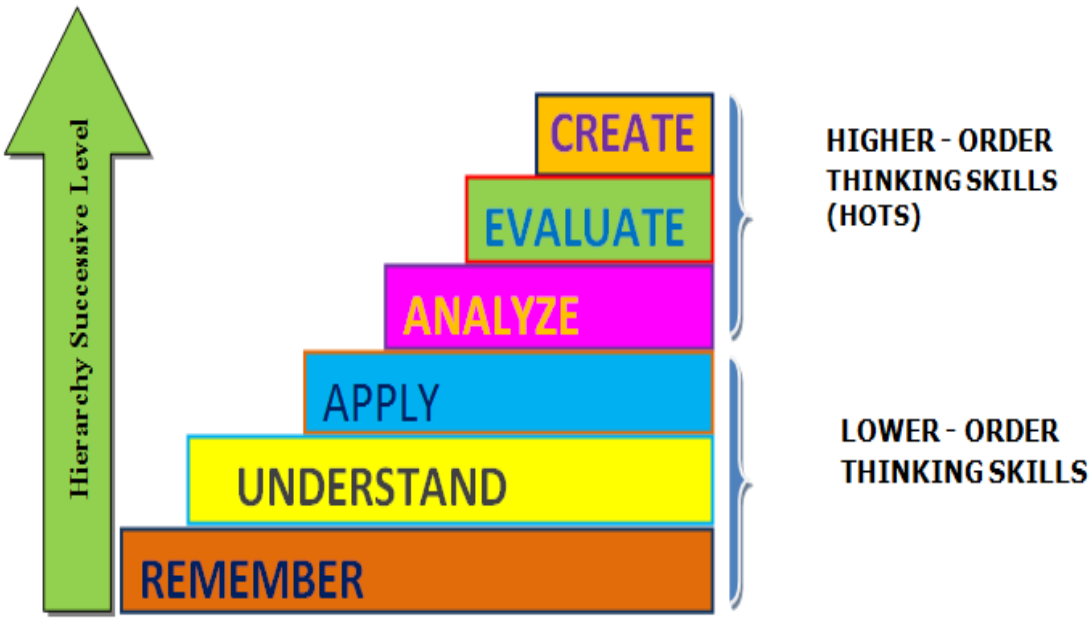
COURSE DESCRIPTOR BOOKLET

B.Tech

MECHANICAL ENGINEERING

(Accredited by NBA)

R-16 REGULATIONS



BLOOM'S TAXONOMY OF LEARNING OUTCOMES

.....Moving Towards Perfection in Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Approved by AICTE; Affiliated to JNTUH and Accredited by NAAC with 'A' Grade
Dundigal, Hyderabad - 500 043

I SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGLISH FOR COMMUNICATION**				
Course Code	AHS001				
Programme	B.Tech				
Semester	I	AE | ME | CE			
	II	CSE | IT | ECE | EEE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	2	1
Chief Coordinator	Ms B Anand Lakshmi, Associate Professor				
Course Faculty	Dr Prudhvi Raju, Associate Professor Ms P B Esther Rani, Assistant Professor Ms Jayshree Naidu, Assistant Professor Ms Shirisha Deshpande, Assistant Professor Mr. Sudhakar Medi, Assistant Professor Mr Kondal, Assistant Professor				

I. COURSE OVERVIEW:

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training students to acquire communicative competence, this Engineering English has been designed to develop linguistic and communicative competence of the students. In the classroom the focus should be on the skills of reading, writing, listening and speaking. The teacher can ask comprehension questions to stimulate discussion and based on the discussions students can be made to write short paragraphs/ essays etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Standard applicability of grammar and vocabulary

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
English for Communication	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Term paper
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	Seminar Listening Test Speaking Test Presentation (Technical / Review: Movie/Book)
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.	2	Five minutes video

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	-	-
PSO 2	**Software Engineering Practices**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	2	Written Test – Verbal Aptitude for Placement and Higher studies

