various hyper-parameters.
III	The provide the role of practical knowledge in handling and analyzing real world applications.
IV	To describe the role of neural networks in engineering, artificial intelligence, and cognitive modeling.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** the concepts of machine learning and the context of deep neural networks to build machine learning algorithms.	Understand
CO 2	**Identify** the activation functions and auto encoders to solve deep learning applications.	Apply
CO 3	**Develop** the CNN Models using hyperparameters with layers, filters etc for unsupervised training of neural networks.	Apply
CO 4	**Evaluate** the performance of CNN architectures by comparing with pretrained models in regularizing the testing error.	Analyze
CO 5	**Choose** the concept of sequential modelling with RNN, Bidirectional RNN and LSTM to solve classification tasks.	Apply
CO 6	**Make Use of** deep learning algorithms that are more appropriate for learning tasks and to solve real-world problems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	CIE/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)	2	CIE/Quiz/ AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1	CIE/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	✓	-	✓	-	-	-	-	-	-	-		✓	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	✓
CO 3	-	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-
CO 4	-	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 5	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 1	PO 2	Making the machines to learn from complex and unstructured data like documents, images, text etc. using deep learning algorithms and perform tasks without being programmed explicitly.	4
	PO 4	Learn definition of AI and its underlying assumptions. The approaches also evolved from the foundation of AI algorithms to the paradigm slot in symbolic algorithms and expert system development, Machine learning and Deep learning to support study of their own engineering discipline applying mathematical and scientific principles.	6
	PSO 1	Identify the need of deep neural networks, design and analyze the performance of new models by interpreting the results obtained through machine learning.	2
CO 2	PO 1	Introducing the basics of machine learning theory and laying down the concepts of deep learning to analyze more complex patterns in data.	2
	PO 2	Making the machines to learn from complex and unstructured data like documents, images, text etc. using deep learning algorithms and perform tasks without being programmed explicitly.	6
	PSO 1	Identify the need of deep neural networks, design and analyze the performance of new models by interpreting the results obtained through machine learning.	1
CO 3	PO 3	Understand the basic building blocks of cnn architectures and develop the new models to perform identification and classification tasks.	2
	PSO 1	Identify the need of deep neural networks, design and analyze the performance of new models by interpreting the results obtained through machine learning.	3
CO 4	PO 2	Focus on several activation functions and construct a fine tuned cnn model to address problems of several deep learning applications.	2
	PO 4	Evaluate the performance of pretrained cnn models and analyze how impact when developed using transfer learning technique.	2
	PSO 1	Identify the need of deep neural networks, design and analyze the performance of new models by interpreting the results obtained through machine learning.	2

CO 5	PO 1	Introducing the basics of machine learning theory and laying down the concepts of deep learning to analyze more complex patterns in data.	2
	PO 4	Evaluate the performance of pretrained cnn models and analyze how impact when developed using transfer learning technique.	4
CO 6	PO 1	Introducing the basics of machine learning theory and laying down the concepts of deep learning to analyze more complex patterns in data.	2
	PO 2	Making the machines to learn from complex and unstructured data like documents, images, text etc. using deep learning algorithms and perform tasks without being programmed explicitly.	4
	PO 4	Evaluate the performance of pretrained cnn models and analyze how impact when developed using transfer learning technique.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	4	-	6	-	-	-	-	-	-	-	-	2	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	1	-	1
CO 3	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	-	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 5	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	4	-	3	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	40	-	54.5	-	-	-	-	-	-	-	-	22.2	-	-
CO 2	66.7	60	-	-	-	-	-	-	-	-	-	-	11.1	-	16.7
CO 3	-	-	20	-	-	-	-	-	-	-	-	-	33.3	-	-
CO 4	-	20	-	18.2	-	-	-	-	-	-	-	-	22.2	-	-
CO 5	66.7	-	-	36.4	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.7	40	-	27.3	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	3	-	3	-	-	-	-	-	-	-	-	2	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	1	-	1
CO 3	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	-	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 5	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	3	-	3	-	-	-	-	-	-	-	-	-	-	-
TOTAL	6	11	2	11	-	-	-	-	-	-	-	-	9	-	1
AVERAGE	0.33	0.18	0.03	0.16	-	-	-	-	-	-	-	-	0.16	-	0.02

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**MACHINE LEARNING BASICS**
	Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality.
MODULE II	**DEEP LEARNING ARCHITECTURES**
	Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.
MODULE III	**CONVOLUTIONAL NEURAL NETWORKS**
	Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet– Applications.
MODULE IV	**TRANSFER LEARNING AND AUTO ENCODERS**
	Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders.
MODULE V	**SEQUENCE MODELLING – RECURRENT AND RECURSIVE NETS**
	Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short Term Memory Networks.

TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2017.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

REFERENCE BOOKS:

1. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017
2. Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.
3. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.

WEB REFERENCE

1. http://noiselab.ucsd.edu/ECE228/Murphy_Machine_Learning.pdf
2. https://medium.com/intro-to-artificial-intelligence/deep-learning-series-1-intro-to-deep-learning-abb1780ee20
3. https://www.analyticsvidhya.com/blog/2018/10/introduction-neural-networks-deep-learning/
4. https://d2l.ai/chapter_convolutional-modern/alexnet.html
5. https://www.geeksforgeeks.org/residual-networks-resnet-deep-learning/

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Outcomes, Program Outcomes, Course Objectives		
CONTENT DELIVERY (THEORY)			
1	Learning algorithms	CO 1	T1:5.1
2	Maximum likelihood estimation	CO 1	T1:5.5
3	Building machine learning algorithm	CO 1	T1: 5.10
4	Neural Networks Multilayer Perceptron	CO 1	R1: 1.2, 1.5
5	Back-propagation algorithm	CO 1	T1: 6.5
6	Stochastic gradient decent	CO 1	T1: 5.9
7	Curse of Dimensionality	CO 1	T2: 2.1
8	Machine Learning and Deep Learning	CO 2	T2: 2.1
9	Representation Learning	CO 2	T2: 2.1, R1:7.1,
10	Width and Depth of Neural Networks	CO 2	T2: 2.1, R1:7.1
11	Activation Functions: RELU, LRELU, ERELU	CO 2	T2: 2.1, R1:7.1
12	Unsupervised Training of Neural Networks	CO 2	T2: 2.1, R1:7.1

13	Restricted Boltzmann Machines	CO 2	T1: 20.1
14	Auto Encoders	CO 2	T1: 14.1
15	Deep Learning Applications	CO 2	T1: 12.1-12.5
16	CNN Architectures	CO 3	T2:3.1, T1:6.1
17	Architecture Motivation and Overview	CO 3	T2:3.1
18	CNN Layers	CO 3	T1:6.1
19	CNN Filters	CO 3	T1:6.3
20	Parameter sharing	CO 3	T1:7.1,7.2
21	Regularization	CO 3	T1:7.3
22	Popular CNN Architectures: ResNet, AlexNet– Applications	CO 3	T2:3.1
23	Applications of Popular CNN Architectures	CO 3	T2:3.1
24	Introduction to Transfer Learning	CO 4	T1:3.1
25	Introduction to Auto Encoders	CO 4	T1:14.1
26	Transfer learning Techniques	CO 4	T1:14.1
27	Variants of CNN	CO 4	T1:3.1
28	DenseNet, PixelNet	CO 4	T2:25
29	Under complete Auto encoder	CO 4	T1:7.1
30	Regularized Auto encoder	CO 4	T1:14.2
31	Stochastic Encoders	CO 4	T1:14.4
32	Stochastic Decoders	CO 4	T1:14.4
33	Contractive Encoders	CO 4	T1:14.2
34	Sequential Modelling	CO 5	T1:7.3.3
35	Recurrent Neural Networks	CO 5	T1: 9.1, 9.2
36	Bidirectional RNNs	CO 5	T1:10.2
37	Encoder-decoder sequence	CO 5	T1:10.4
38	Sequence Architectures	CO 5	T2:10.1
39	BPTT for training RNN	CO 5	T2:10.2
40	Long Short Term Memory Networks	CO 5	T1:10.10, 10.11
PROBLEM SOLVING/CASE STUDIES			
41	Develop a computer vision application that recognizes sound waves from the vibrations they induce in objects visible in a video	CO 6	T1:12.2
42	Perform the input preprocessing and show why standardization of images is required.	CO 6	T1:12.2.1
43	Implement the data augmentations to preprocess the training set images and prove how it reduces the generalization errors.	CO 6	T1: 12.2.1
44	Apply two types of contrast normalization and show how global contrast normlization (GCN) prevents the varying amounts of contrast and performs rescaling	CO 3	T1:12.2.1.1

45	Implement the code to perform the task of speech recognition by mapping an acoustic signal containing a spoken natural language utterance in a sequence of words.	CO 3	T1:12.3
46	Develop the code to typically read and emit the specialized languages designed to allow efficient and unambiguous parsing.	CO 3	T1:12.4
47	Develop a neural language model to overcome the curse of dimensionality problems for modeling natural languge sequence by using a distributed representation of words.	CO 3	T1: 12.4.2
48	Develop the code to implement the sampling and speed uo the training of neural network models and avoid explicit computing the contribution of the gradient from all the words that do not appearin the next position.	CO 2	T1:12.4.3.3
49	Develop a neural machine translation to read a sentence in one natural language andemitting a sentence with the equivalent meaning in another language.	CO 3	T1: 12.4.5
50	Develop a recommender systems to make recommendations of items to potentialusers or customers.	CO 6	T1:5.12.5.1
51	Enable precision medicine which includes remedies based on genetic, environmental or lifestyle factors (also called personalised medicine).	CO 6	T2:6.3,6.10 T1:4.9-4.10
52	Scanning the image of product to find the product on the store or suggest similar alternatives.	CO 6	T2:6.1,6.4 T1:4.1-4.5
53	Provide personalised shopper experience based on browsing/purchasing history in store or online.	CO 6	T2:3.1-3.4 T1:2.1-2.4
54	Examine data in customer feedback forms/texts, identify potential churners and communicate with the customer without losing time.	CO 6	T2: 7.6 7.7, 8.9-8.10
55	Automatically extract data from documents using deep learning models.	CO 6	T2:5.1-5.3 T1:2.8,3.7-3.8
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	MODULE-I: Machine Learning Basics	CO 1	T1:6.2-6.3,6.7 T1:4.8,4.11
57	Module-II: Deep Learning Architectures	CO 2	T1:6.1,6.4 T1:4.1-4.5
58	Module-III: Convolutional Neural Networks	CO 3	T1: 7.6 7.7, 8.9-8.10
59	Module-IV: Transfer Learning and Auto Encoders	CO 4	T1:6.3,6.10 T1:4.9-4.10

60	Module-V: Sequence Modelling - Recurrent and Recursive NETs	CO 5	T1:6.3,6.10 T1:4.9-4.10
DISCUSSION OF QUESTION BANK			
61	What are the applications of machine learning and deep neural networks?	CO 1	T1:5.1-5.3 T1:2.8,3.7-3.8
62	What Is the Role of Activation Functions in a Neural Network?	CO 2	T1:6.2-6.3,6.7 T1:4.8,4.11
63	Explain the architecture of convolutional neural networks and hyperparameter tuning process.	CO 3	T1: 7.6 7.7, 8.9-8.10
64	What are the essential components of autoencoders?	CO 4	T1:6.3,6.10 T1:4.9-4.10
65	Explain how the memory cell in an LSTM is implemented computationally?	CO 5	T1:6.1,6.4 T1:4.1-4.5

Signature of Course Coordinator
Dr. M.Nagaraju, Assistant Professor

HOD,CSE(AI & ML)

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering (AI & ML)**				
Course Title	**Embedded Systems**				
Course Code	AECC40				
Program	B. Tech				
Semester	VII				
Course Type	Open Elective-II				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. S. Lakshmanachari, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	ACSC07	III	Computer Organization and Architecture	3
B.Tech	ACSC12	III	Operating Systems	3

II COURSE OVERVIEW:

This course allows students to learn the fundamentals of embedded system hardware and firmware design. It focusses on embedded system design process, embedded C, interfacing modules, software development tools for debugging and testing of embedded applications, ARM and SHARC processor architectures and memory organization. It provides hands-on experience on implementation of embedded application prototype design using embedded C.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Embedded Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
66.6%	Understand
16.6 %	Apply
16.6 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Videos	Tech-talk	Open Ended Experiment
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

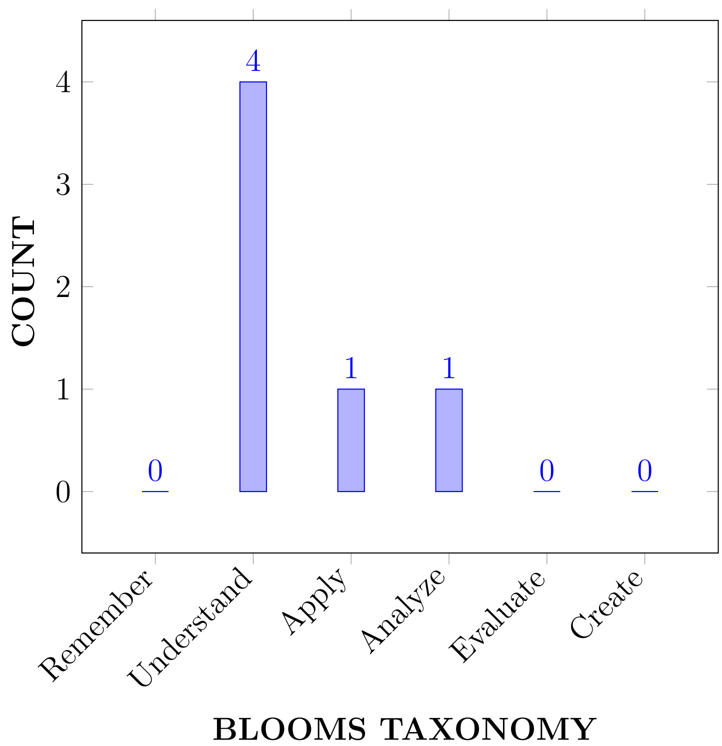
I	The concepts of embedded computing, embedded C, RTOS and embedded software tools for implementing embedded systems.
II	Embedded software development tools for debugging and testing of embedded applications, architectures of ARM and SHARC processors.
III	Interfacing with external environments using sensors, actuators and communication in distributed embedded systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the concepts of Embedded Systems and formalisms for system design with examples.	Understand
CO 2	**Examine** and write the Embedded Systems programming in C with Keil Integrated Development Environment (IDE).	Analyze
CO 3	**Demonstrate** the principles of RTOS and the methods used for saving memory and power in real time environments.	Understand
CO 4	**Make use of** embedded software development tools for debugging and testing of embedded applications.	Apply
CO 5	**Illustrate** the architecture, memory organization and instruction level parallelism of ARM and SHARC processors used in Embedded Systems.	Understand
CO 6	**Interpret** the concepts of Internet of Things used in the embedded systems applications.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	SEE/CIE/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1	AAT / Projects

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Illustrate the concepts (knowledge) of embedded systems using their architectures by using **mathematics, science, engineering fundamentals** to the solution of complex engineering problems.	3
	PO 10	Describe the concepts of Embedded Systems and formalisms by **giving effective presentations and take clear instructions** for system design with examples.	1
	PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1
CO 2	PO 1	Apply the integration of sensors, actuators and on-chip peripherals of microcontroller architectures for prototype design by applying **science** and **engineering fundamentals**.	2
	PO 2	Understand the given embedded application **problem statement** and finding the solution implementation and select proper language for **information and data collection** for **solution development** by writing embedded C language programming efficient and **interpretation of results**.The prototype embedded system design by analyzing complex engineering problems.	4
	PO 3	**Manage the design process** and make **use of creativity to establish solutions** by selecting proper syntaxes to write the embedded C language programming by **understanding of the requirement for engineering activities to promote sustainable development** and design solutions for complex Engineering problems and design system components of embedded applications that meet the specified needs with appropriate consideration for the public **health and safety, and the cultural, societal, and Environmental considerations.**	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 5	Select and apply appropriate techniques of **(Modern Tool Usage)** Keil Integrated Development Environment, for design of the basic embedded modules using different electronic circuits to provide valid conclusions.	1
	PO 10	Use Keil Integrated Development Environment by **giving effective presentations and take clear instructions** for analyzing the Embedded Systems programming in C.	1
CO 3	PO 1	Demonstrate (knowledge) the principles of RTOS such as interrupt latency and context switching in hard real time environments by applying the knowledge of **mathematical model, science and engineering fundamentals**	3
	PO 10	Describe the principles of RTOS and the methods used for saving memory and power with Keil Integrated Development Environment by **giving effective presentations and take clear instructions** in real time environments.	1
	PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1
CO 4	PO 1	Make use of embedded software development tools (knowledge) for debugging and testing of embedded applications to the solution of complex engineering problems using **mathematics, science, engineering fundamentals**.	3
	PO 2	**Identify the problem** and understand the given embedded application and choose necessary hardware and software interface for **information and data collection** and **conduct experimental design** and **finding the solution implementation** of embedded applications using development tools by analyzing complex engineering problems.	4
	PO 3	**Understand the customer and user needs** and select an appropriate RTOS and Software development tools by **managing the design process and evaluate outcomes** to **promote sustainable development** for data transfer between the devices using **creativity to establish innovative solutions**.	4
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering tools including prediction and modelling the embedded circuits using **Keil integrated development environment tool** to complex Engineering activities with an understanding of the limitations.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Use embedded software development tools by **giving effective presentations and take clear instructions** for debugging and testing of embedded applications.	1
CO 5	PO 1	Understand (knowledge) the architecture, memory management and application development using ARM and SHARC processors by applying **science and engineering fundamentals**.	2
	PO 10	Explain the architecture, memory organization and instruction level parallelism of ARM and SHARC processors by **giving effective presentations and taking clear instructions**.	1
CO 6	PO 1	Model a embedded application prototype using embedded C by applying **engineering fundamentals**.	1
	PO 2	Understand the **problem statement** and **solve** embedded **prototype implementation** using the concepts of Internet Of Things **(information and data collection)** and **interpret the results** in global engineering applications in complex problem analysis using mathematics.	5
	PO 3	**Using creativity to establish innovative solutions** and **understanding of the requirement for engineering activities to promote sustainable development** for design a complex engineering problems and real time processes that meet the specified needs with appropriate consideration for the **public health and environmental considerations**.	3
	PO 10	Interpret the concepts of Internet of Things used in embedded systems applications by **giving effective presentations and taking clear instructions**.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	6	2	2
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	1
CO 2	2	4	4	-	1	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	-	-	1
CO 4	3	4	4	-	1	-	-	-	-	1	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	5	3	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	-	-	50
CO 2	66.6	40	40	-	100	-	-	-	-	20	-	-	-	-	-
CO 3	100	-	-	-	-	-	-	-	-	20	-	-	-	-	50
CO 4	100	40	40	-	100	-	-	-	-	20	-	-	-	-	-
CO 5	66.6	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	33.3	50	30	-	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 2	3	1	1	-	3	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	1	1	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	2	1	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	16	4	3	-	6	-	-	-	-	6	-	-	-	-	4
AVERAGE	2.66	1.33	1	-	3	-	-	-	-	1	-	-	-	-	2