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Communicate in an intelligible English accent and pronunciation.
II	Use the four language skills i.e., Listening, Speaking, Reading and Writing effectively.
III	Develop the art of writing simple English with correct spelling, grammar and punctuation.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS001.01	CLO 1	Understand the value of English as an international language and try to improve the knowledge regarding language skills and	PO 10	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		elements to be perfect in their usage.		
AHS001.02	CLO 2	Develop the ability to listen effectively in order to analyze the language used in descriptions and narrations.	PO 9	2
AHS001.03	CLO 3	Paraphrase listening skills for different purposes with special emphasis on intensive listening.	PO 9	2
AHS001.04	CLO 4	Interpret how to contextualize the use of language for different purposes.	PO 9 PO 10	2
AHS001.05	CLO 5	Ability to comprehend speaking skills for different purposes with special emphasis on intensive listening	PO 9, PO 10, PO 11	3
AHS001.06	CLO 6	Express fluently without any grammatical mistakes and also give presentations with proper modulation.	PO 10	3
AHS001.07	CLO 7	Translate the importance of critical reading to get information from the context with the help of root words and contextual clues.	PO 10	3
AHS001.08	CLO 8	Grasp the importance of reading skills for focused and selective information at various levels of professional career.	PO 10	3
AHS00.09	CLO 9	Summarize the topic to write different types of argumentative, narrative, descriptive and persuasive paragraphs and essays.	PO 9, PO 10	3
AHS001.10	CLO 10	Infer the use of language for developing behavioral skills.	PO 9, PO 10, PO 11, PSO 3	2
AHS001.11	CLO 11	Translate the importance of reading techniques and applying it to literary texts.	PO 11	3
AHS001.12	CLO 12	Ability to learn and understand techniques of grammar to apply in the functions of English language	PO 10	2
AHS001.13	CLO 13	Remember to use the knowledge of grammar and vocabulary in writing more meaningfully.	PO 10	3
AHS001.14	CLO 14	Infer the importance of language and applying to learn to be sensitive according to the needs of the society.	PO 9, PO 10, PO 11, PSO 3	2
AHS001.15	CLO 15	Develop writing skills in order to apply in day to day life.	PO 9, PO 10	3
AHS001.16	CLO 16	Understand the importance of written communication for the future correspondence throw out the career of the students.	PO 9, PO 10	3
AHS001.17	CLO 17	Develop the ability to analyze the results of experiments and be competent in writing reports, work in teams in real time situations	PO 9, PO 10	3
AHS001.18	CLO 18	Understand the value of writing skills to be a responsive, attentive and empathetic writer in order to face the real-world situations	PO 9, PO 10	3
AHS001.19	CLO 19	Infer the importance of vocabulary and writing as an essential ability in the real-time situations for those who desire to advance their career.	PO 11, PSO 3	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1										1					
CLO 2									2						
CLO 3									2						
CLO 4									2	1					
CLO 5									3	3	1				
CLO 6										3					
CLO 7										3					
CLO 8										3					
CLO 9									3	3					
CLO 10									2	3	2				1
CLO 11											3				
CLO 12										2					
CLO 13										3					
CLO 14									1	1	3				1
CLO 15									3	3					
CLO 16									3	3					
CLO 17									3	3					
CLO 18									3	3					
CLO 19											2				2

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 9, PO 10, PO11, PSO 3	SEE Exams	PO 9, PO 10, PO11, PSO 3	Assignments	-	Seminars	PO 10
Laboratory Practices	PO 9, PO 10, PO11, PSO 3	Student Viva	PO 10	Mini Project	-	Certification	-
Term Paper	PO 9						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	LISTENING SKILLS
Significance, essentials, barriers and effectiveness of listening; Listening to dialogues, conversation, discussions, monologues; Listening to sounds, silent letters, stressed syllables in English; Listening for the gist of the text, for identifying the topic, general meaning and specific information; Listening for multiple choice questions, positive and negative comments for interpretation. Note: instructions in theory and practice in the lab.	
Unit-II	**SPEAKING SKILLS**
Significance, essentials, barriers and effectiveness of speaking; Simple oral or casual interaction, dialogue, conversation; Debates: Differences between disagreeing and being disagreeable; Brief presentations; Role plays; Generating talks based on visual or written prompts; Addressing a small group or a large formal gathering; Speaking about present, past experiences and future plans; Arguing out a topic without verbal fights; Paper presentation. Note: instructions in theory and practice in the lab.	
Unit-III	**READING SKILLS**
Techniques of reading: Skimming, scanning, intensive and extensive reading; Reading comprehension: Exercises for multiple choice questions and contextual meaning- values in Dr. Kalam. Vocabulary enrichment and grammar exercises based on selective readings: Power of dreams- vision to mission- prose passage for intellectual and emotional comments; Reading for the gist of a text, for specific information, for information transfer and interpretation.	
Unit-IV	**WRITING SKILLS**
Significance, essentials and effectiveness of writing; Writing emails; Writing paragraphs: Comparing, contrasting, presentations with an introduction, body and conclusion; Writing formal and informal letters: Letter of invitation, accepting, declining, requesting, cover letter enclosing a CV.	
Unit-V	**GRAMMAR AND VOCABULARY**
Punctuation, parts of speech, articles, prepositions, tenses, concords, phrasal verbs; Forms of verbs: Regular and irregular, direct and indirect speech, change of voice; prefixes, suffixes, Synonyms, antonyms, one word substitutes, idioms and phrases, technical vocabulary.	
Text Books:	
1. Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles Practices", Oxford University Press, New Delhi, 3rd Edition , 2015.	
Reference Books:	
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 5. Dr. N V Sudershan, "President Kalam's Call to the Nation", Bala Bharathi Publications, Secunderabad, 1st Edition, 2003.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Explain the importance of English Language as a tool for global communication and emphasis to acquire communicative competence	CLO 1	T1:1.1
2	Recognize the importance of English as the global language.	CLO 1	T1:1.1
3	Identify the learning levels and their competencies	CLO 1	T1:1.1-1.5
4-7	Recall the functions of punctuation and practice exercises	CLO 6, CLO12	R3:5
8	Develop the ability to understand that speaking skills are essential to be a responsive, attentive and empathetic speaker in order to face the real-world situations.	CLO 5, CLO 14	R2:1.1
9-11	Apply the knowledge of preparation for oral presentation	CLO 6	R4:2.21
12	Identify common errors in the language through the concept of word formation	CLO 13, CLO 19	R4:60.1
13-15	Prepare the students to be aware of the importance of commonly used technical vocabulary	CLO 19	R4:1.1-2.1
16	Infer the concept of grammatical ambiguity & sentence construction	CLO 6, CLO 12	R4:4.2
17	Recognize the concept of "Subject-Verb agreement", to familiarize the students with the usage of "Concord"	CLO 6	R3:1.3
18-22	Identify and understand conventional signs, prefixes, suffixes, Synonyms, antonyms, one word substitutes used by writers to make their meaning clear to the reader	CLO 13	R4:47.1
23	Appraise the students in order to acquire the knowledge of sentence structure	CLO 6	R4:42.1
24-25	Learn to use the vocabulary in writing more meaningfully	CLO 13	R3:4.4
26-27	Infer the difference between phrases and idioms & learn to use them in sentences	CLO 13	R3:4.2
28	To make the students learn and identify commonly used technical vocabulary.	CLO 13	R4:1.3
29	Understand the significance, essentials, and effectiveness of reading	CLO 7, CLO 8	T1:2.4
30	Interpret derivatives, and standard abbreviations in English through reading skills	CLO 11	T1:27.2
31-33	Infer the gist of the text, for identifying the topic through reading skills	CLO 11	R4:5.8
34	Apply the general meaning and specific information through writing skills	CLO 16	T1:2.7
35	Analyze and Interpret multiple choice questions, positive and negative comments through comprehension passages	CLO 17	T1:2.6
36	Identify passage for intellectual and emotional comments; reading for the gist of a text.	CLO 11	T1:4.15
37	Associate the students to identify their common errors in the language	CLO 9	R2:3
38	Understand the importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents to foster the writing skills of the students	CLO 17	R2:3
39	Evaluate Letter writing-formal and Informal writing and E-mail writing.	CLO 19	T1:4.13
40	To make learners aware of the selection of language to make presentations and prepare the students for an effective presentation giving them necessary inputs	CLO 18	T1:4.13
41	Distinguish writing skills such as describing, defining,	CLO 17	T1:4.13