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	AAT	✓
Quiz	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-
Seminars	-	Laboratory Practices	-		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**EMBEDDED COMPUTING**
	Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, characteristics and quality attributes of embedded systems, formalisms for system design, design examples.
MODULE II	**INTRODUCTION TO EMBEDDED C AND APPLICATIONS**
	C looping structures, register allocation, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly, portability issues; Embedded systems programming in C, binding and running embedded C program in Keil IDE, dissecting the program, building the hardware; Basic techniques for reading and writing from I/O port pins, switch bounce; Applications: Switch bounce, LED interfacing, interfacing with keyboards, displays, D/A and A/D conversions, multiple interrupts, serial data communication using embedded C interfacing.
MODULE III	**RTOS FUNDAMENTALS AND PROGRAMMING**
	Operating system basics, types of operating systems, tasks and task states, process and threads, multiprocessing and multitasking, how to choose an RTOS ,task scheduling, semaphores and queues, hard real-time scheduling considerations, saving memory and power. Task communication: Shared memory, message passing, remote procedure call and sockets; Task synchronization: Task communication synchronization issues, task synchronization techniques, device drivers.
MODULE IV	**EMBEDDED SOFTWARE DEVELOPMENT TOOLS**
	Host and target machines, linker/locators for embedded software, getting embedded software into the target system; Debugging techniques: Testing on host machine, using laboratory tools, an example system.

MODULE V	**INTRODUCTION TO ADVANCED PROCESSOR**
	Introduction to advanced architectures: ARM and SHARC, processor and memory organization and instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled systems, design example-Elevator controller.

TEXTBOOKS

1. Shibu K.V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition, 2009.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2nd Edition, 2011.
3. Andrew Sloss, Dominic Symes, Wright, "ARM System Developer's Guide Designing and Optimizing System Software", 1st Edition, 2004.

REFERENCE BOOKS:

1. Wayne Wolf, — Computers as Components, Principles of Embedded Computing Systems Design, Elsevier, 2 nd Edition, 2009
2. Dr. K. V. K. K. Prasad, — Embedded / Real-Time Systems: Concepts, Design & Programming, dreamtech publishers, 1 st Edition, 2003.
3. Frank Vahid, Tony Givargis, —Embedded System Design‖, John Wiley & Sons, 3 rd Edition, 2006
4. Lyla B Das, "Embedded Systems" , Pearson Education, 1st Edition, 2012.
5. David E. Simon, "An Embedded Software Primer", Addison-Wesley, 1st Edition, 1999.
6. Michael J.Pont, "Embedded C", Pearson Education, 2nd Edition, 2008.

WEB REFERENCES:

1. https://www.smartzworld.com/notes/embedded-systems-es/
2. http://notes.specworld.in/embedded-systems-es/
3. http://education.uandistar.net/jntu-study-materials
4. http://www.nptelvideos.in/2012/11/embedded-systems.html

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/playercourseid = 228sectionid = 729lessonid = 7135

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&courseid=228
CONTENT DELIVERY (THEORY)			
2	Definition of embedded system, embedded systems vs. general computing systems.	CO 1	T1-1.1
3	History of Embedded systems	CO 1	T1-1.
4	Complex systems and microprocessor, classification,major application areas.	CO 1	T1-1.3
5	The embedded system design process	CO 1	T2-1.4
6	Characteristics and quality attributes of embedded systems	CO 1	T2-1.5
7	Formalisms for system design, design examples.	CO1	R2-1.2
10	Introduction to embedded C,C looping structures.	CO 2	T3-1.3
11	Register allocation, Function calls, and pointer aliasing.	CO 2	T3-2.4
12	Structure arrangement, Bit fields, unaligned data and endianness.	CO 2	T3-2.5
13	Inline functions and inline assembly, portability issues.	CO 2	T3-2.6
14	Embedded systems programming in C, binding and running embedded C program in Keil IDE	CO 2	T3-2.7
15	Embedded C program in Keil IDE, dissecting the program, building the hardware	CO 2	T3-2.8
16	Basic techniques for reading and writing from I/O port pins, switch bounce	CO 2	T3-2.9
17	Applications: Switch bounce, LED interfacing.	CO 2	R2-3.1
18	Interfacing with keyboards, displays	CO 2	R2-3.2
19	D/A and A/D conversions, multiple interrupts.	CO 2	R2-3.3
20	Serial data communication using embedded C interfacing.	CO 2	R2-3.4
28	RTOS Fundamentals, Operating system basics, types of operating systems	CO 3	R2-3.5
29	Tasks and task states, process and threads	CO 3	R2-3.6
30	Multiprocessing and multitasking, how to choose an RTOS	CO 3	R3-3.7
31	Task scheduling, semaphores and queues	CO 3	R3-3.8
32	Hard real-time scheduling considerations, saving memory and power.	CO 3	R3-4.1

33	Task communication: Shared memory, message passing	CO 3	R3-4.1
34	Remote procedure call and sockets	CO 3	R3-4.2
35	Task synchronization: Task communication synchronization issues	CO 3	R3-4.2
36	Task synchronization techniques, device drivers.	CO 3	R3-4.3
37	Host and target machines	CO 4	R3-4.3
38	Linker for embedded software	CO 4	R3-4.4
39	Locators for embedded software	CO 4	R3-4.4
40	Getting embedded software into the target system	CO 4	R3-4.5
41	Debugging techniques: Testing on host machine	CO 4	R3-4.5
44	Debugging techniques using laboratory tools, an example system.	CO 4	R3-4.5
47	Introduction to advanced architectures: ARM	CO 5	T2-8.1
48	Introduction to advanced architectures: SHARC	CO 5	T2-8.1
49	Processor and memory organization	CO 5	T2-8.2
50	Instruction level parallelism	CO 5	T2-8.2
51	Networked embedded systems: Bus protocols	CO 6	T2-8.3
52	Networked embedded systems: I2C bus and CAN bus	CO 6	T2-8.3
53	Internet-Enabled systems	CO 6	T2-8.4
54	Design example-Elevator controller.	CO 6	T2-8.4
PROBLEM SOLVING/ CASE STUDIES			
8	BMW 850i brake and stability control system	CO 1	T2-1.4
9	Design example of model train controller	CO 1	T3-2.7
21	Embedded C program for Switch bounce	CO 2	R2-3.2
22	Embedded C program for LED interface	CO 2	R3-4.5
23	Embedded C program for Interfacing with keyboards	CO 2	T2-8.2
24	Embedded C program for Interfacing with displays	CO 2	T2-1.4
25	Embedded C program for 7 Segment Display Interfacing	CO 2	T3-2.7
26	Embedded C program for ADC Interfacing with 8051 microcontroller	CO 2	R2-3.2
27	Embedded C program for DAC Interfacing with 8051 microcontroller	CO 2	R3-4.5
45	Design of Digital camera	CO 4	T2-8.2
46	Design of Microwave oven	CO 4	T2-1.4
55	Design of Elevator controller	CO 6	T3-2.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Embedded computing	CO 1	T1-1.3
57	Introduction to embedded c and applications	CO 2	T3-2.4
58	RTOS fundamentals and programming	CO 3	R3-4.2
59	Embedded software development tools	CO 4	R3-4.4
60	Introduction to advanced processors	CO 5, CO 6	T2-8.3
DISCUSSION OF QUESTION BANK			
61	Embedded computing	CO 1	T1-1.3

62	Introduction to embedded c and applications	CO 2	T3-2.4
63	RTOS fundamentals and programming	CO 3	R3-4.2
64	Embedded software development tools	CO 4	R3-4.4
65	Introduction to advanced processors	CO 5, CO 6	T2-8.3

Course Coordinator **HOD, CSE(AI & ML)**
Mr. S.Lakshmanachari, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA statement / Vital features (VF)	No. of VF's
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR). 1. Identify the need and problem specific constraints 2. Develop computer programs related to Algorithms for specific problem / project. 3. Develop data centric applications using the concepts of Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking. 4. Design and analyze algorithms for problems. 5. Use data structures for developing solutions. 6. Apply appropriate algorithms for data processing.	**6**
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems. 1. Design and develop software applications with a focus on high security and reliability. 2. Design and develop information retrieval systems for specific applications.	**2**
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas. 1. Identify the technical skills and Knowledge on advanced frameworks and platforms necessary for engineering practice and higher studies. 2. Extend the knowledge to become an entrepreneur	**2**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering(AI&ML)**				
Course Title	**Human Computer Interaction (UI & UX)**				
Course Code	ACDC12				
Program	B.Tech				
Semester	VII				
Course Type	Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Mr.B.Mohan Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC06	V	Computer Networks

II COURSE OVERVIEW:

This course is an introduction to Human-Computer Interaction (HCI), a discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. The course considers the inherently multi- and interdisciplinary nature of HCI and situates various HCI issues in the organizational and societal contexts. It introduces theories of human psychology, principles of computer systems and user interfaces designs, a methodology of developing effective HCI for information systems, and issues involved in using technologies for different purposes. It is intended to give students an overview of the entire HCI field by covering most aspects of it. This course will thus provide a background for students to practice system design, selection, installation, evaluation, and use with the knowledge of human characteristics, interaction styles, use context, task characteristics, and design processes

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Human Computer Interaction (UI & UX	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
33.3%	Understand
66.6%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

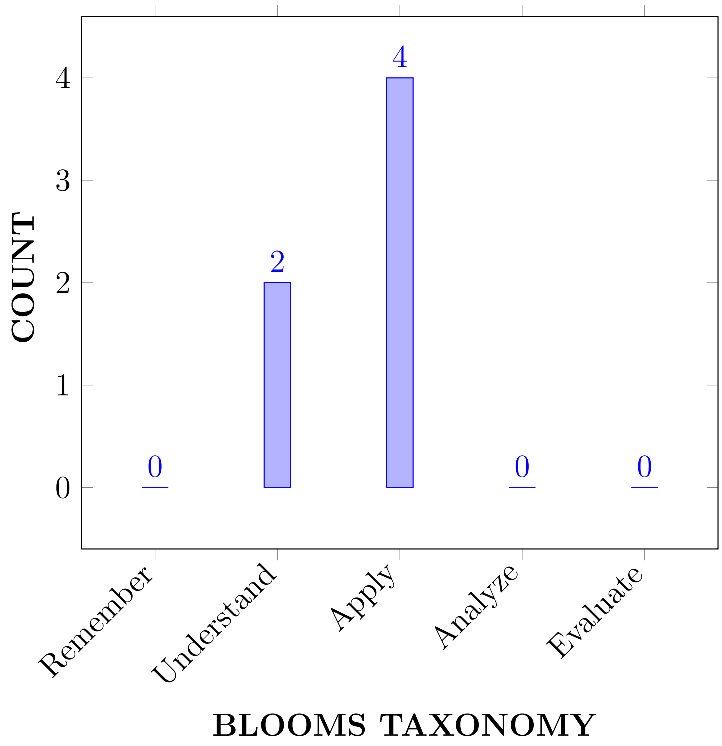
I	The essentials of designing interactive systems
II	The different techniques for designing interactive systems
III	The contexts for designing interactive systems
IV	The important aspects of implementation of human-computer interfaces
V	Identify the various tools and techniques for interface analysis, design, and evaluation

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the essentials of the design process and skills to develop the human-centered intractive systems	Understand
CO 2	**Identify** the design requirements to perform the evaluation process through participants and experts	Apply
CO 3	**Choose** the design guidelines and psychological principles to develop user interfaces	Apply
CO 4	**Construct** a conceptual basis to design HCI by considering internet sites usability, and user appreciation designs through case studies.	Apply
CO 5	**Compare** HCI designs to gain knowledge on user-centric interfaces while designing and developing collaborative applications.	Understand
CO 6	**Make use of** computing skills to design efficient interactive systems that align with human capabilities and needs.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	1	CIE/Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓		-
CO 2	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 3	-	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
CO 4	-	-	✓	✓	✓	-	-	-	-	-	-	-	✓	-	-
CO 5	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Throughout the design process, the application of mathematics, science, engineering fundamentals, and specialized engineering knowledge ensures that the resulting human-centered interactive system is not only user-friendly but also technically sound, reliable, and capable of solving complex engineering problems effectively.	2
	PO 2	Demonstrating the essentials of the design process and applying problem analysis while integrating first principles from mathematics, natural sciences, and engineering sciences, designers create human-centered interactive systems that go beyond aesthetics.	4
	PO 3	Integrating the essentials of the design process and skills to develop human-centered interactive systems with a focus on the design and development of solutions for complex engineering problems reflects a comprehensive and responsible approach to technology development.	3
	PO 4	Integrating investigations of complex problems with the design process for human-centered interactive systems ensures that the solutions are not only user-friendly but also well-founded in research-based knowledge.	6
	PO 5	This approach aligns with the dynamic nature of modern engineering, where the utilization of cutting-edge tools and techniques plays a pivotal role in addressing complex challenges and producing innovative solutions that enhance user experiences.	1
	PSO 1	Specialized areas often come with unique challenges. For example, in AI and ML, ensuring the transparency and interpretability of models is crucial. In AR/VR, providing seamless and immersive experiences is a challenge.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	Applying engineering knowledge, including mathematics, science, engineering fundamentals, and specialization, to the identification of design requirements and the execution of the evaluation process ensures a systematic, rigorous, and comprehensive assessment of the system.	2
	PO 2	Incorporating problem analysis and leveraging first principles from mathematics, natural sciences, and engineering sciences in the design requirements of the evaluation process ensures a robust and systematic approach.	4
	PO 3	Integrating design requirements that involve participants and experts in the evaluation process ensure that solutions for complex engineering problems are comprehensive, user- centered, safe, and socially responsible.	5
	PO 4	This approach aligns with the research-driven nature of problem- solving, where empirical evidence and expert insights guide the development of solutions that are not only theoretically sound but also practically viable in addressing intricate challenges.	3
	PSO 1	This validation is crucial in fields like AR/VR, where immersive experiences must be seamless and intuitive.	1
CO 3	PO 2	Incorporating these design guidelines and psychological principles into the development of user interfaces aligns with the principles of engineering problem-solving. By applying mathematical precision, scientific understanding, engineering fundamentals, and specialized knowledge,	5
	PO 3	Integrating design guidelines and psychological principles into the development of user interfaces align with the principles of responsible engineering.	4
	PO 5	This approach ensures that the solutions not only embrace technological advancements but also prioritize user experiences, psychological comfort, and ethical considerations. By combining these elements, designers create interfaces that stand at the forefront of innovation while remaining user-centered and ethically responsible.	1
	PSO 3	Incorporating these design guidelines and psychological principles, you create user interfaces that leverage the capabilities of AI and ML while prioritizing usability, efficiency, safety, adaptability, ethical considerations, and effective data presentation	1
CO 4	PO 3	Summary, a strong conceptual basis for designing HCI involves a deep understanding of usability, user appreciation, case studies,	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	Summary, a conceptual basis for designing HCI through internet site usability and user appreciation, supported by case studies and research-based methods, enables the investigation of complex problems and the development of valid, user-centered solutions..	5
	PO 5	A conceptual basis for designing HCI through internet site usability and user appreciation, while applying modern tool usage, ensures that designers have access to the right techniques, resources, and data-driven insights to create effective and engaging digital experiences..	1
	PSO 1	This approach ensures that software applications in AI, ML, Data Science, Web Development, Gaming, and AR/VR are user-centered, innovative, and effective in meeting the specific requirements of each specialized field.	1
CO 5	PO 1	Engineering knowledge helps in analyzing user feedback, identifying areas for improvement, and implementing updates that align with both user needs and technical constraints.	1
	PO 2	It allows you to identify, formulate, and address complex problems in a structured manner, leveraging the wealth of knowledge from HCI research while integrating first principles of mathematics, natural sciences, and engineering sciences to create user-centric and technically sound interfaces.	3
	PO 3	Comparing HCI designs in the context of designing and developing collaborative applications aligns with the process of creating solutions for complex engineering problems while considering public health, safety, cultural, societal, and environmental aspects	5
	PO 4	Conducting controlled experiments is a fundamental aspect of both HCI and engineering. By comparing HCI designs, you essentially create a natural experiment where you can observe how users interact with different interface elements,	3
	PSO 1	Comparing HCI designs is a powerful approach to gain knowledge on user-centric interfaces, especially when building software applications in specialized areas of computer science and engineering	1
CO 6	PO 1	This integrated approach ensures that the design process is rooted in both the art of effective user interaction and the science of engineering, leading to successful outcomes in the development of complex engineering solutions.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Formulate usability challenges, leverage HCI research, analyze complex engineering problems, and draw substantiated conclusions. This integrated approach ensures that the resulting systems are not only technically proficient but also user-centric, effectively addressing the complex challenges that arise in interactive system design.	3
	PO 3	It enables the creation of user-centric, safe, culturally aware, and environmentally responsible systems, contributing to effective solutions that address a wide range of considerations.	5
	PSO 3	Making use of computing skills to design efficient interactive systems with AI and ML techniques in industrial applications aligns with human capabilities and needs	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	4	3	6	1	-	-	-	-	-	-	-	1	-	-
CO 2	2	4	5	3	-	-	-	-	-	-	-	-	1	-	-
CO 3	-	3	4	-	1	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	4	5	1	-	-	-	-	-	-	-	1	-	-
CO 5	1	3	5	3	-	-	-	-	-	-	-	-	1	-	-
CO 6	2	3	5	-	-	-	-	-	-	-	-	-	-	-	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66	40	30	54	100	-	-	-	-	-		-	11	-	-
CO 2	66	40	50	27	-	-	-	-	-	-	-	-	11	-	-
CO 3	-	100	40	-	100	-	-	-	-	-	-	-	-	-	16
CO 4	-	-	40	44	20	-	-	-	-	-	-	-	11	-	-
CO 5	33	30	50	27	-	-	-	-	-	-	-	-	11	-	-
CO 6	66	30	50	-	-	-	-	-	-	-	-	-	-	-	11

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	3	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO 3	-	3	2	-	1	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	2	2	1	-	-	-	-	-	-	-	1	-	-
CO 5	1	1	2	1	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	1	2	-	-	-	-	-	-	-	-	-	-	-	1
TOTAL	11	11	11	6	5	-	-	-	-	-	-	-	4	-	2
AVERAGE	1.8	1.8	1.8	1	0.8	-	-	-	-	-	-	-	0.6	-	0.3

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ESSENTIALS OF DESIGNING INTERACTIVE SYSTEMS (09)**
	Designing interactive systems: a fusion of skills: The variety of interactive systems - The concerns of interactive systems design-Being digital-The skills of the interactive systems designer-Why being human-centered is important; The process of human-centered interactive systems design: Introduction-Developing personas and scenarios- Using scenarios throughout design - A scenario-based design method.
MODULE II	**TECHNIQUES FOR DESIGNING INTERACTIVE SYSTEMS (09)**
	Understanding: Understanding requirements- Participative design-Interviews- Questionnaires- Probes- Card sorting techniques-Working with groups - Fieldwork: observing activities in situ - Artefact collection and 'desk work'; Envisionment: Finding suitable representations- Basic techniques-Prototypes- Envisionment in practice; Design Introduction-Conceptual design- Metaphors in design- Conceptual design using scenarios - Physical design Designing interactions; Evaluation Introduction -Expert evaluation -Participant-based evaluation - Evaluation in practice -Evaluation: further issues.

MODULE III	**VISUAL INTERFACE DESIGN, MULTIMODAL INTERFACE DESIGN (09)**
	Visual interface design: Introduction, Graphical user interfaces, interface design guidelines, psychological principles and interface design, information design, visualization. Multimodal interface design: Introduction, interacting in mixed reality, using sound at the interface, tangible interaction, gestural interaction and surface computing
MODULE IV	**CONTEXTS FOR DESIGNING INTERACTIVE SYSTEMS (09)**
	Designing websites 3io: Introduction, website development, the information architecture of websites, navigation design for websites; Case study: designing the Robert Louis Stevenson website; Social media: Introduction, background ideas, Social networking, Sharing with others, the developing web; Collaborative environments: Introduction, issues for cooperative working, technologies to support cooperative working, collaborative virtual environments; Case study: Developing a collaborative tabletop application.
MODULE V	**UBIQUITOUS COMPUTING, MOBILE COMPUTING, WEARABLE COMPUTING (09)**
	Ubiquitous computing: Information spaces, blended spaces, home environments, navigating in wireless sensor networks; Mobile computing: Introduction, context awareness, understanding in mobile computing, designing for mobiles, evaluation for mobile computing; Wearable computing Introduction: Smart materials,material design, from materials to implants.

TEXTBOOKS

1. David R. Benyon, "Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design", Pearson; 3rd Edition, 2013

2. James Cabrera, "Modular Design Frameworks: A Projects-based Guide for UI/UX Designers", Apress, 1 st Edition, 2017.

3. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004.

REFERENCE BOOKS:

1. Ben Schneiderman, "Designing the User Interface", Pearson Education Asia, 3rd Edition, 2013.

2. Prece, Rogers, Sharps, "Interaction Design", Wiley Dreamtech

3. SorenLauesen, "User Interface Design", Pearson Education.

4. D. R. Olsen, "Human –Computer Interaction", Cengage Learning.

5. Smith –Atakan, "Human –Computer Interaction", Cengage Learning.

WEB REFERENCES:

1. http://staff.fit.ac.cy/com.ph/vp/VP Lecture 2.pdf

2. https://fac.ksu.edu.sa/nmalmobarak/course/41031

3. https://www.tutorialspoint.com/human computer interface/quick guide.htm

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Designing interactive systems a fusion of skills	CO1	T1: 1.1
2	The variety of interactive systems	CO1	T1: 1.2
3	The concerns of interactive systems	CO1	T1: 1.3
4	design-Being digital-The skills of the interactive systems	CO1	T1:1.4
5	designer-Why being human-centered is important	CO1	T1: 1.5
6	The process of human-centered interactive systems design	CO1	T1:7.1
7	Introduction- Developing personas and scenarios-Using scenarios throughout design	CO1	T1: 2.14
8	A scenario-based design method.	CO1	T1: 8.3
9	Understanding requirements Participative design	CO2	T1: 8.2
10	Interviews- Questionnaires- Probes Card sorting techniques-Working with groups - Fieldwork	CO2	T1: 10.0
11	observing activities in situ Artefact collection and 'desk work'	CO2	T1: 10.1
12	Envisionment: Finding suitable representations	CO2	T1: 10.1
13	Basic techniques- Prototypes- Envisionment in practice	CO2	T1: 10.2
14	Design Introduction-Conceptual design Metaphors in design	CO2	T1: 10.2
15	Conceptual design using scenarios Physical design	CO2	T1: 11.1
16	Designing interactions Evaluation Introduction -Expert evaluation	CO2	T1: 11.2
17	Expert evaluation -Participant-based evaluation	CO2	T1: 11.3
18	Evaluation in practice Evaluation: further issues	CO2	T1:15.3
19	Visual interface design: Introduction Graphical user interface	CO3	T1:19.1
20	interface design guideline	CO3	T1: T1:19.1
21	psychological principles and interface design, information design, visualization	CO3	T1:19.1
22	Multimodal interface design: Introduction, interacting in mixed reality	CO3	T1:19.1
23	tangible interaction gestural interaction and surface computing	CO3	T1:19.1
24	Designing websites 3io: Introduction website development	CO4	T1:19.1
25	the information architecture of websites, navigation design for websites	CO4	T1:23.0
26	Case study: designing the Robert Louis Stevenson website	CO4	T1:23.1
27	Social media: Introduction, background ideas	CO4	T1:23.2

28	Social networking, Sharing with others, the developing web	CO4	T1:23.3
29	Collaborative environments: Introduction issues for cooperative working	CO4	T1:23.3
30	technologies to support cooperative working	CO4	T1:23.3
31	collaborative virtual environments	CO4	T1:25.1
32	Case study: Developing a collaborative tabletop application	CO4	T1:25.1
33	Ubiquitous computing: Information spaces, blended spaces,	CO5	T1:25.2
34	home environments, navigating in wireless sensor networks	CO5	T1:25.2
35	Mobile computing: Introduction, context awareness	CO5	T1:25.2
36	understanding in mobile computing	CO5	T1:25.3
37	designing for mobiles	CO5	T1:25.4
38	evaluation for mobile computing	CO5	T1:25.5
39	Wearable computing Introduction	CO5	T1:25.6
40	Smart materials,material design, from materials to implants.	CO5	T1:25.7
PROBLEM SOLVING/ CASE STUDIES			
41	Google Maps' Turn-by-turn Navigation: Google Maps offers a user-friendly turn-by-turn navigation system with real-time traffic updates. Its clear and simple interface provides users with easy-to-follow directions, helping them reach their destinations efficiently.	CO 6	T2:18
42	Facebook's News Feed: Facebook's News Feed algorithm is designed to display relevant content based on users' interests and interactions. By personalizing the user experience, Facebook keeps its users engaged and encourages them to spend more time on the platform.	CO6	T2:18
43	Duolingo Language Learning App: Duolingo's language learning app employs gamification techniques, interactive exercises, and progress tracking to make language learning fun and engaging for users.	CO6	T2:18
44	Waze Community-based Traffic App: Waze uses crowdsourced data from its community of drivers to provide real-time traffic and navigation information. Users can actively contribute to the app by reporting accidents, hazards, and road closures, creating a cooperative user experience.	CO6	T2:24
45	Fitbit Fitness Trackers: Fitbit's wearable devices offer a straightforward and accessible interface for tracking health and fitness metrics. Users can easily monitor their steps, heart rate, sleep patterns, and other health-related data through the device and the accompanying mobile app.	CO6	T2:25
46	WhatsApp's Chat Interface: WhatsApp's simple and intuitive chat interface allows users to send text messages, voice messages, images, and videos effortlessly. Its popularity is due in part to the seamless user experience it offers.	CO6	T2:25.23

47	Adobe Photoshop's User Interface Evolution: Adobe Photoshop, a powerful image editing software, has undergone significant UI improvements over the years to cater to user needs better. Through iterative design updates, Adobe has made the software more accessible to both beginners and experienced professionals.	CO6	T2:25.23.1
48	Uber's Ride-hailing App: Uber's app provides a user-friendly interface for booking rides, tracking drivers, and processing payments. The intuitive design has played a vital role in the success and global adoption of the ride-hailing service.	CO6	T2:25.23.2
49	Netflix's Personalized Content Recommendations: Netflix's recommendation system uses machine learning algorithms to suggest content based on users' viewing history and preferences. This personalized approach enhances user engagement and retention on the platform.	CO6	T2:28.23.6
10	Microsoft Office Suite's Ribbon UI: Microsoft redesigned its Office Suite with the introduction of the Ribbon UI. This change made it easier for users to access and utilize various features, leading to better productivity and a more streamlined experience	CO6	T2:28.24.3
51	Spotify's Music Discovery Features: Spotify's music streaming platform employs personalized playlists, curated content, and machine learning to recommend songs and artists that align with users' music tastes, promoting longer user engagement.	CO6	T2:28.23.7
52	Airbnb's User Reviews and Ratings: Airbnb's user review system helps build trust and transparency between hosts and guests. The platform's focus on user feedback enables users to make informed decisions when booking accommodations.	CO6	T2:29.2.56
53	Google Assistant's Voice Interaction: Google Assistant's natural language processing capabilities enable users to interact with their devices through voice commands, simplifying tasks and providing a more hands-free experience.	CO6	T2:29.2.59
54	Pinterest's Visual Discovery: Pinterest's visual search feature allows users to find content by simply uploading an image. This visual discovery mechanism enhances the user experience and helps users discover new ideas and inspiration.	CO6	T2:30.3.32
55	Microsoft Windows 10's Touch-friendly Interface: With Windows 10, Microsoft introduced a touch-friendly interface that adapts to different devices, providing a consistent and seamless user experience across PCs, tablets, and smartphones. These case studies demonstrate the diverse applications of HCI principles in designing products and services that prioritize user needs, preferences, and expectations. User-centered design remains a crucial factor in creating successful and impactful digital experiences.	CO6	T2:30.3.61
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Essentials of designing interactive systems	CO 1	T2:2.1

57	Techniques for designing interactive systems	CO 2	T2:2.3
58	Visual interface design multimodal interface design	CO 3	T2:2.3.1
59	Contexts for designing interactive systems	CO 4	T2:7.2,7.3
60	Ubiquitous Computing ,mobile computing wearable computing	CO 5	T2:10.3.1
DISCUSSION OF QUESTION BANK			
61	List and explain the key principles of user-centered design in the context of interactive system design.	CO 1	R4:2.1
62	Implement responsive design techniques to ensure a consistent user experience across various devices.	CO 2	T4:7.3
63	Compare and contrast single-mode interfaces and multimodal interfaces in terms of user engagement and efficiency.	CO 3	R4:5.1
64	Apply context-aware design techniques to tailor an interactive system's interface based on user preferences and environmental conditions.	CO 4	T1:7.5
65	Critique the effectiveness of a ubiquitous computing system in providing seamless user experiences.	CO 5,6	T1: 4.1

Signature of Course Coordinator **HOD,CSE(AI&ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING (AI & ML)**				
Course Title	**VIRTUAL REALITY**				
Course Code	ACDC11				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Mr.K.Subba shankar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

This course will introduce you to Virtual Reality (VR). The course will teach you everything from the basics of VR the hardware and the history of VR- to different applications of VR, the psychology of Virtual Reality, and the challenges of the medium. The main objective of the course is to teach evaluation existing VR applications, and design, test, and implement their own VR experiences/games. This course reaches to student by power point presentations, lecture notes, and lab which will give you the chance to apply knowledge of Virtual Reality.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Virtual Reality	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	White Board	✓	Tech Talks	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Concep Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage

in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
50 %	Remember
16.66%	Understand
33.33%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