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	classifying, writing introduction and conclusion.		
42-43	Evaluate writing skills through creating coherence, organizing principles of paragraphs in documents.	CLO 9	T1:3.10
44-45	Understand the importance of vocabulary enrichment and grammar exercises to foster the writing skill of the students.	CLO 19	T1:4.13

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Construct basic and intermediate skills in English language.	Seminars	PO 10	PSO 3
2	Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work.	Seminars / NPTEL	PO 9	PSO 3
3	To build confidence for communicating in English and create interest for the life-long learning of English language.	Guest lecture	PO 10	PSO 3

Prepared by:
Ms. B Anand Lakshmi, Associate Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATION**				
Course Code	AHS002				
Programme	B.Tech				
Semester	I	AE | CSE | IT | ECE | EEE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. P Rajani, Assistant Professor				
Course Faculty	Dr. M Anita, Professor Mr. J Suresh Goud, Assistant Professor Ms. P Srilatha, Assistant Professor Ms. C Rachana, Assistant Professor Ms. B Praveena, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes Types of matrices, difference calculus methods and differential equations. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Linear Algebra and Ordinary Differential Equations	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of probability on single random variables and probability distributions.
II	Apply the concept of correlation and regression to find covariance.
III	Analyze the given data for appropriate test of hypothesis.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS002.01	CLO 1	Demonstrate knowledge of matrix calculation as an elegant and powerful mathematical languagein connection with rank of a matrix.	PO 1	1
AHS002.02	CLO 2	Finding rank by reducing the matrix to Echelon and Normal forms.	PO 1	3
AHS002.03	CLO 3	Determine inverse of the matrix by Gauss Jordon Method.	PO 1	3
AHS002.04	CLO 4	Apply the method of LU Decomposition and solve the simultaneous equations.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS002.05	CLO 5	Use the method of LU factorization real world problems such as circuit designing and solving complex circuits	PO 2	3
AHS002.06	CLO 6	Use the method of LU factorization real world problems such as economize and accumulate sums in double precision Computer Programme.	PO 2	2
AHS002.07	CLO 7	Interpret the Eigen values and Eigen vectors of matrix for a linear transformation and use properties of Eigen values	PO 4	1
AHS002.08	CLO 8	Understand the concept of Eigen values in real world problems of control field where they are pole of closed loop system.	PO 4	1
AHS002.09	CLO 9	Apply the concept of Eigen values in real world problems of mechanical systems where Eigen values are natural frequency and mode shape.	PO4	1
AHS002.10	CLO 10	Use the system of linear equations and matrix to determine the dependency and independency.	PO 2	2
AHS002.11	CLO 11	Determine a modal matrix, and reducing a matrix to diagonal form.	PO 1	3
AHS002.12	CLO 12	Evaluate inverse and powers of matrices by using Cayley-Hamilton theorem.	PO 1	3
AHS002.13	CLO 13	Solving differential equations of first order.	PO 1	3
AHS002.14	CLO 14	Finding orthogonal trajectories of Cartesian and polar equations.	PO 1, PO 2	2
AHS002.15	CLO 15	Apply the first order differential equations in real world problems such as Newton's Law of cooling and Law of natural growth and decay	PO 2	2
AHS002.16	CLO 16	Solving Second and higher order differential equations with constant coefficients.	PO 2	2
AHS002.17	CLO 17	Apply the second order differential equations for real world problems of electrical circuits and simple harmonic motion.	PO 4	1
AHS002.18	CLO 18	Apply the Mean value theorems for the single variable functions.	PO 1, PO 2	2
AHS002.19	CLO 19	Understand the basic concepts of Partial Differential equations.	PO 1, PO 2	2
AHS002.20	CLO 20	Determine Jacobian for the coordinate transformation	PO 1, PO 2	2
AHS002.21	CLO 21	Apply the technique of Jacobian and inverse Jacobian relation to real world problems such as kinematics and inverse kinematic solutions of robot	PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		manipulators.		
AHS002.22	CLO 22	Understand the techniques of multidimensional change –of –variables to transform the coordinates by utilizing the Jacobian.	PO 1	3
AHS002.23	CLO 23	Apply maxima and minima for functions of several variable's and Lagrange's method of multipliers	PO 1	3
AHS002.24	CLO 24	Understand the concept and acquire the knowledge for attempting the competitive exams	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	1												1		
CLO 2	2												1		
CLO 3	3												1		
CLO 4		2													
CLO 5		3													
CLO 6		2													
CLO 7				1									1		
CLO 8				1											
CLO 9				2									1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	1	2											1		
CLO 15		2													
CLO 16		2													