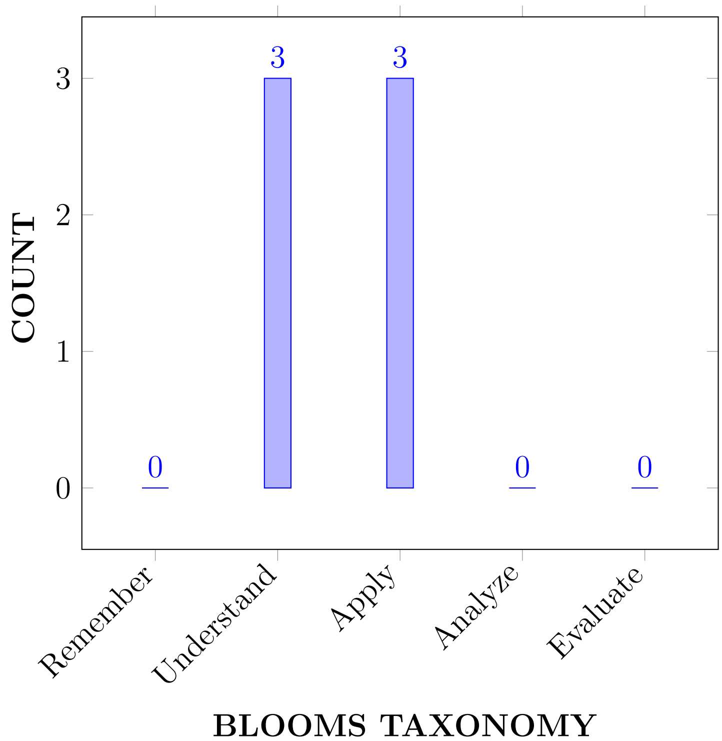
I	Basic concepts of virtual environment and compelling virtual reality experience. .
II	Fundamental issues of virtual reality.
III	Human Factors, Virtual Hardware and Software related to Virtual Reality.
IV	Applications of Virtual Reality.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the concepts of virtual systems and computer graphics in a multidimensional environment for the benefits of virtual reality .	Understanding
CO 2	**Interpret** the geometric modeling from 2D to 3D space curves for the transformation of a virtual environment .	Understanding
CO 3	**Demonstrate** the computer environment and virtual reality technology for collision detection of the generic system .	Understanding
CO 4	**Acquire** the concept of virtual environments and physical simulations for obtaining dynamically animated environments in many areas like Elastic collisions.	Apply
CO 5	**Make use of** the virtual reality hardware and software including sensors to integrate the system modelling, simulation, and tool kits.	Apply
CO 6	**Evaluate** the VR applications for various application domains for future purposes.of virtual environment	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	CIE/Quiz/AAT
PO 8	**Ethics:** : Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	CIE/Quiz/AAT
PO 9	**Individual and team work:** : Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	CIE/Quiz/AAT
PO 10	**Communication:** :Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	CIE/Quiz/AAT
PO 11	**Project management and finance:** :Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	CIE/Quiz/AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change..	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR)..	3	CIE /Quiz /AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems..	2	CIE /Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2	CIE /Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	-
CO 2	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
CO 3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-
CO 4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	✓
CO 5	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	-	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	-	-	-	✓	-	-	✓	✓	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	virtual systems **combined with advanced computer graphics in a multidimensional environment** offer immense benefits for knowledge acquisition, experiential learning, and engineering applications..	2
	PO 2	The integration of virtual systems and advanced computer graphics into **problem analysis through virtual reality**offers a powerful toolkit for understanding, dissecting, and solving complex challenges..	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	integrating virtual systems and computer graphics in a **multidimensional environment provides numerous benefits** for the design and development of solutions in virtual reality	1
	PSO 1	understanding and applying the concepts of **virtual systems and computer graphics in a multidimensional environment are fundamental** for creating compelling virtual reality experiences.	2
	PSO 2	the integration of virtual systems and computer graphics with machine learning techniques offers exciting possibilities in the realm of virtual reality.	2
CO2	PO 1	transitioning from 2D to 3D space curves in a **virtual environment enhances engineering knowledge** by providing a more comprehensive and accurate representation of objects, structures, and designs.	2
	PO 2	the transition from 2D to 3D geometric modeling using **space curves in a virtual environment greatly enhances problem analysis**	3
	PO 3	transitioning from 2D to 3D geometric modeling using **space curves within a virtual environment revolutionizes the design and development of solutions.**	2
	PO 4	transitioning from 2D to 3D geometric modeling using space curves **in a virtual environment significantly enhances** the investigation of complex problems	2
	PSO1	the application of geometric modeling from 2D to 3D space curves has far-reaching **implications across specialized areas of Computer Science and Engineering.**	2
	PSO2	the concept of geometric modeling from 2D to 3D space **curves plays a crucial role in creating dynamic and realistic virtual environments.**	2
CO 3	PO1	the combination of **computer modeling, virtual reality technology, and collision detection algorithms provides engineers with a powerful tool to visualize, simulate,**and optimize complex engineering systems before they are physically built.	3
	PO2	In this problem analysis **scenario, computer modeling, VR technology, and collision detection algorithms work together to simulate and analyze**the behavior of an automated warehouse system	3
	PO3	the combination of computer environments and virtual reality technology offers a **powerful platform for collision detection in the design and development** of solutions.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO4	utilizing computer environments and virtual reality technology **for investigating complex problems with collision detection**enhances problem-solving capabilities.	2
	PO5	utilizing computer environments, **3D modeling, and virtual reality technology in modern tools provides** an effective way to demonstrate collision detection concepts.	1
	PSO1	demonstrating collision detection using virtual reality **technology showcases the practicality and importance**	3
	PSO2	applying supervised, unsupervised, and reinforcement learning to collision detection within **a computer environment and VR technology offers practical solutions to AI problems across various domains.**	2
CO 4	PO1	combining virtual environments and physical simulations offers **a powerful educational tool for understanding complex engineering concepts** like elastic collisions.	2
	PO2	combining virtual environments and physical simulations offers **a robust approach to problem analysis, particularly when examining complex phenomena** like elastic collisions.	2
	PO3	leveraging virtual environments and physical simulations in **the design and development process enhances understanding, optimization, and validation of** solutions involving elastic collisions.	2
	PO 4	using virtual environments and physical simulations in **conducting investigations of complex problems, particularly**those involving elastic collisions, offers a powerful toolset. ,	2
	PO 5	leveraging virtual environments and physical simulations **using modern tools enhances the comprehension**of elastic collisions.	1
	PS01	Understanding virtual environments, physical simulations, and concepts **like elastic collisions is essential** in various fields of Computer Science and Engineering.	3
	PSO 2	The understanding of virtual environments, physical simulations, and concepts **like elastic collisions is pivotal across several domains.**	3
	PSO3	the concepts of virtual environments, physical simulations, and elastic collisions with **AI and ML techniques offers a powerful toolkit** for addressing industrial challenges.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO1	integrating virtual reality **hardware, software, and sensors into system modeling, simulation, and toolkits** offers a transformative approach to engineering knowledge.	3
	PO2	the integration of virtual reality **hardware, software, and sensors into the problem analysis process enhances understanding, collaboration, and experimentation.**	2
	PO3	integrating virtual reality **hardware, software, and sensors into the design** and development process enhances visualization, collaboration, and experimentation.	2
	PO4	integrating virtual reality hardware, software, and sensors into **the process of conducting investigations of complex problems** enhances analysis, collaboration, and experimentation.	2
	PO 5	integrating virtual reality **hardware, software, and sensors into modern tool usage** enhances visualization, collaboration, and experimentation.	1
	PO8	VR technology might not directly address **ethical principles, it can be harnessed to create** immersive ethical scenarios and discussions.	1
	PO9	integrating virtual reality **hardware, software, and sensors into individual and teamwork scenarios enhances skill development, collaboration, and experiential learning.**	1
	PO10	integrating virtual reality **hardware, software, and sensors into communication scenarios enhances** engagement, visualization, and interaction.	1
	PO11	integrating virtual reality hardware, software, and sensors **into project management and finance enhances visualization, collaboration, and informed decision-making.**	1
	PSO1	The integration of virtual reality **hardware, software, and sensors opens new avenues for system modeling, simulation, and skill development** across various specialized areas.	3
	PSO2	By harnessing virtual reality **hardware, software, and sensors, developers can integrate system modeling, simulation, and toolkits in innovative ways.**	2
	PSO3	By integrating virtual reality **hardware, software, sensors, and AI/ML techniques, developers can create powerful solutions for complex industrial challenges.**	1
CO 6	PO1	VR applications hold immense promise for **the future of engineering knowledge across various domains.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO2	VR applications in problem analysis hold **immense potential for future purposes across various domains.**	5
	PO 3	VR applications in the design and development of solutions have **the potential to reshape industries by** providing immersive and collaborative design experiences.	3
	PO 4	VR applications in conducting investigations of **complex problems hold immense potential for** enhancing problem analysis and solution discovery across diverse domains	3
	PO5	VR applications for modern tool usage offer **innovative ways to enhance productivity, learning, collaboration, and decision-making across diverse domains.**	1
	PO9	VR applications for individual and teamwork offer **transformative opportunities** transformative opportunities	2
	PO 12	VR applications in lifelong learning offer **transformative possibilities** across various domains.	2
	PSO 1	virtual reality has vast potential across various domains, enhancing user **experiences, training effectiveness, and creativity.**	2
	PSO3	the integration of VR applications with AI and ML **techniques in industrial areas holds immense potential for innovation and advancement.**	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	3	2	1	-	-	-	-	-	-	-	-		2	2	-
CO 2	2	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO 3	3	3	3	2	1	-	-	-	-	-	-	-	3	2	-
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	3	3	1
CO 5	3	2	2	2	1	-	-	1	1	1	1	-	3	2	1
CO 6	2	5	3	3	1	-	-	-	2	-	-	2	2	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	100	20	10	-	-	-	-	-	-	-	-		22	50	-
CO 2	66	30	20	18	-	-	-	-	-	-	-	-	22	50	-
CO 3	100	30	30	18	-	-	-	-	-	-	-	-	33	50	-
CO 4	66	20	20	18	100	-	-	-	-	-	-	-	33	75	16
CO 5	100	20	20	18	100	-	-	33	8	20	8	-	33	50	16
CO 6	66	50	30	27	100	-	-	-	16	-	-	25	22	-	33

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	9	4	6
CO 1	3	1	1	-	-	-	-	-	-	-	-	-	1	2	
CO 2	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO 3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO 4	3	1	1	1	3	-	-	-	-	-	-	-	1	3	1
CO 5	3	1	1	1	3	-	-	1	1	1	1	-	1	2	1
CO 6	3	2	1	1	3	-	-	-	2	-	-	1	1	-	1
TOTAL	18	7	6	5	9	0	0	1	3	1	1	1	6	11	3
AVERAGE	3	1.1	1	0.8	1.5	0.0	0.0	0.1	0.5	0.1	0.1	0.1	1	1.8	0.5

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO VIRTUAL REALITY**
	Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.
MODULE II	**GEOMETRIC MODELLING**
	Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE. Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.
MODULE III	**VIRTUAL ENVIRONMENT**
	Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.
MODULE IV	**VR HARDWARE AND SOFTWARE**
	Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML
MODULE V	**VR APPLICATIONS**
	Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction.

TEXTBOOKS

1. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007 Edition

REFERENCE BOOKS:

1. Anand R., “Augmented and Virtual Reality”, Khanna Publishing House, Delhi.
2. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
3. Grigore C. Burdea, Philippe Coiffet , “Virtual Reality Technology”, Wiley Inter Science, 2nd Edition, 2006.
4. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality: Interface, Application and Design”, Morgan Kaufmann, 2008.

WEB REFERENCES:

1. http://www.vrac.iastate.edu/

COURSE WEB PAGE:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re
3. http://www.nltk.org/
4. http://www.nlp.stanford.edu/
5. http://www.textrazor.com

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be Covered	CO's	Reference
OBE DISCUSSION			
Discussion on Subject CO-PO Mapping			
CONTENT DELIVERY (THEORY)			
1	Introduction to Virtual Reality	CO1	T2: 1
2	Computer graphics	CO1	T2: 1
3	Real time computer graphics	CO1	T2: 2-6
4	Flight Simulation, Virtual environment requirement	CO1	T2: 2-6
5	Benefits of virtual reality, Historical development of VR	CO1	R2:-21-22
6	Scientific Landmark 3D Computer Graphics: Introduction	CO1	R2:-21-22
7	The Virtual world space, positioning the virtual observer, the perspective projection	CO1	T2:3
8	human vision, stereo perspective projection, 3D clipping, Colour theory	CO1	R2:33-37
9	Simple 3D modelling, Illumination models, Reflection models	CO1	R2:43
10	Shading algorithms, Radiosity, Hidden Surface Removal	CO1	R2:43
11	Realism-Stereographic image.	CO1	R2:43
12	Geometric Modelling: Introduction, From 2D to 3D, 3D space curves	CO2	T1: 21
13	3D boundary representation Geometrical Transformations: Introduction	CO2	T1: 191
14	Frames of reference, Modelling transformations	CO2	T1: 191
15	Instances, Picking, Flying, Scaling the VE	CO2	T1: 191
16	Collision detection Generic VR system: Introduction,	CO2	R2:123-126
17	Virtual environment, Computer environment	CO2	R2:123-126
18	VR technology, Model of interaction, VR Systems.	CO2	R2:123-126
19	Model of interaction, VR Systems.	CO2	T1:423-424
20	Animating the Virtual Environment: Introduction & Transducer, N-grams.	CO3	T1:423-424
21	The dynamics of numbers, Linear and Nonlinear interpolation	CO3	T1:427

22	The animation of objects, linear and non-linear translation,	CO3	T1:62-69
23	Shape and object in between, free from deformation	CO3	T1:62-69
24	particle system.	CO3	T1:143-145
25	Physical Simulation: Introduction, Objects falling in a gravitational field	CO3	T1:144-145
26	Rotating wheels, Elastic collisions,	CO3	T1:149,157
27	projectiles, simple pendulum,	CO3	T1:149,157
28	springs, Flight dynamics of an aircraft.	CO3	T1:149,157
29	VR Hardware and Software	CO4	T1:113-120,286
30	Human factors: Introduction, the eye, the ear, the somatic senses.	CO4	T1:113-120,286
31	VR Hardware: Introduction	CO4	T1:113-120,286
32	sensor hardware, Head-coupled displays,	CO4	T1:113-120,286
33	Acoustic hardware, Integrated VR systems.	CO4	T1:233-245
34	VR Software: Introduction, Modelling virtual world,	CO4	T1:233-245
35	Physical simulation,	CO4	T1:233-245
36	VR toolkits,	CO4	T1:233-245
37	Introduction to VRML	CO4	T1:309-313
38	VR Applications	CO5	T1:309-313
39	VR Applications Introduction	CO5	T1:168-170
40	Engineering,	CO5	T1:171-176
41	Entertainment	CO5	T1:171-176
42	Science	CO5	T1:171-176
43	Training	CO5	T1:171-176
44	The Future: Virtual environment,	CO5	T1:171-176
45	Modes of interaction	CO5	T1:171-176
PROBLEM SOLVING/ CASE STUDIES			
46	Virtual reality can be used to train medical professionals, especially surgeons, in a safe and controlled environment. Surgeons can practice procedures in VR simulations before performing them on real patients. This helps improve their skills and reduces the risk of errors. Additionally, VR can be used for medical visualization, allowing doctors to explore 3D models of organs and anomalies, aiding in diagnosis and treatment planning.	CO 6	T1:43
47	Architects and urban planners use VR to create immersive walkthroughs of their designs. This allows stakeholders to experience and provide feedback on a virtual representation of a building or an entire city before construction. Case studies could examine how VR improves design accuracy, reduces errors, and enhances client engagement..	CO 6	T1:43

48	VR exposure therapy has been effective in treating various phobias and anxiety disorders. Individuals can confront their fears in a controlled virtual environment, gradually reducing their anxiety over time. Case studies might investigate the success rates of VR therapy compared to traditional methods.	CO 6	T1:43
49	Remote Collaboration and Communication: VR enables remote teams to collaborate as if they were in the same room. Virtual meeting spaces and whiteboards allow real-time interactions, fostering creativity and problem-solving. Case studies could explore the impact of VR on remote team productivity and communication.	CO 6	T1:84
50	Disaster Preparedness and Response: VR can simulate disaster scenarios to train emergency responders and decision-makers. These simulations help them practice coordination, communication, and decision-making during crisis situations. Case studies may analyze the effectiveness of VR simulations in improving response times and outcomes.	CO 6	T1:85
51	Automotive and Aerospace Engineering: Engineers use VR to visualize and analyze complex mechanical systems, test vehicle prototypes, and simulate crash scenarios. This aids in identifying potential issues early in the design process. Case studies might evaluate how VR reduces development time and costs in these industries.	CO6	T1:107
52	Historical and Cultural Preservation: VR allows users to explore historical sites and cultural heritage sites virtually. This can aid in preservation efforts by providing immersive experiences for education and tourism. Case studies could focus on the impact of VR on cultural awareness and heritage conservation.	CO 6	T1:43
53	Training for Dangerous Professions: VR is used to train individuals in hazardous professions, such as firefighting, mining, and military operations. Trainees can practice dangerous scenarios without real-world risks. Case studies may assess the effectiveness of VR training in improving safety and performance.	CO 6	T1:44
54	Education and Classroom Learning: VR has the potential to revolutionize education by creating interactive and engaging learning experiences. Case studies could investigate how VR enhances student engagement, knowledge retention, and overall learning outcomes.	CO 6	T1:19
55	Environmental Conservation and Planning: VR can simulate the effects of various environmental changes and urban planning decisions. This aids in making informed decisions about land use, resource management, and conservation efforts. Case studies might analyze how VR influences sustainable development practices.	CO 6	T1:18
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Introduction To Virtual Reality	CO 1	T1:1-13
57	Geometric Modelling	CO 2	T1:21-41

68	Virtual Environment	CO 3	T1:47-69
59	VR Hardware And Software	CO 4	T1:86-123
60	VR Applications	CO 5	T1:125-158
DISCUSSION OF QUESTION BANK			
61	Definitions and terminology discussion on Virtual Reality and Virtual Environment	CO 1	T1:1-13
62	Definitions and terminology disscussion on Geometric Modelling	CO 2	T1:21-41
63	Definitions and terminology discussion on Animating the Virtual Environment	CO 3	T1:47-69
64	Definitions and terminology discussion on Physical Simulation.	CO 4	T1:86-123
65	Definitions and terminology discussion on Human factors and VR applications	CO 5	T1:125-158

Signature of Course Coordinator **HOD,CSE(AI & ML)**
Mr.K.Subba shankar, Assistant Professor.

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI&ML)**				
Course Title	**VIRTUAL REALITY LABORATORY**				
Course Code	ACDC16				
Program	B.Tech				
Semester	VII	CSE(AI & ML)			
Course Type	Core				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	0	0	0	3	1.5
Course Coordinator	Ms.T.Manasa, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC04	II	Programming for problem solving using C laboratory

II COURSE OVERVIEW:

The objective of this course is to explore the concepts of Virtual reality , develop 3D virtual environment and understand the physical principles of VR.
Designed for new users, this course introduces you to the basics, hardware, history, applications and the challenges of Virtual Reality.
Introducing to everything from the basics of VR- the hardware, applications of VR, and the challenges of the medium.
A learner with no previous experience in Virtual Reality , game programming will be able to evaluate existing VR applications, and design, test, and implement their own VR experiences/games using Unity by the end of the specialisation.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Virtual Reality Laboratory	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Questions

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

	Experiment Based	**Programming based**
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		**Total Marks**
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
-	-	-	-	-	-

2. **Programming Based**

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	To describe how VR systems work and list the applications of VR.
II	To use Unity to create a smooth, powerful VR application.
III	To find, study, and create software that reflects the fundamental methods used in the creation and implementation of VR experiences.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** how modern VR handset "trick the brain" into believing it is somewhere else. In addintion, create a 3D VR project targetting a device as simple as iOS/Android cardboard.	Apply
CO 2	**Construct** interactive VR game plays with advanced unity features, including Ray casting and Navigation(Path finding).	Apply
CO 3	**Extend** how to add support for Game controllers and Cardboard "Screantouch" button. Students will be use unity remote to test things in the editor.	Understand
CO 4	**Explain** take advantge of unity 3 events to trigger actions an interactive objects , including loading scenes. Students will be able to create interactive head's up 3D user interfaces.	Understand
CO 5	**Make use of** VR supported hardware like oculas Rift and HTC Vive. Create an environment and setup game mode how it works with unreal engine4. Lern to build beautifull virtual reality experiences.	Apply
CO 6	**Build** a game in unreal engine-virtual realitu space shooten game combined with real time strategy with study focus on cooperation and coordination among the team members during game-play.	Apply

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/ CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/ CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE/ CIE / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	SEE/ CIE / AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	SEE/ CIE / AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	SEE/ CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	SEE/ CIE / AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	SEE/ CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	3	SEE/ CIE / AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	✓	✓	-	-	-	-	-	✓	✓	-	-
CO 2	✓	-	-	-	✓	✓	-	-	-	✓	-	✓	✓	-	-
CO 3	✓	✓	-	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	-	-	✓	-	-	-	-	✓	-	✓	✓	-	-
CO 5	✓	-	✓	✓	✓	-	-	-	-	-	-	✓	✓	-	
CO 6	-	-	-	✓	✓	-	-	-		✓	-	✓	✓	-	-

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

Week-1	**Setup VR Environment**
	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
Week-2	**VR View**
	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
Week-3	**GREEDY METHOD AND DYNAMIC PROGRAMMING**
	Develop a scene in Unity that includes: i. A cube, plane, and sphere, apply transformations on the 3 game objects. ii. Add a video and audio source.
Week-4	**Working with game objects**
	Develop a scene in Unity that includes a cube, plane, and sphere. ii. Create a new material and texture separately for three Game objects. iii. Change the color, material, and texture of each Game object separately in the scene. iv. Write a Csharp program in visual studio to change the color and material/texture of the game objects dynamically on button click.
Week-5	**VR Controller**
	i. Develop a scene in Unity that includes a sphere and plane. Apply Rigid body component, material, and Box collider to the game Objects. ii. Write a Csharp program to grab and throw the sphere using VR controller.
Week-6	**VR User Interface**
	Develop a simple UI (User interface) menu with images, canvas, sprites, and button. ii. Write a Csharp program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene.
Week-7	**VR 3D Models**
	Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models
Week-8	**Animation**
	Include animation and interaction in the immersive environment created in Week 7.
Week-9	**VR Application**
	Create a virtual environment for any use case. The application must include at least 4 scenes which can be changed dynamically, a good UI, animation and interaction with game objects. (e.g. VR application to visit a zoo).
Week-10	**Creating Unity Script**
	Working with unity script i. Creating and assigning scripts ii. Adding Code
Week-11	**Post Processing Rendering-I**
	kode80SSR - screen-space reflections. KinoObscurance - screen-space ambient obscurance. PixelRenderUnity3D - pixelized rendering. PixelCamera2D - pixel-perfect rendering. KinoMotion - motion blur using motion vectors. KinoContour - edge detection. KinoGlitch - glitch effect.

Week-12	**Post Processing Rendering-II**
	KinoBloom - bloom. KinoBokeh - bokeh effect. KinoVision - frame information visualizer. Unity5Effects - post-processing collection. LightShafts - light shafts. SonarFx - wave patterns. Cinematic Image Effects - cinematic image effects

TEXT BOOKS:

1. Todd Brinkman, "Virtual Reality for Main Street A Beginner's Guide to Unleashing Human Connections".

2. J. Davidso, "Oculus Rift (For Beginners)".

3. Dr. Edward Lavieri, "Getting Started with Unity 2018, Third Edition: A Beginner's Guide to 2D and 3D game development with Unity".

REFFERENCE BOOKS:

1. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.

2. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.

3. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.

4. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

WEB REFERENCE:

1. http://www.vrac.iastate.edu/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Setup VR Environment	CO1,CO2	T20, T21,T22
2	VR View	CO1,CO2	T60, T61,T62
3	Working with Objects	CO2,CO3	T101
4	Working with game objects	CO2,CO3	T150,T152
5	VR Controller	CO3,CO5	T160,T165
6	VR User Interface	CO5,CO6	T205
7	VR 3D Models	CO6	T210
8	Animation	CO4, CO5,CO6	T250,T251
9	VR Application	CO1,CO3, CO4,CO6	TT252,T253
10	Creating Unity scripts	CO3, CO4,CO6	T260,T261
11	Post-Processing AND Rendering-I	CO4, CO5,CO6	T265, T266,T267
12	Post-Processing and Rendering-II	CO4, CO5,CO6	T270

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR.
2	Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates
3	Side effects of using VR systems/ VR sickness.

Course Coordinator **HOD**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

COMPUTER SCIENCE AND ENGINEERING (AI & ML)

Course Title	**Deep Neural Networks Laboratory**				
Course Code	ACAC25				
Program	B.Tech				
Semester	VII	CSE(AI&ML)			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	0	0	0	3	1.5
Course Coordinator	Dr. M.Nagaraju, Assistant Professor CSE(AI&ML)				

I COURSE PRE-REQUISITES:

Level	**Course Code**	**Semester**	**Prerequisites**
B.Tech	ACSC01	I	Python Programming

II COURSE OVERVIEW:

This course will introduce students will get practical implementations of various deep learning models using Python and the PyTorch library. Recommended lectures are: Machine Learning, and basic courses on Linear Algebra, Analysis, Probability & Statistics. While it is not a hard requirement, basic knowledge of Python will be greatly helpful.

III MARKS DISTRIBUTION:

Subject	**SEE Examination**	**CIE Examination**	**Total Marks**
Deep Neural Networks Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	The theoretical foundations, algorithms and methodologies of Neural Network.
II	The design of single and multi-layer feed-forward deep networks and tune various hyper-parameters.
III	The provide the role of practical knowledge in handling and analyzing real world applications.
IV	To describe the role of neural networks in engineering, artificial intelligence, and cognitive modeling.

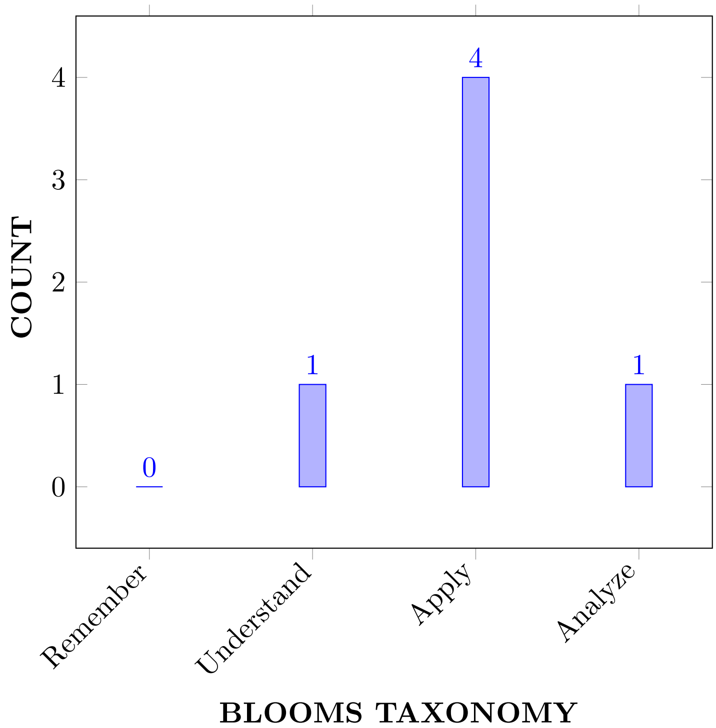
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Understand** the concepts of machine learning algorithms and deep neural networks for solving domain specific problems.	Understand
CO 2	**Select** the concept of multi-layer perceptron and use the regularization technique to prevent the problem of model overfitting.	Apply

CO 3	**Make use of** the activation functions and interpret how the performance of a CNN model varies during various classification tasks.	Apply
CO 4	**Develop** the auto encoders and decoders to reconstruct the initial data from noisy data and visualize the inputs with encoded representations.	Apply
CO 5	**Construct** a simple possible autoencoder and configure the model using different entropies and optimizers for dimensionality reduction.	Apply
CO 6	**Examine** the recurrent neural networks and analyze how they predict the next possible outcomes for a given input.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	2	Lab Exercises
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	1	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Courses Outcomes	Program Outcomes				Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	-	3	6	-	-	-	1
CO 2	2	2	1	-	2	-	1
CO 3	2	2	1	-1	1	-	1
CO 4	-	2	1	-	1	-	1
CO 5	-	2	1	-	2	-	2
CO 6	-	2	3	-	2	-	-

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**BUILDING A MACHINE LEARNING MODEL**
	1. Problem Statement: Understand the process of developing a machine learning model with different approaches of training. Learn how machine learning models can be used as a powerful tool used to perform complex problem solving efficiently. Make use of IRIS dataset for classification and Boston Housing dataset for regression. **Solutions Expected:** a. Contextualise machine learning. b. Explore the data and choose the type of algorithm. c. Prepare and clean the dataset. d. Split the prepared dataset and perform cross validation. e. Deploy the model.
WEEK 2	**BUILDING A MULTI-LAYER PERCEPTION**
	2. Problem Statement: Develop a multilayer perceptron neural network and understand how perceptrons are inspired by the human brain and try to simulate its functionality to solve problems. Construct different layers of perceptron and train the model in an iterative manner. Use the regularization of the loss function to prevent overfitting in the model. **Solutions Expected:** a. Load the HR dataset and perform data pre-processing like label encoding. b. Divide the dataset into training and testing to assess the model performance. c. Build a classification model using various parameters. d. Make prediction and evaluate the model.
WEEK 3	**BUILDING A FEED-FORWARD NEURAL NETWORK**
	3. Problem Statement: Develop a feed-forward neural network and understand how backpropagation algorithm for artificial neural networks can helps in improving the accuracy of a model and get a good prediction. **Solutions Expected:** a. Import the libraries to load IRIS dataset. b. Prepare the training and testing datasets and initialize weights. c. Build a back propagation model and create a loop by updating the weights in each iteration. d. Calculate the accuracy cum loss and plot the mean squared error and accuracy graphs.

WEEK 4	**ACTIVATION FUNCTIONS**
	4. Problem Statement: Without an activation function, a neural network is a linear regression model that doesn't perform complex tasks. It can learn and carry out more complex tasks by performing non-linear transformations. Implement the activation functions such as **Solutions Expected:** a. Implement the code to visualize the binary step activation function. b. Implement the code to visualize the linear activation function. c. Implement the code to visualize the sigmoid activation function. d. Implement the code to visualize the Tanh activation function. e. Implement the code to visualize the RELU activation function. f. Implement the code to visualize the Softmax activation function.
WEEK 5	**UNSUPERVISED TRAINING OF NEURAL NETWORKS**
	5. Problem Statement: During my first project, I was working with a bank's marketing division. The director asked me to meet with him to talk about a data science project. I was eager to get started and was hoping to find a problem that would allow me to implement my skills and improve the customer's experience. The meeting started promptly. The director told me that the bank had a lot of data about its customers, but it didn't know how to use it to improve its operations. He wanted to use data science to enhance the company's marketing efforts. **Solutions Expected:** a. Consider the case study of unsupervised deep learning on the MNIST dataset. b. Define the problem and organize a photo gallery. c. Arrange on the photos based on time, and location. d. Extract semantic meaning from the images.
WEEK 6	**AUTO ENCODERS**
	6. Problem Statement: Autoencoders are only capable of properly compressing data on the images that they have been trained to use. For instance, if they were trained to use images of cats, then it would not perform well. To improve its performance, the training network will learn how to encode data. This process can help reduce the dimensionality of the data. Develop a neural network using autoencoder, loss function, and a decoding method to replicate the loss with minimum loss. **Solutions Expected:** a. Import all the required libraries and begin with simple autoencoder. b. Implement the code to develop a deep CNN autoencoder. c. Show how the model performs using denoising autoencoder.

WEEK 7	**CONVOLUTIONAL NEURAL NETWORKS**
	7. Problem Statement: Demonstrate a simple convolutional neural network (CNN) to classify CIFAR images. Create and train the model to perform the image classification. Make sure that the classes are mutually exclusive and there is no overlap between them. **Solutions Expected:** a. Download and prepare the CIFAR10 dataset. b. Perform the dataset verifications and create the convolutional base. c. Add dense layers, compile, train, and evaluate the model.
WEEK 8	**FOOLING NEURAL NETWORKS**
	8. Problem Statement: To train the neural network, it can use weights and biases in the two parameters W and b. For each pixel in an image, the program can link the darkness of the object to the probability that it will represent a particular digit. For each digit, the program shows one image with 28 x 28 pixels. Blue and red pixels represent positive and negative weights, respectively. **Solutions Expected:** a. Design and develop a neural network using two important parameters like weights and biases. b. Implement the code for w has 10 rows of 784 elements each, where w[n] contains the weights for digit n. c. Reshape the elements into 28 x 28-pixel images each time we display them.
WEEK 9	**PERFORMANCE EVALUATION**
	9. Problem Statement: Performance metrics can be used to evaluate the efficiency of various types of algorithms, such as regression, classification, and ML. We must choose the right ones for our analysis since their impact on the results will be entirely dependent on the chosen metric. **Solutions Expected:** a. Select any dataset and develop a CNN model. b. Perform the image classification for binary datasets. c. Evaluate the model performance using metrics like confusion matrix and d. Submit the classification report by including accuracy and loss.

WEEK 10	**STOCHASTIC ENCODERS AND DECODERS**
	10. Problem Statement: There are two of the practical applications of auto encoders. One of these is data denoising, while the other is the reduction of dimensionality in data visualization. With the appropriate constraints, autoencoders can learn interesting data projections. Implement the code to demonstrate stochastic encoders and decoders. **Solutions Expected:** a. Develop a simple and basic possible autoencoder. b. Create a separate encoder and decoder model and reconstruct the MNIST digits. c. Configure the model using binary cross entropy and Adam optimizer. d. Visualize the reconstructed inputs and encoded representations.
WEEK 11	**RECURRENT NEURAL NETWORKS**
	11. Problem Statement: We do not automatically reboot our understanding of language when we hear a sentence. We rely on our previous knowledge to interpret the words given in an article. One of the most critical characteristics that we have is our memory. One of the first techniques that people might think of when it comes to developing an algorithm is a neural network. Unfortunately, this is not feasible with the traditional NNs. Implement to code to understand how recurrent neural networks contributes in predicting the next possible outcome for a given input. **Solutions Expected:** a. Perform the data preparation to fit for the model. b. Create a RNN model which can take in the input sequence. c. Train the model and check the accuracy on training data. d. Check the loss on the validation data and perform the actual training.
WEEK 12	**LONG SHORT TERM MEMORY**
	12. Problem Statement: One of the most challenging problems that people might encounter when it comes to developing an unsupervised algorithm is sequence prediction. This is different from other problems such as regression and classification. Instead of relying on the previous knowledge, you need to consider the order of the observations. One of the most important factors that you must consider when it comes to implementing LSTM is the learning of temporal dependence. Implement the code to demonstrate how LSTM can be used to address the problem. **Solutions Expected:** a. Understand the memorization task to test the capabilities of LSTM. b. Test the learned temporal dependency capability of LSTM. c. Implement some arithmetic tasks to evaluate the interpretation capability of LSTM.

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2. Wierstra, D., F¨orster, A., Peters, J., and Schmidhuber, J. (2009).Recurrent policy gradients.

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XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Understand the concepts of machine learning and deep neural networks.	CO 1	R1: 2.1 (25-30)
2	Explore the basics of DNN and present how it is suitable for text and image processing tasks.	CO 2	R1: 2.2 (30-36)
3	Convert any dataset labels vector to categorical data matrix.	CO 2	R1: 4.1 (79-82)
4	Perform the classification task by training the model from scratch using a dataset with different objects.	CO 2	R1: 2.3 (36-43)
5	Create the image classifier using CNN by importing all the required libraries and implement some preprocessing techniques.	CO 2	R1: 2.4
6	Implementing different types of poolings using keras.	CO 1, CO 2, CO 3	R1: 9
7	Implementing the code to fool the neural network	CO 1, CO 2, CO 3	R1: 3.1-3.6 (50-72)
8	Implement the code to perform the classification of images and interpret the misclassification error rate.	CO 1, CO 2, CO 3	R1: 3.4 (64-68)
9	Implementing the code to perform the digit identification by removing some noisy data.	CO 1, CO 2, CO 3	R1: 3.6
10	Implementing the code to train the CNN model and save model weights.	CO 1, CO 2, CO3	R1: 10
11	Perform the text recognition task using image processing techniques.	CO 1, CO 2, CO 3	R1: 12.1-12.6(231-245)

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design the neural network and perform the training process on nonlinear time series forecasting.
2	Design the feed-forward neural network and apply the same to solve biomedical problems.
3	Perform the comparative study on the functionalities of various activation functions and identify the best one during image classification.
4	Discover how various neural network architectures work with natural language data.
5	Design the CNN model to perform the image classification using hyperparameter tuning mechanism.
6	Design a specific long-short term memory model to control the mechanically driven reconfigurable robots.