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 17				1									1		
CLO 18	1	2											1		
CLO 19	1	2											1		
CLO 20	1	2											1		
CLO 21				1											
CLO 22	3														
CLO 23	3														
CLO 24				1											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2	SEE Exams	PO 1, PO2, PO 4	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-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, elementary matrix, finding rank of a matrix by reducing to Echelon form and normal form; Finding the inverse of a matrix using elementary row/column transformations: Gauss-Jordan method; Solving of linear system of equations by LU decomposition method.	
Unit-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; Properties of eigen values and eigen vectors of real and complex matrices; Diagonalization of matrix.	
Unit-III	**DIFFERENTIAL EQUATIONS OF FIRST ORDER AND THEIR APPLICATIONS**
Formation of a differential equation; Differential equations of first order and first degree: Exact, non exact, linear equations; Bernoulli equation; Applications of first order differential equations: Orthogonal trajectories; Newton's law of cooling; Law of natural growth and decay.	

Unit-IV	HIGHER ORDINARY LINEAR DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS
Linear differential equations of second and higher order with constant coefficients, non homogeneous term of the type $f(x)=e^{ax}, \sin ax, \cos ax$ and $f(x)=x^n, e^{ax}v(x), x^n v(x)$; Method of variation of parameters; Applications to electrical circuits and simple harmonic motion.	
Unit-V	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES**
Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem and generalized mean value theorems-without proofs. Functions of several variables: Functional dependence, Jacobian, maxima and minima of functions of two variables without constraints and with constraints; Method of Lagrang multipliers.	
Text Books:	
1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 42nd Edition, 2012.	
Reference Books:	
1. RK Jain & SRK Iyengar, "Advanced Engineering Mathematics", Narosa Publishers, 5th Edition, 2016. 2. Ravish R Singh, Mukul Bhatt, "Engineering Mathematics-1", Tata Mc Graw Hill Education, 1st Edition, 2009. 3. Srimanthapal & Suboth C.Bhunia, "Engineering Mathematics", Oxford Publishers, 3rd Edition, 2015.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Theory of Matrices Introduction of matrices	CLO 1	T1:22.5 R1:2.3
2-3	Real and complex matrices	CLO 2	T1:22.5 R1:2.4
4-6	Find rank by echelon and normal form	CLO 2	T1:22.6 R1:2.6
7	Gauss-Jordan method	CLO 4	T1:22.7 R1:4.4
8	LU decomposition method	CLO 4	T1:22.7 R1:4.10
9-12	Cayley Hamilton theorem	CLO 7	T1:22.8 R1:4.15
13-16	Eigen values and Eigen vectors	CLO 9	T1:22.9 R1:5.4
17-18	Diagonalisation	CLO 9	T1:22.9 R1:5.8
19--22	Differential equations Introduction of first order differential equations	CLO 11	T1:23.10 R1:6.8
23-24	Orthogonal trajectories	CLO 11	T1:23.10 R1:6.13
25-26	Applications	CLO 13	T1:23.9 R1:7.5
27-30	Second and Higher order differential equations with constant coefficients	CLO 11	T1:23.10 R1:7.5
31-34	Method of variation of parameters	CLO 9	T1:23.10 R1:8.1
35-36	Applications of second order differential equations	CLO 14	T1:23.1 R1:9.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
37	Differential Calculus Methods Verification of Rolle's Theorem to the given functions	CLO 14	T1:23.1 R1:9.4
38-39	Verification of Lagrange's Mean value theorem to the given functions	CLO 14	T1:23.1 R1:9.9
40	Verification of Cauchy's mean value theorem to the given functions	CLO 14	T1:23.1 R1:9.10
41	Functional dependence for two and three functions	CLO 14	T2:27.5 R1:10.2
42-43	Maxima and minima of functions of two variables without constraints	CLO 17	T2:27.7 R1:11.3
44-45	Lagranges method of undetermined multipliers	CLO 17	T2:27.8 R1:11.6