Signature of Course Coordinator **HOD,CSE(AI&ML)**
Dr. M.Nagaraju, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING(AI & ML)**				
Course Title	**COMPUTER VISION**				
Course Code	ACDC21				
Program	B.Tech				
Semester	VIII				
Course Type	Professional Elective				
Regulation	IARE- UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs P.Sumathi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACDC08	V	Image processing Analytics

II COURSE OVERVIEW:

This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. It also provides methods for depth recovery from stereo images, camera calibration, automated alignment, tracking, boundary detection, and recognition. We'll use both classical machine learning and deep learning to approach these problems. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer vision	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
15%	Remember
35%	Understand
50%	Apply

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz \Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk
50%	50%

VI COURSE OBJECTIVES:

The students will try to learn:

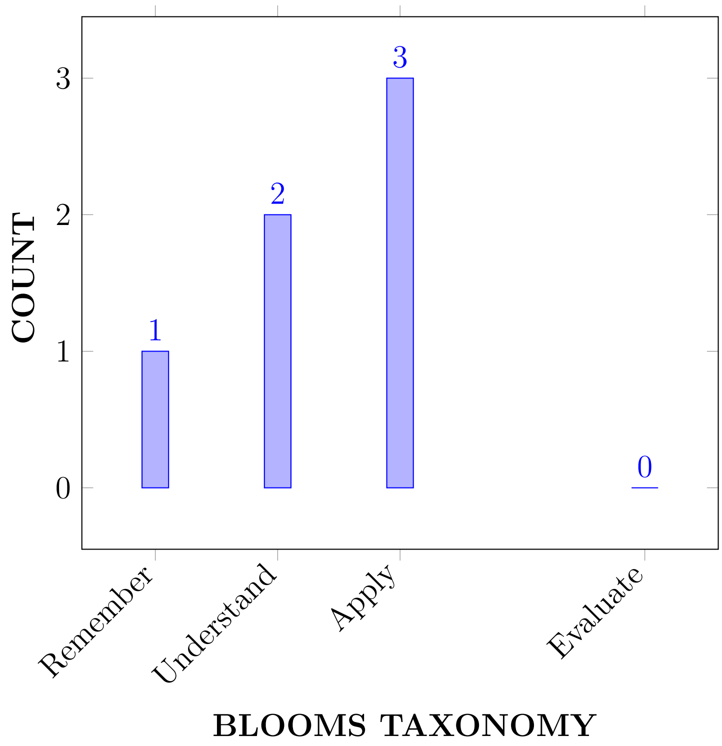
I	The theoretical and practical aspects of computing with images and connect issues from computer vision to human vision.
II	The foundations of shape and region analysis and understand the basics of 2D and 3D computer vision.
III	The Hough Transform and its applications to detect lines, circles, ellipses. The applications related to computer vision algorithms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** basic concepts, terminology, theories, models and methods in the field of computer vision.	Remember
CO 2	**Understand** fundamental concepts and principles of computer vision, including image filtering, edge detection, and feature extraction	Understand
CO 3	**Implement** the various concepts of shapes and regions for the applications of object detection recognition, medical image analysis and robotics and automation systems etc.	Apply
CO 4	**Apply** the Hough transform techniques to detect lines circles and shapes involved in the image.	Apply
CO 5	**Understand** 3D geometry principles to find the spatial relationships between objects in a scene	Understand
CO 6	**Devel0p** the ability to apply computer vision techniques to real-world problems and evaluate their performance.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1.6	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2.6	SEE / CIE / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2.6	SEE / CIE / AAT
PO 5	**Modern tool usage:** Create,select and apply appropriate techniques resources and modern engineering and it tool including prediction and modelling to complex engineering activities with an understanding of the limitations.	3	SEE / CIE / AAT
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2.5	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	2.6	SEE/CIE/AAT
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	3	SEE/CIE/AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	2.6	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓		-	-		-		-	✓	✓	-	✓
CO 2	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓	-	-	-		-	-	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Summarize the knowledge of mathematics, Scientific and Engineering Applying image processing foundations in surveillance systems enables advanced object detection and tracking, enhancing security and safety measures in public spaces.	2
	PO 2	Understanding the computational complexity of various image processing algorithms through problem analysis helps in optimizing processing time and resource utilization, leading to more efficient implementations.	2
	PO 3	Design development in image processing foundations involves exploring various algorithmic approaches to address specific image processing tasks, ensuring the most effective and efficient solutions are chosen for implementation.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	Conducting investigations of complex problems in image processing foundations enables researchers to gain deeper insights into the challenges and intricacies of handling real-world image data.	4
	PO 12	Embracing lifelong learning in image processing foundations allows professionals to stay updated with the latest advancements, ensuring they can leverage the most innovative techniques and tools in their work.	4
	PSO1	Building suitable statistical models and tools in image processing foundations allows for the quantitative analysis and characterization of image data, leading to more robust and data-driven solutions.	2
	PSO 3	Making use of computing theory and mathematics in image processing foundations provides a solid theoretical framework for understanding the algorithms and techniques employed in image processing.	2
CO 2	PO 1	Understanding the fundamental concepts in computer vision enables engineers to design and implement algorithms for tasks like object detection, image segmentation, and image recognition, which are fundamental to many computer vision applications.	2
	PO 2	Understanding the foundational concepts of computer vision through problem analysis enables engineers to identify the most suitable image representations, feature extraction techniques, and data preprocessing methods for a given application.	4
	PO 3	Design development enables engineers to integrate computer vision algorithms with other technologies, such as sensor data fusion or natural language processing, to create more sophisticated and comprehensive applications.	7
	PO 4	Through investigations, researchers can explore the impact of different datasets and image representations on the performance of computer vision models, ensuring that the algorithms are robust and applicable to diverse real-world scenarios.	6
	PO 5	By using modern tools, researchers can take advantage of optimized libraries and frameworks, which significantly accelerate the computation and training of computer vision models, leading to faster prototyping and experimentation.	1
	PO 12	Computer vision is a rapidly evolving field, and staying up-to-date with the latest advancements and research ensures that professionals can leverage cutting-edge techniques and methodologies in their work.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	Building suitable statistical models in computer vision is essential to accurately represent and interpret visual data, enabling advanced applications like object recognition, image segmentation, and scene understanding.	3
	PSO 2	Focusing on improving software reliability in computer vision is crucial for ensuring that AI-driven applications based on visual data produce consistent and accurate results, reducing the risk of errors and potential harm.	1
	PSO 3	Mathematics in computer vision enables the quantification and measurement of visual features, allowing us to extract meaningful information and patterns from images and videos.	3
CO 3	PO 1	Optimization: Engineers can leverage their knowledge to optimize algorithms and data structures, making shape and region analysis more efficient and scalable. Integration: Integrating shape and region concepts into existing computer vision systems	3
	PO 2	Performance Optimization: Problem analysis helps identify potential bottlenecks and inefficiencies in the implementation, allowing for targeted optimization of shape and region algorithms to achieve better performance.	4
	PO 3	designing and developing custom solutions for implementing shape and region concepts in computer vision empowers organizations with tailored, efficient, and adaptable systems that can address unique challenges and deliver accurate results in a wide range of applications.	6
	PO 4	In-Depth Understanding: Investigation allows researchers and developers to gain a deeper understanding of the complexities involved in shape and region analysis, leading to more informed design decisions..	6
	PO 5	Modern tools often come with pre-built libraries and state-of-the-art algorithms, enabling developers to leverage cutting-edge techniques without having to implement them from scratch.	1
	PO 12	Continuously Improving Solutions: Lifelong learning encourages professionals to seek new knowledge and insights, leading to continuous improvement in the implementation of shape and region concepts for better accuracy and efficiency.	4
	PSO 1	Statistical models leverage data-driven approaches, enabling the development of shape and region algorithms that learn from examples and adapt to diverse datasets.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 2	Reliable software instills confidence in users and stakeholders, promoting adoption and acceptance of computer vision solutions in various industries.	2
'	PSO 3	Reliable software instills confidence in users and stakeholders, promoting adoption and acceptance of computer vision solutions in various industries.	3
CO 4	PO 1	Engineering knowledge aids in selecting appropriate Hough transform parameters, such as the resolution of the accumulator space and the threshold for line detection, optimizing the algorithm for specific applications	3
	PO 2	Analysis helps in selecting suitable thresholding techniques for line detection, striking a balance between sensitivity and specificity to avoid missing relevant lines or detecting false positives.	4
	PO 3	Designing custom solutions allows for the development of intuitive visualization tools, aiding in the interpretation and analysis of the detected lines and accumulator space.	6
	PO 4	Investigating complex problems facilitates the detection and handling of fragmented lines, ensuring that the Hough transform can accurately reconstruct broken lines in the input data.	6
	PO 5	Visualization: Modern tools offer intuitive visualization capabilities, allowing users to interpret and analyze the detected lines and the accumulator space, aiding in understanding the algorithm's behavior.	1
	PO 12	Lifelong learners can draw insights from other domains, such as mathematics, statistics, or image processing, to improve the theoretical foundations and practical implementation of the Hough transform.	4
	PSO1	Statistical models provide a robust framework for line detection, enabling the Hough transform to handle noise, outliers, and complex data distributions while maintaining accurate results.	3
	PSO2	Continuous Monitoring Focusing on software reliability facilitates continuous monitoring and testing, enabling prompt detection and resolution of any issues that may arise during line detection.	2
	PSO 3	Computing theory offers various algorithmic paradigms that can be applied to improve the efficiency and accuracy of the Hough transform, such as divide and conquer or dynamic programming.	3
CO 5	PO 1	Engineering knowledge in 3D geometry allows for precise object localization by understanding the relative positions and orientations of objects in 3D space.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Problem analysis helps in identifying and resolving ambiguities in the spatial relationships, ensuring accurate and unambiguous interpretations of object positions and orientations.	5
	PO 3	Designing solutions allows for tailoring the 3D geometry principles to specific application requirements, ensuring optimal performance and accuracy in spatial relationship analysis.	5
	PO 4	Investigating complex problems allows for the exploration of various geometric transformations, such as rotations or translations, to align objects accurately in 3D space	5
	PO 12	Life-long learning empowers researchers to explore advanced techniques and algorithms to handle complex spatial relationships in challenging real-world scenarios.	3
	PSO1	Statistical models and techniques provide a robust framework for spatial relationship analysis, enabling accurate and reliable results even in the presence of noise or uncertainty in the 3D data.	3
	PSO 2	Reliable software facilitates robust data validation techniques, ensuring that input 3D geometry data is accurate and free from errors that could affect the quality of spatial relationship analysis.	2
	PSO3	Computing theory and mathematics provide a rigorous formalism for expressing and analyzing spatial relationships, ensuring precise and consistent definitions for various geometric properties.	2
CO 6	PO 1	Engineering knowledge enables the precise formulation of computer vision tasks based on real-world objectives, ensuring that the techniques align with the practical goals of the application.	2
	PO 2	Problem analysis helps in selecting the most appropriate computer vision algorithms and techniques based on the nature of the problem and the characteristics of the data, optimizing the chances of successful implementation.	3
	PO 3	Designing solutions incorporates robust error-handling mechanisms, allowing the computer vision techniques to handle noisy or imperfect real-world data gracefully.	5
	PO 4	Complex numbers provide a powerful mathematical tool to represent and manipulate both magnitude and phase information, enhancing the representation of signals and patterns in computer vision.	5
	PO 5	Utilizing modern tools with AutoML capabilities automates certain aspects of model development and hyperparameter tuning, making it easier for non-experts to apply computer vision techniques to real-world problems.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	Life-long learning equips professionals to develop real-time computer vision solutions for time-critical applications, such as autonomous vehicles, surveillance, and medical imaging.	3
	PS01	Life-long learning equips professionals to develop real-time computer vision solutions for time-critical applications, such as autonomous vehicles, surveillance, and medical imaging.	2
	PSO2	In consumer-facing applications, improved software reliability enhances end-user trust and adoption, making computer vision solutions more appealing and valuable to a broader audience.	2
	PSO3	Mathematics allows for the precise representation of real-world data in computer vision tasks, enabling accurate modeling and analysis of visual information.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO-PO/PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
Key competencies	3	10	10	11	1	5	3	3	12	5	12	8	4	2	4
CO 1	2	3	4	4	-	-	-	-	-	-	-	4	2	-	2
CO 2	2	4	7	6	1	-	-	-	-	-	-	4	3	1	3
CO 3	3	4	6	6	1	-	-	-	-	-	-	4	3	2	3
CO 4	3	4	6	6	1	-	-	-	-	-	-	4	3	2	2
CO 5	2	5	5	5	-	-	-	-	-	-	-	3	3	2	2
CO 6	2	3	5	5	1	-	-	-	-	-	-	3	2	2	3

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO-PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.6	30	40	40	-	-	-	-	-	-	-	50	50	-	50
CO 2	66.6	40	70	60	100	-	-	-	-	-	-	-	75	50	75
CO 3	100	40	60	60	100	-	-	-	-	-	-	50	75	100	75
CO 4	100	40	60	60	100	-	-	-	-	-	-	50	75	100	75
CO 5	66.7	50	50	50	-	-	-	-	-	-	-	25	75	100	50
CO 6	66.6	30	60	60	100	-	-	-	-	-	-	37.5	50	100	75

XV COURSE OF ARTCULATION MATRIX (PO/ PSO MAPPING)

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	2	2	-	-	-	-	-	-	-	2	2	-	2
CO 2	3	2	3	3	3	-	-	-	-	-	-	2	3	3	3
CO 3	3	2	3	3	3	-	-	-	-	-	-	2	3	3	3
CO 4	3	2	3	3	3	-	-	-	-	-	-	2	3	3	3
CO 5	3	2	2	2	-	-	-	-	-	-	-	1	3	3	2
CO 6	3	1	3	3	3	-	-	-	-	-	-	1	3	3	3
TOTAL	18	10	16	16	12	-	-	-	-	-	-	10	17	15	16
AVERAGE	3	1.6	2.6	2.6	3	-	-	-	-	-	-	2.5	2.6	3	2.6

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-
Assignments	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**IMAGE PROCESSING FOUNDATIONS**
	Review of image processing techniques, classical filtering operations, thresholding techniques, edge detection techniques, corner and interest point detection, mathematical morphology, texture.
MODULE II	**SHAPES AND REGIONS**
	Binary shape analysis, connectedness, object labeling and counting, size filtering, distance functions, skeletons and thinning, deformable shape analysis, boundary tracking procedures, active contours, shape models and shape recognition, centroidal profiles, handling occlusion, boundary length measures, boundary descriptors, chain codes, Fourier descriptors, region descriptors, moments.

MODULE III	**HOUGH TRANSFORM**
	Line detection, Hough Transform (HT) for line detection, foot-of-normal method, line localization, line fitting, RANSAC for straight line detection, HT based circular object detection, accurate center location, speed problem, ellipse detection Case study: Human Iris location, hole detection, generalized Hough Transform (GHT), spatial matched filtering, GHT for ellipse detection, object location, GHT for feature collation.
MODULE IV	**3D VISION AND MOTION**
	E-mail Security: Pretty Good Privacy; S/MIMI IP Security: IP security overview, IP security architecture, authentication header, encapsulating security payload, combining security associations, key management.
MODULE V	**APPLICATIONS**
	Photo album, Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces, foreground background separation, particle filters, Chamfer matching, tracking, and occlusion, combining views from multiple cameras, human gait analysis.