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with P0s	Relevance with PSOs
1	To improve standards and analyze the concepts.	Guest lecture	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
Ms. P Rajani, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING CHEMISTRY**				
Course Code	AHS005				
Programme	B. Tech				
Semester	I	AE | CIVIL | CSE | ECE | EEE | IT | ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	2	1
Chief Coordinator	Ms. V Anitha Rani, Associate Professor				
Course Faculty	Dr. C Mahendar, Professor Mr. M Praveen, Assistant Professor Mr. B Raju, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Lakshmi Prasanna, Assistant Professor Ms. M Swathi, Assistant Professor				

I. COURSE OVERVIEW:

The primary objective of an Engineering Chemistry course is to introduce the students to the concepts and applications of chemistry in engineering. It should cultivate in them an ability to identify chemistry in each piece of finely engineered products used in households and industry. It aims to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications. It deals with applied and industrially useful topics, such as water technology, engineering materials, electrode potential and cells, fuels, polymers and corrosion. Water and its treatment for various purposes, engineering materials such as plastics, composites, ceramic, abrasives, their preparation, properties and applications, conventional and non-conventional energy sources, nuclear, solar, various batteries, combustion calculations, corrosion and control of metallic materials.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of chemistry

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering Chemistry	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Seminar
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	Seminar
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.	2	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**ProfessionalSkills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Apply the electrochemical principles in batteries.
II	Understand the fundamentals of corrosion and development of different techniques in corrosion control.
III	Analysis of water for its various parameters and its significance in industrial, applications.
IV	Improve the fundamental science and engineering principles relevant to materials.

IX.COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS005.01	CLO 1	Extrapolate the knowledge of electrolytic cell, electrochemical cell, electrode potential and reference electrodes.	PO 1	3
AHS005.02	CLO 2	Use of primary and secondary batteries in various fields such as automobiles, railways, medical devices, aircrafts and day to day life.	PO 1 PO 2	1
AHS005.03	CLO 3	Explain the characteristic factors of a metal and environment influencing the rate of corrosion.	PO 1 PO 7	2
AHS005.04	CLO 4	Use appropriate methods such as protective, metallic and organic coatings to control corrosion in metals.	PO 1 PO 7	2
AHS005.05	CLO 5	Evaluate the quality and utility of suitable water for industrial as well as domestic applications.	PO 1 PO 7	3
AHS005.06	CLO 6	Use innovative methods to improve the quality of soft water for Potable and industrial purpose at cheaper cost.	PO 1 PO 7	2
AHS005.07	CLO 7	Understand the concepts of polymers for viscoelastic nature of polymer materials in real-time application.	PO 1 PO 7	1
AHS005.08	CLO 8	Demonstrate the ability to use polymeric materials for engineering problems in different domains.	PO 1 PO 7	1
AHS005.09	CLO 9	Justify the immense importance of basic constructional material, Portland cement in civil engineering works.	PO 1	1
AHS005.10	CLO 10	Describe various instruments used for measuring various properties of lubricants in industries.	PO 1	3
AHS005.11	CLO 11	Understand refractory use in metallurgical furnaces, kilns and other equipments.	PO 1	2
AHS005.12	CLO 12	Demonstrate comprehensive knowledge of conventional fuel properties on engine performance.	PO 1	2
AHS005.13	CLO 13	Understand the importance of cracking, knocking in IC engines and operations involved in petroleum refining for real-time application.	PO 1 PO 2	2
AHS005.14	CLO 14	Describe the physical and chemical properties of alternate fuels like natural gas, LPG and CNG.	PO 1	1
AHS005.15	CLO 15	Determine efficiency of the fuel in terms of calorific value and combustion reactions of the fuel.	PO 1	2
AHS005.16	CLO 16	Understand the concepts of electro chemistry in solar cell, Fuel cells and batteries for real-time application.	PO 1	2
AHS005.17	CLO 17	Understand the concepts of corrosion control methods in pipeline leaks and ruptures as real-time application.	PO 1 PO 7	2
AHS005.18	CLO 18	Understand the concepts of water technology in applications of image recognition for real-time water level and surface velocity.	PO 1 PO 7	2