TEXTBOOKS

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2. https://patrec.cs.tu-dortmund.de/lectures/SS12/computervision/computervision.pdf
3. http://csundergrad.science.uoit.ca/courses/cv-notes/ item
http://www.cs.cmu.edu/afs/cs/academic/class/15385-s06/lectures/ppts/

COURSE WEB PAGE:

https://lms.iare.ac.in/index ?route=course/details& course id=84

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
2	Introduction of image processing techniques	CO 1	T1:1.1-1.4
3	Feature Extraction Optical Character Recognition (OCR)	CO 1	T1:1.5
4	Classical filtering operations	CO 1	T2:2.2
5	Thresholding techniques: Introduction, plain text and cipher text,	CO 1	T2:2.1-2.2
6	Smoothing,Edge detection filtering operations techniques	CO 1	T2:2.3-2.5
7	Adaptive thresholding,	CO 1	T1:2.6
8	Edge detection techniques,	CO 1	T1:2.7-2.8
9	Edge detection Features,	CO 1	T1:2.7-2.8
10	Corner Harris corner detector,	CO 2	T1:3.1-3.2
11	Steganography, key range and key size	CO 2	T1:3.2-3.4
12	Interest point detection.	CO 2	T1:5.2
13	Mathematical morphology	CO 2	T1:5.3
14	Texture, LBP,GLCM,HOG	CO 2	T1:5.3
15	Binary shape analysis	CO 3	T1:5.4-5.5
16	Connectedness, object labeling and counting	CO 3	T1:5.6, 21.4
17	Size filtering, distance functions, skeletons and thinning,	CO 3	T1:6.1
18	Deformable shape analysis, boundary tracking procedures	CO 3	T1:6.2-6.3
19	Active contours, shape models and shape recognition	CO 3	T1:6.4
20	Centroidal profiles, handling occlusion, boundary length measures	CO 3	T1:6.6-6.7
21	Boundary descriptors, chain codes	CO 3	T1:8.1-8.3
22	Fourier descriptors, region descriptors, moments.	CO 3	T1:8.4-8.5
23	Line detection, Hough Transform (HT) for line detection,	CO 4	T1:8.6
24	Public – foot-of-normal method, line localization, line fitting.	CO 4	T1:9.5

25	, RANSAC for straight line detection, HT based circular object detection ;	CO 4	T1:9.6
26	Accurate center location, speed problem	CO 4	T1:10.1-10.2
27	Ellipse detection Case study: Human Iris location,hole detection, generalized Hough Transform (GHT)	CO 4	T1:10.3
28	GHT for ellipse detection, object location, GHT for feature collation.	CO 4	T1:10.6
29	Methods for 3D vision, projection schemes, shape from shading	CO 5	T1:11.3
30	Photometric stereo, shape from texture, shape from focus, active range finding, surface representations,	CO 5	T1:11.4
31	Point-based representation, volumetric representations, 3D object recognition,	CO 5	T1:11.5
32	Introduction to motion, triangulation, bundle adjustment, translational alignment,	CO 5	T1:11.6
33	parametric motion, spline-based motion, optical flow, layered motion.	CO 5	T1:12.1-12.3
34	Applications Photo album, Face detection, Face recognition	CO 6	T1:12.4-12.6
35	Eigen faces, Active appearance and 3D shape models of faces,	CO 6	T1:12.7-12.8
36	foreground background separation, particle filters;	CO6	T1:8.1
37	Chamfer matching, tracking, and occlusion	CO 6	T1:8.2
38	combining views from multiple cameras	CO 6	T1:8.3
39	case study on spatial matched filtering,	CO 6	T2:27.8
40	Human gait analysis..	CO 6	T1:8.2-8.3
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on Threshold techniques	CO 1	T1:5.3-5.3
2	Problems on corner and interest point detection	CO 2	T1:8.1-8.3
3	case study on Binary shape Analysis	CO 3	T1:8.4-8.6 T1:9.1-9.2
4	Problems on boundary length measures	CO 3	T1:9.4-9.6
5	case study on human iris location	CO 4	T1:11.3-11.6
6	case study on generalized hough transform	CO 4	T1:12.1-12.6
7	case study on spatial matched filtering	CO 4	T1:8.1-8.3
8	Case study GHT for ellipse detection, object location,	CO 4	T1:8.1-8.3

9	Case study onshape from texture, shape from focus, active range finding,	CO5	T1:12.1-12.4
10	case study on surface representations, point-based representation	CO 5	T1:10.1-10.2
11	case study on photo album,Face detection	CO 6	T1:5.1-5.2
12	Problems on Active appearance and 3D shape models of faces,	CO 6	T1:13.1-13.3
13	Problems on particle filters	CO 6	T1:15.1-15.2
14	Problems on combining views from multiple cameras	CO 6	T1:18.1-18.3
15	Problems on human gait analysis	CO 6	T1:20.1-20.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions of image processing techniques	CO 1,2	T1:1.2
2	Definitions onShapes and regions , Binary shape analysis,	CO 3	T1:1.5
3	Definitions on Hough transform for line detection,	CO 4	T1:8,9
4	Definitions on 3D vision and Projection schem	CO 5	T1:10,11
5	Definitions Applications of photo album	CO 6	T1:9.1
DISCUSSION OF QUESTION BANK			
1	Image processing foudations	CO 1,2	T1:1.2
2	Shapes and regions	CO 3	T1:1.5
3	Hough Transform	CO 4	T1:8,9
4	3D Vision and motion	CO 5	T1:10,11
5	Applications photo albums	CO 6	T1: 9.1

Signature of Course Coordinator **HOD, CSE(AI & ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering(AI&ML)**				
Course Title	**Human Computer Interaction (UI & UX)**				
Course Code	ACDC12				
Program	B.Tech				
Semester	VIII				
Course Type	Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Mr.B.Mohan Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC06	V	Computer Networks

II COURSE OVERVIEW:

This course is an introduction to Human-Computer Interaction (HCI), a discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. The course considers the inherently multi- and interdisciplinary nature of HCI and situates various HCI issues in the organizational and societal contexts. It introduces theories of human psychology, principles of computer systems and user interfaces designs, a methodology of developing effective HCI for information systems, and issues involved in using technologies for different purposes. It is intended to give students an overview of the entire HCI field by covering most aspects of it. This course will thus provide a background for students to practice system design, selection, installation, evaluation, and use with the knowledge of human characteristics, interaction styles, use context, task characteristics, and design processes

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Human Computer Interaction (UI & UX	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
33.3%	Understand
66.6%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

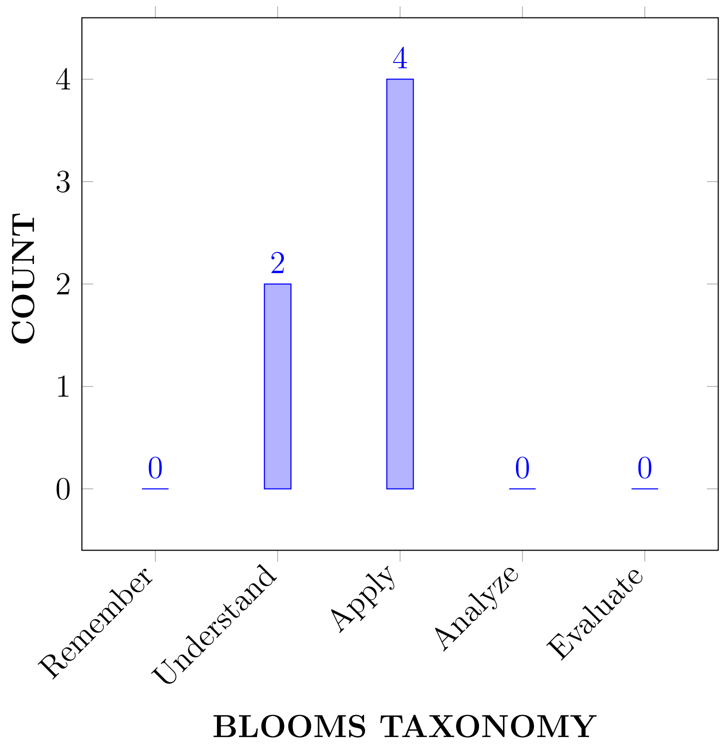
I	The essentials of designing interactive systems
II	The different techniques for designing interactive systems
III	The contexts for designing interactive systems
IV	The important aspects of implementation of human-computer interfaces
V	Identify the various tools and techniques for interface analysis, design, and evaluation

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the essentials of the design process and skills to develop the human-centered intractive systems	Understand
CO 2	**Identify** the design requirements to perform the evaluation process through participants and experts	Apply
CO 3	**Choose** the design guidelines and psychological principles to develop user interfaces	Apply
CO 4	**Construct** a conceptual basis to design HCI by considering internet sites usability, and user appreciation designs through case studies.	Apply
CO 5	**Compare** HCI designs to gain knowledge on user-centric interfaces while designing and developing collaborative applications.	Understand
CO 6	**Make use of** computing skills to design efficient interactive systems that align with human capabilities and needs.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CIE/Quiz/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	1	CIE/Quiz /AAT
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	3	CIE/Quiz /AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓		-
CO 2	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 3	-	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
CO 4	-	-	✓	✓	✓	-	-	-	-	-	-	-	✓	-	-
CO 5	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Throughout the design process, the application of mathematics, science, engineering fundamentals, and specialized engineering knowledge ensures that the resulting human-centered interactive system is not only user-friendly but also technically sound, reliable, and capable of solving complex engineering problems effectively.	2
	PO 2	Demonstrating the essentials of the design process and applying problem analysis while integrating first principles from mathematics, natural sciences, and engineering sciences, designers create human-centered interactive systems that go beyond aesthetics.	4
	PO 3	Integrating the essentials of the design process and skills to develop human-centered interactive systems with a focus on the design and development of solutions for complex engineering problems reflects a comprehensive and responsible approach to technology development.	3
	PO 4	Integrating investigations of complex problems with the design process for human-centered interactive systems ensures that the solutions are not only user-friendly but also well-founded in research-based knowledge.	6
	PO 5	This approach aligns with the dynamic nature of modern engineering, where the utilization of cutting-edge tools and techniques plays a pivotal role in addressing complex challenges and producing innovative solutions that enhance user experiences.	1
	PSO 1	Specialized areas often come with unique challenges. For example, in AI and ML, ensuring the transparency and interpretability of models is crucial. In AR/VR, providing seamless and immersive experiences is a challenge.	1
CO 2	PO 1	Applying engineering knowledge, including mathematics, science, engineering fundamentals, and specialization, to the identification of design requirements and the execution of the evaluation process ensures a systematic, rigorous, and comprehensive assessment of the system.	2
	PO 2	Incorporating problem analysis and leveraging first principles from mathematics, natural sciences, and engineering sciences in the design requirements of the evaluation process ensures a robust and systematic approach.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Integrating design requirements that involve participants and experts in the evaluation process ensure that solutions for complex engineering problems are comprehensive, user- centered, safe, and socially responsible.	5
	PO 4	This approach aligns with the research-driven nature of problem- solving, where empirical evidence and expert insights guide the development of solutions that are not only theoretically sound but also practically viable in addressing intricate challenges.	3
	PSO 1	This validation is crucial in fields like AR/VR, where immersive experiences must be seamless and intuitive.	1
CO 3	PO 2	Incorporating these design guidelines and psychological principles into the development of user interfaces aligns with the principles of engineering problem-solving. By applying mathematical precision, scientific understanding, engineering fundamentals, and specialized knowledge,	5
	PO 3	Integrating design guidelines and psychological principles into the development of user interfaces align with the principles of responsible engineering.	4
	PO 5	This approach ensures that the solutions not only embrace technological advancements but also prioritize user experiences, psychological comfort, and ethical considerations. By combining these elements, designers create interfaces that stand at the forefront of innovation while remaining user-centered and ethically responsible.	1
	PSO 3	Incorporating these design guidelines and psychological principles, you create user interfaces that leverage the capabilities of AI and ML while prioritizing usability, efficiency, safety, adaptability, ethical considerations, and effective data presentation	1
CO 4	PO 3	Summary, a strong conceptual basis for designing HCI involves a deep understanding of usability, user appreciation, case studies,	4
	PO 4	Summary, a conceptual basis for designing HCI through internet site usability and user appreciation, supported by case studies and research-based methods, enables the investigation of complex problems and the development of valid, user-centered solutions..	5
	PO 5	A conceptual basis for designing HCI through internet site usability and user appreciation, while applying modern tool usage, ensures that designers have access to the right techniques, resources, and data-driven insights to create effective and engaging digital experiences..	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	This approach ensures that software applications in AI, ML, Data Science, Web Development, Gaming, and AR/VR are user-centered, innovative, and effective in meeting the specific requirements of each specialized field.	1
CO 5	PO 1	Engineering knowledge helps in analyzing user feedback, identifying areas for improvement, and implementing updates that align with both user needs and technical constraints.	1
	PO 2	It allows you to identify, formulate, and address complex problems in a structured manner, leveraging the wealth of knowledge from HCI research while integrating first principles of mathematics, natural sciences, and engineering sciences to create user-centric and technically sound interfaces.	3
	PO 3	Comparing HCI designs in the context of designing and developing collaborative applications aligns with the process of creating solutions for complex engineering problems while considering public health, safety, cultural, societal, and environmental aspects	5
	PO 4	Conducting controlled experiments is a fundamental aspect of both HCI and engineering. By comparing HCI designs, you essentially create a natural experiment where you can observe how users interact with different interface elements,	3
	PSO 1	Comparing HCI designs is a powerful approach to gain knowledge on user-centric interfaces, especially when building software applications in specialized areas of computer science and engineering	1
CO 6	PO 1	This integrated approach ensures that the design process is rooted in both the art of effective user interaction and the science of engineering, leading to successful outcomes in the development of complex engineering solutions.	2
	PO 2	Formulate usability challenges, leverage HCI research, analyze complex engineering problems, and draw substantiated conclusions. This integrated approach ensures that the resulting systems are not only technically proficient but also user-centric, effectively addressing the complex challenges that arise in interactive system design.	3
	PO 3	It enables the creation of user-centric, safe, culturally aware, and environmentally responsible systems, contributing to effective solutions that address a wide range of considerations.	5
	PSO 3	Making use of computing skills to design efficient interactive systems with AI and ML techniques in industrial applications aligns with human capabilities and needs	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	4	3	6	1	-	-	-	-	-	-	-	1	-	-
CO 2	2	4	5	3	-	-	-	-	-	-	-	-	1	-	-
CO 3	-	3	4	-	1	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	4	5	1	-	-	-	-	-	-	-	1	-	-
CO 5	1	3	5	3	-	-	-	-	-	-	-	-	1	-	-
CO 6	2	3	5	-	-	-	-	-	-	-	-	-	-	-	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66	40	30	54	100	-	-	-	-	-		-	11	-	-
CO 2	66	40	50	27	-	-	-	-	-	-	-	-	11	-	-
CO 3	-	100	40	-	100	-	-	-	-	-	-	-	-	-	16
CO 4	-	-	40	44	20	-	-	-	-	-	-	-	11	-	-
CO 5	33	30	50	27	-	-	-	-	-	-	-	-	11	-	-
CO 6	66	30	50	-	-	-	-	-	-	-	-	-	-	-	11

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	3	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO 3	-	3	2	-	1	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	2	2	1	-	-	-	-	-	-	-	1	-	-
CO 5	1	1	2	1	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	1	2	-	-	-	-	-	-	-	-	-	-	-	1
TOTAL	11	11	11	6	5	-	-	-	-	-	-	-	4	-	2
AVERAGE	1.8	1.8	1.8	1	0.8	-	-	-	-	-	-	-	0.6	-	0.3

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ESSENTIALS OF DESIGNING INTERACTIVE SYSTEMS (09)**
	Designing interactive systems: a fusion of skills: The variety of interactive systems - The concerns of interactive systems design-Being digital-The skills of the interactive systems designer-Why being human-centered is important; The process of human-centered interactive systems design: Introduction-Developing personas and scenarios- Using scenarios throughout design - A scenario-based design method.
MODULE II	**TECHNIQUES FOR DESIGNING INTERACTIVE SYSTEMS (09)**
	Understanding: Understanding requirements- Participative design-Interviews- Questionnaires- Probes- Card sorting techniques-Working with groups - Fieldwork: observing activities in situ - Artefact collection and 'desk work'; Envisionment: Finding suitable representations- Basic techniques-Prototypes- Envisionment in practice; Design Introduction-Conceptual design- Metaphors in design- Conceptual design using scenarios - Physical design Designing interactions; Evaluation Introduction -Expert evaluation -Participant-based evaluation - Evaluation in practice -Evaluation: further issues.
MODULE III	**VISUAL INTERFACE DESIGN, MULTIMODAL INTERFACE DESIGN (09)**
	Visual interface design: Introduction, Graphical user interfaces, interface design guidelines, psychological principles and interface design, information design, visualization. Multimodal interface design: Introduction, interacting in mixed reality, using sound at the interface, tangible interaction, gestural interaction and surface computing
MODULE IV	**CONTEXTS FOR DESIGNING INTERACTIVE SYSTEMS (09)**
	Designing websites 3io: Introduction, website development, the information architecture of websites, navigation design for websites; Case study: designing the Robert Louis Stevenson website; Social media: Introduction, background ideas, Social networking, Sharing with others, the developing web; Collaborative environments: Introduction, issues for cooperative working, technologies to support cooperative working, collaborative virtual environments; Case study: Developing a collaborative tabletop application.

MODULE V	**UBIQUITOUS COMPUTING, MOBILE COMPUTING, WEARABLE COMPUTING (09)**
	Ubiquitous computing: Information spaces, blended spaces, home environments, navigating in wireless sensor networks; Mobile computing: Introduction, context awareness, understanding in mobile computing, designing for mobiles, evaluation for mobile computing; Wearable computing Introduction: Smart materials,material design, from materials to implants.

TEXTBOOKS

1. David R. Benyon, "Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design", Pearson; 3rd Edition, 2013
2. James Cabrera, "Modular Design Frameworks: A Projects-based Guide for UI/UX Designers", Apress, 1 st Edition, 2017.
3. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004.

REFERENCE BOOKS:

1. Ben Schneiderman, "Designing the User Interface", Pearson Education Asia, 3rd Edition, 2013.
2. Prece, Rogers, Sharps, "Interaction Design", Wiley Dreamtech
3. SorenLauesen, "User Interface Design", Pearson Education.
4. D. R. Olsen, "Human –Computer Interaction", Cengage Learning.
5. Smith –Atakan, "Human –Computer Interaction", Cengage Learning.