3 = High; 2 = Medium; 1 = Low

IX. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3														
CLO 2	2	1													
CLO 3	2						2						1		
CLO 4	2						2						1		
CLO 5	3						3								
CLO 6	2						2								
CLO 7	2						1								
CLO 8	1						1								
CLO 9	1														
CLO 10	3												1		
CLO 11	2												1		
CLO 12	2												1		
CLO 13	3	1											1		
CLO 14	1														
CLO 15	2												1		
CLO 16	2														
CLO 17	2						2								
CLO 18	2						2								

3 = High; 2 = Medium; 1 = Low

X. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1,PO 2, PO 7	SEE Exams	PO 1,PO 2 PO 7	Assignments	PO 2	Seminars	PO 1, PO 2
Laboratory Practices	PO 1	Student Viva	-	Mini Project	-	Certificatior	-
Term Paper	-						

XI. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XII. SYLLABUS

Unit-I	ELECTROCHEMISTRY AND BATTERIES
Electrochemistry: Basic concepts of electrochemistry; Conductance: Specific, equivalent and molar conductance and effect of dilution on conductance; Electrochemical cells: Galvanic cell (daniel cell); Electrode potential; Electrochemical series and its applications; Nernst equation; Types of electrodes: Calomel electrode, quinhydrone electrode; Batteries: Classification of batteries, primary cells (dry cells) and secondary cells (lead-acid battery, Ni-Cd cell), applications of batteries, numerical problems.	
Unit-II	**CORROSION AND ITS CONTROL**
Corrosion: Introduction, causes and effects of corrosion; Theories of corrosion: Chemical and electrochemical corrosion with mechanism; Factors affecting the rate of corrosion: Nature of the metal and nature of the environment; Types of corrosion: Waterline and crevice corrosion; Corrosion control methods: Cathodic protection- sacrificial anodic protection and impressed current cathodic protection; Surface coatings: Metallic coatings, methods of application of metallic coatings-hot dipping(galvanizing, tinning), electroplating(copper plating); Organic coatings: Paints, its constituents and their functions.	
Unit-III	**WATER TECHNOLOGY**
Water: Sources and impurities of water, hardness of water, expression of hardness-units; Types of hardness: Temporary hardness, permanent hardness and numerical problems; Estimation of temporary and permanent hardness of water by EDTA method; Determination of dissolved oxygen by Winkler's method; Boiler troubles: Priming, foaming, scales, sludges and caustic embrittlement. Treatment of water: Internal treatment of boiler feed water- carbonate, calgon and phosphate conditioning, softening of water by Zeolite process and Ion exchange process; Potable water-its specifications, steps involved in the treatment of potable water, sterilization of potable water by chlorination and ozonization, purification of water by reverse osmosis process.	
Unit-IV	**MATERIALS CHEMISTRY**
Materials chemistry: 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; Rubbers: Natural rubber its process and vulcanization; Elastomers: Buna-s and Thiokol rubber; Fibers: Characteristics of fibers, preparation properties and applications of Dacron; Characteristics of fiber reinforced plastics; Cement: Composition of Portland cement, setting and hardening of Portland cement; Lubricants: Classification with examples; Properties: Viscosity, flash, fire, cloud and pour point; Refractories: Characteristics and classification with examples.	
Unit-V	**FUELS AND COMBUSTION**
Fuel: Definition, classification of fuels and characteristics of a good fuels; Solid fuels: Coal; Analysis of coal: Proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Cracking: Fixed bed catalytic cracking; Knocking: Octane and cetane numbers; Gaseous fuels: Composition, characteristics and applications of natural gas, LPG and CNG; Combustion: Calorific value: Gross Calorific Value(GCV) and Net Calorific Value(NCV), calculation of air quantity required for complete combustion of fuel, numerical problems.	
Text Books:	
1. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 15th Edition, 2015.	