WEB REFERENCES:

1. http://staff.fit.ac.cy/com.ph/vp/VP Lecture 2.pdf
2. https://fac.ksu.edu.sa/nmalmobarak/course/41031
3. https://www.tutorialspoint.com/human computer interface/quick guide.htm

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Designing interactive systems a fusion of skills	CO1	T1: 1.1
2	The variety of interactive systems	CO1	T1: 1.2
3	The concerns of interactive systems	CO1	T1: 1.3
4	design-Being digital-The skills of the interactive systems	CO1	T1:1.4

5	designer-Why being human-centered is important	CO1	T1: 1.5
6	The process of human-centered interactive systems design	CO1	T1:7.1
7	Introduction- Developing personas and scenarios-Using scenarios throughout design	CO1	T1: 2.14
8	A scenario-based design method.	CO1	T1: 8.3
9	Understanding requirements Participative design	CO2	T1: 8.2
10	Interviews- Questionnaires- Probes Card sorting techniques-Working with groups - Fieldwork	CO2	T1: 10.0
11	observing activities in situ Artefact collection and 'desk work'	CO2	T1: 10.1
12	Envisionment: Finding suitable representations	CO2	T1: 10.1
13	Basic techniques- Prototypes- Envisionment in practice	CO2	T1: 10.2
14	Design Introduction-Conceptual design Metaphors in design	CO2	T1: 10.2
15	Conceptual design using scenarios Physical design	CO2	T1: 11.1
16	Designing interactions Evaluation Introduction -Expert evaluation	CO2	T1: 11.2
17	Expert evaluation -Participant-based evaluation	CO2	T1: 11.3
18	Evaluation in practice Evaluation: further issues	CO2	T1:15.3
19	Visual interface design: Introduction Graphical user interface	CO3	T1:19.1
20	interface design guideline	CO3	T1: T1:19.1
21	psychological principles and interface design, information design, visualization	CO3	T1:19.1
22	Multimodal interface design: Introduction, interacting in mixed reality	CO3	T1:19.1
23	tangible interaction gestural interaction and surface computing	CO3	T1:19.1
24	Designing websites 3io: Introduction website development	CO4	T1:19.1
25	the information architecture of websites, navigation design for websites	CO4	T1:23.0
26	Case study: designing the Robert Louis Stevenson website	CO4	T1:23.1
27	Social media: Introduction, background ideas	CO4	T1:23.2
28	Social networking, Sharing with others, the developing web	CO4	T1:23.3
29	Collaborative environments: Introduction issues for cooperative working	CO4	T1:23.3
30	technologies to support cooperative working	CO4	T1:23.3
31	collaborative virtual environments	CO4	T1:25.1
32	Case study: Developing a collaborative tabletop application	CO4	T1:25.1
33	Ubiquitous computing: Information spaces, blended spaces,	CO5	T1:25.2
34	home environments, navigating in wireless sensor networks	CO5	T1:25.2
35	Mobile computing: Introduction, context awareness	CO5	T1:25.2
36	understanding in mobile computing	CO5	T1:25.3
37	designing for mobiles	CO5	T1:25.4
38	evaluation for mobile computing	CO5	T1:25.5

39	Wearable computing Introduction	CO5	T1:25.6
40	Smart materials,material design, from materials to implants.	CO5	T1:25.7
PROBLEM SOLVING/ CASE STUDIES			
41	Google Maps' Turn-by-turn Navigation: Google Maps offers a user-friendly turn-by-turn navigation system with real-time traffic updates. Its clear and simple interface provides users with easy-to-follow directions, helping them reach their destinations efficiently.	CO 6	T2:18
42	Facebook's News Feed: Facebook's News Feed algorithm is designed to display relevant content based on users' interests and interactions. By personalizing the user experience, Facebook keeps its users engaged and encourages them to spend more time on the platform.	CO6	T2:18
43	Duolingo Language Learning App: Duolingo's language learning app employs gamification techniques, interactive exercises, and progress tracking to make language learning fun and engaging for users.	CO6	T2:18
44	Waze Community-based Traffic App: Waze uses crowdsourced data from its community of drivers to provide real-time traffic and navigation information. Users can actively contribute to the app by reporting accidents, hazards, and road closures, creating a cooperative user experience.	CO6	T2:24
45	Fitbit Fitness Trackers: Fitbit's wearable devices offer a straightforward and accessible interface for tracking health and fitness metrics. Users can easily monitor their steps, heart rate, sleep patterns, and other health-related data through the device and the accompanying mobile app.	CO6	T2:25
46	WhatsApp's Chat Interface: WhatsApp's simple and intuitive chat interface allows users to send text messages, voice messages, images, and videos effortlessly. Its popularity is due in part to the seamless user experience it offers.	CO6	T2:25.23
47	Adobe Photoshop's User Interface Evolution: Adobe Photoshop, a powerful image editing software, has undergone significant UI improvements over the years to cater to user needs better. Through iterative design updates, Adobe has made the software more accessible to both beginners and experienced professionals.	CO6	T2:25.23.1
48	Uber's Ride-hailing App: Uber's app provides a user-friendly interface for booking rides, tracking drivers, and processing payments. The intuitive design has played a vital role in the success and global adoption of the ride-hailing service.	CO6	T2:25.23.2
49	Netflix's Personalized Content Recommendations: Netflix's recommendation system uses machine learning algorithms to suggest content based on users' viewing history and preferences. This personalized approach enhances user engagement and retention on the platform.	CO6	T2:28.23.6

10	Microsoft Office Suite's Ribbon UI: Microsoft redesigned its Office Suite with the introduction of the Ribbon UI. This change made it easier for users to access and utilize various features, leading to better productivity and a more streamlined experience	CO6	T2:28.24.3
51	Spotify's Music Discovery Features: Spotify's music streaming platform employs personalized playlists, curated content, and machine learning to recommend songs and artists that align with users' music tastes, promoting longer user engagement.	CO6	T2:28.23.7
52	Airbnb's User Reviews and Ratings: Airbnb's user review system helps build trust and transparency between hosts and guests. The platform's focus on user feedback enables users to make informed decisions when booking accommodations.	CO6	T2:29.2.56
53	Google Assistant's Voice Interaction: Google Assistant's natural language processing capabilities enable users to interact with their devices through voice commands, simplifying tasks and providing a more hands-free experience.	CO6	T2:29.2.59
54	Pinterest's Visual Discovery: Pinterest's visual search feature allows users to find content by simply uploading an image. This visual discovery mechanism enhances the user experience and helps users discover new ideas and inspiration.	CO6	T2:30.3.32
55	Microsoft Windows 10's Touch-friendly Interface: With Windows 10, Microsoft introduced a touch-friendly interface that adapts to different devices, providing a consistent and seamless user experience across PCs, tablets, and smartphones. These case studies demonstrate the diverse applications of HCI principles in designing products and services that prioritize user needs, preferences, and expectations. User-centered design remains a crucial factor in creating successful and impactful digital experiences.	CO6	T2:30.3.61
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Essentials of designing interactive systems	CO 1	T2:2.1
57	Techniques for designing interactive systems	CO 2	T2:2.3
58	Visual interface design multimodal interface design	CO 3	T2:2.3.1
59	Contexts for designing interactive systems	CO 4	T2:7.2,7.3
60	Ubiquitous Computing ,mobile computing wearable computing	CO 5	T2:10.3.1

DISCUSSION OF QUESTION BANK			
61	List and explain the key principles of user-centered design in the context of interactive system design.	CO 1	R4:2.1
62	Implement responsive design techniques to ensure a consistent user experience across various devices.	CO 2	T4:7.3
63	Compare and contrast single-mode interfaces and multimodal interfaces in terms of user engagement and efficiency.	CO 3	R4:5.1
64	Apply context-aware design techniques to tailor an interactive system's interface based on user preferences and environmental conditions.	CO 4	T1:7.5
65	Critique the effectiveness of a ubiquitous computing system in providing seamless user experiences.	CO 5,6	T1: 4.1

Signature of Course Coordinator **HOD,CSE(AI&ML)**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)				
Course Title	DISASTER MANAGEMENT				
Course Code	ACEC31				
Program	B.Tech				
Semester	VIII				
Course Type	Open Elective-III				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Kavita Singh, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Disaster Management	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
17%	Remember
83 %	Understand
0%	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. **Alternative Assessment Tool (AAT)**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	**Tech-talk**	**Complex Problem Solving**
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

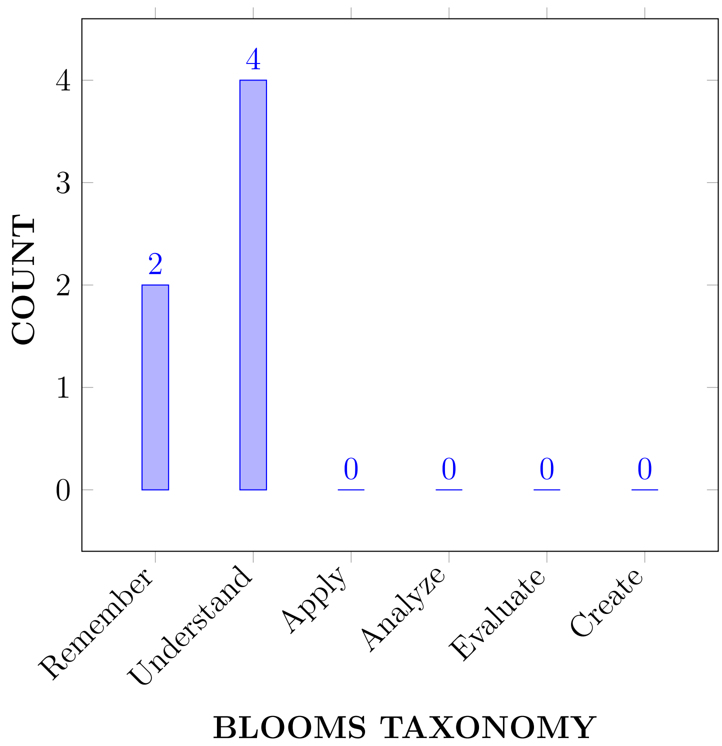
I	The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II	The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III	The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV	The immediate response and damage assessment with information reporting and monitoring tools.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** Environmental hazards for developing modern disaster management system.	Remember
CO 2	**Illustrate** various approches for reducing the level of risk associated with Disasters.	Understand
CO 3	**Compare** natural and manmade disasters for finding out intensity of damage loss occurred by them.	Understand
CO 4	**List** various hazards and their effects for evaluating their impact on society and Environment.	Remember
CO 5	**Outline** human adjustments and perception towards hazards for mitigation of disasters.	Understand
CO 6	**Summarize** disaster phenomenon and its different contextual aspects for implementing the Disaster Risk Reduction Strategy.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/SEE/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/SEE/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	-	-
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	-	-
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 2	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge and principals of mathematics to engineering problems in determining an area enclosed by irregular boundary line using the knowledge of **mathematics and science fundamentals**	2
	PO 7	Understand the disaster management by considering Environmental impacts on the livelihood and their effect on Socio economic issues for sustainable development.	2
CO 2	PO 1	Apply the knowledge on various disaster mitigation approaches in **engineering disciplines** and and use their application in geographical researches.	1
	PO 6	Apply the engineering knowledge in disaster management to **promote sustainable development** and build **Awareness on health, safety,** and **risk issues** associated with Disasters.	4
CO 3	PO 6	Identify **engineering activities including personnel, health, safety, and risk and effective disaster management strategies** for implementing, analyzing disaster impacts on human life and environment.	4
	PO 7	Understand intensity of disasters and their impact on **environment** and influence on **socio economic** parameter for assessment of intensity of risk.	2
CO 4	PO 6	Identify **engineering activities including personnel, health, safety, and risk** for analyzing hazard impacts on environment.	4
	PO 7	Identify the impact of various hazards in **socio economic and environmental** aspects for developing modern disaster management system.	2

CO 5	PO 1	Understand the **methodology and scientific principal towards** hazards for human adjustments and perception by sharing technological knowledge from **other engineering branches.**	2
	PO 6	Understanding of the need for a **high level of professional and ethical conduct in engineering** for human adjustments, perception with effective **management strategies**for disaster mitigation.	4
CO 6	PO 1	Understand the **knowledge of scientific principal and methodology** in disaster phenomenon for minimizing impact by implementing the Disaster Risk Reduction Strategy.	2
	PO 6	**Appropriate management strategies** are to be applied to reduce the level of risk in disaster mitigation.	1
	PO 9	Apply disaster risk reduction strategy using vrious organizations and **work effetively as an individual** and **as a member** or **a leader** are to be applied to reduce the level of risk in disaster mitigation.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	2	-	-	-	-	-	2	-	-	-	-		-	-	-
CO 2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	4	2	-	-	-	-		-	-	-
CO 4	-	-	-	-	-	4	2	-	-	-	-	-	-		-
CO 5	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	1	-	-	3	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	33.3	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	80	66.6	-	-	-	-	-	-		-
CO 4	-	-	-	-	-	80	66.6	-	-	-	-	-	-	-	-
CO 5	66.6	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	20	-	-	25	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0≤ C≤ 5% – No correlation
1 - 5≤ C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	3	3	-	-	-	-	-	-		-
CO 5	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	1	-	-	1	-	-	-	-	-	-
TOTAL	10	-	-	-	-	13	9	-	1	-	-	-	-	-	-
AVERAGE	3	-	-	-	-	3	3	-	1	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	-
Assignments	-	Mini project	-	Tech Talk	✓

XVII ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of mini projects by Experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ENVIRONMENTAL HAZARDS AND DISASTERS**
	Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.
MODULE II	**TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS**
	Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE III	**ENDOGENOUS HAZARDS**
	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India,human adjustment, perception and mitigation of earthquake.
MODULE IV	**EXOGENOUS HAZARDS**
	Exogenous hazards/disasters, infrequent events, cumulative atmospheric hazards/disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation); Droughts:Impacts of droughts, drought hazards in India, drought control measures,extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.
MODULE V	**EMERGING APPROACHES IN DISASTER MANAGEMENT**
	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness) 2. Emergency Stage 3. Post Disaster stage, Rehabilitation.

TEXTBOOKS

1. PardeepSahni, "Disaster Mitigation: Experiences and Reflections", PHI Learning Pvt. Ltd., 1 st Edition, 2001.

2. J.Glynn, GaryW.HeinKe, "Environmental Science and Engineering",Prentice Hall Publishers, 2 nd Edition, 1996.

REFERENCE BOOKS:

1. R.B.Singh (Ed), "Environmental Geography", 2nd Edition, 1990.

2. R.B. Singh (Ed), "Disaster Management", 2nd Edition, 2006.

3. Donald Hyndman "Natural Hazards and Disasters" - 5th edition, 2017.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be a changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
	OBE DISCUSSION		
1	Course Objectives, Course Outcomes, Program Outcomes, CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
2	Classify Environmental Hazards & Disasters	CO 1	T2:26.3, R2: 3.1
3	Understand the Meaning of Environmental Hazards	CO 1	T2:2.2.2
4	Understand Environmental Stress	CO 1	T2:2.2.2, R3:3.7
5	Understand Environmental stress.	CO 2	T2:2.2.2
6	Obtain knowledge on Concept of Environmental Hazards	CO 2	T1:8.1
7	Capacity to analyze Environmental stress & Environmental Disasters	CO 2	T1:7.1, R2: 1.2
8	Capacity to analyze Ecology concept	CO 2	T2:3.2.3, R2: 1.3
9	Understand Different Approaches	CO 3	T2:4.2.3
10	Understand Landscape Approach -.	CO 3	T2:4.5.2
11	Explain Ecosystem approach -Perception approach.	CO 3	T2:4.7.9
12	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
13	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
14	Understand Types of Environmental hazards & Disasters	CO 4	T2:5.4
15	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
16	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
17	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
18	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
19	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
20	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
21	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
22	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2

23	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
24	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
25	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
26	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
27	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
28	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
29	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
30	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
31	Distribution of earthquakes - Hazardous effects of - earthquakes - Earthquake Hazards in India	CO 4	T2:8.9.2
32	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
33	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
34	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
35	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
36	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
37	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
38	Analyze the Tropical cyclones and Local storms	CO 5	T2:9.6.2, R3: 8.5
39	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
40	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
41	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
42	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
43	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4

44	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
45	Analyze the Exogenous hazards/ disasters - Infrequent events- Cumulative atmospheric hazards/ disasters	CO 6	T2:9.5.6
PROBLEM SOLVING/ CASE STUDIES			
1	Case study on modern disaster management system	CO 1	T2:2.2.2
2	Case study on natural disaster	CO 2	T2:2.2.2
3	Case study on manmade disaster	CO 3	T2:2.2.2
2	Case study on Latur earthquake	CO 4	T2:2.2.2
4	Case study on Fukushima Nuclear disaster	CO 4	T2:2.2.2, R3:3.7
5	Case study on tsunami occurred in Japan	CO 5	T2:2.2.2
6	Case study on Hiroshima and Nagasaki	CO 4	T1:8.1
7	Case study on Russian Siberia oil spill	CO 4	T1:7.1, R2: 1.2
8	Case study on Hudhud Cyclone 2014	CO 5	T2:3.2.3, R2: 1.3
9	Case study on South India Floods 2015	CO 5	T2:4.2.3
10	Case study on Bihar Heat Wave 2019	CO 5	T2:4.5.2
11	Case study on Bihar Floods 2019	CO 5	T2:4.7.9
12	Case study on Oil Spillage in Russia 2020	CO 4	T2:5.4
13	Case study on Yellow River Flood in china	CO 4	T2:5.5.3
14	Case study on Bhola Cyclone Bangladesh	CO 5	T2:6.2.2
15	Causes of wildfires and effects	CO 4	T2:9.5.4
16	pre-disaster activities to reduce the impact of cyclones	CO 5	T2:9.5.4
17	Tectonic plate theory	CO 4	T2:9.5.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach	CO 1	T2:2.2.2
2	Natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards	CO 2	T2:2.2.2, R3:3.7
3	Effects of volcanic eruptions, environmental impacts of volcanic eruptions	CO 3, CO 4	T2:2.2.2
4	Lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters:	CO 5	T1:8.1
5	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness), 2. Emergency Stage ,3. Post Disaster stage, Rehabilitation.	CO 6	T1:7.1, R2: 1.2

DISCUSSION OF QUESTION BANK			
1	Environmental hazards and disasters	CO 1	R1:2.1
2	Types of environmental hazards and disasters	CO 2	T4:7.3
3	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, and their environmental impacts.	CO 3, CO 4	R2:5.1
4	Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.	CO 5	T1:7.5
5	Emerging approaches in disaster management	CO 6	T1: 4.1

Signature of Course Coordinator **HOD,CE**