2. Shashi Chawla, "Text Book of Engineering Chemistry" Dhanat Rai and Company, 1st Edition 2011
Reference Books:
1.B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015. 2. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006. 3. C. V. Agarwal, C. P. Murthy, A. Naidu, "Chemistry of Engineering Materials", Wiley India, 5thEdition, 2013. 4.R. P. Mani, K. N. Mishra, "Chemistry of Engineering Materials", Cengage Learning, 3rd Edition, 2015.

XIV.COURSE PLAN:

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

Lecture No	Topics to be covered	CLOs	Reference
1	Understands the concept of electrochemistry. Differentiate the electronic conductors and electrolytes.	CLO 1	T1:5.1,6.3
2	Define the terms specific, equivalence and molar conductance. Explain the dilution effect on these conductance	CLO 1	T1:5.5
3	Understands the concept of specific, equivalence and molar conductance. Define the EMF of the cell. Demonstrate the Daniel cell.	CLO 1	T2:6.1,6.2, 6.3
4	Describe the construction and chemical reactions of different electrodes. Use the Calomel	CLO 1	T2:11,12.2.1
5	Quinhydrone electrodes in calculation of potential of the single electrode.	CLO 1	T1:6.7(4)
6	Derive the relation between cell reaction and emf of the single electrodes.	CLO 1	T2:3.4
7	Use the standard potential values of elements from electrochemical series.	CLO 1	T2:5,5.1
8	Define the battery; differentiate the primary and secondary batteries. Demonstrate the construction of the dry cell.	CLO 2	T2:16,17.1
9	Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries.	CLO 2	T2:17.3
10	Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries.	CLO 2	T2:17.4
11	Define corrosion and its disadvantages.	CLO 3	T2:1.1
12	Explain the mechanism of oxidation corrosion when dry gases attack on metal.	CLO 3	T2:2.1
13	Explain the mechanism of hydrogen evolution type and oxygen absorption type corrosion.	CLO 3	T2:2.2
14	Distinguish the types of corrosion.	CLO 3	T2:2.4.5
15	Analyze the effect of different factors on rate of corrosion.	CLO 3	T2:5,5.1,5.2
16	Explain the process of cathodic protection with examples.	CLO 4	T2:6.4
17	Use the methods of application of metallic coatings and Relate the galvanization and tinning	CLO 4	T1:17.1
18	Explain the process of electroplating. Apply the organic coatings for control of corrosion.	CLO 4	T1:8.6 T2:6.3.3
19	List the various sources of water, Differentiate the temporary and permanent hardness and give its units.	CLO 5	T2:3,4,5
20	Calculate the total, permanent and temporary hardness of	CLO 5	T2:6

Lecture No	Topics to be covered	CLOs	Reference
	sample hard water by using EDTA		
21	Calculate the dissolved oxygen in water by Winkler's method	CLO 5	T1:1.14(4)
22-23	Recognize the boiler troubles.	CLO 5	T2:9.2,9.5
24	Discuss the internal treatment methods of boiler feed water. Name the different chemicals used in internal treatment.	CLO 6	T2:12,12.4, 12.2,12.3
25	Explain the process of zeolite and analyze the advantages and disadvantages.	CLO 6	T2:11.2
26	Explain ion-exchange process.	CLO 6	T2:11.3,13
27	Demonstrate the treatment of potable water Purification of potable water. Describe the process of reverse osmosis	CLO 6	T2:13,14 (d)
28	Define monomer and polymer Explain the mechanism of different types of Chain and step growth polymerization.	CLO 7	T2:2,2.2,4,4.1,4.2,4.7
29	Distinguish the thermoplastic and thermo set plasitcs. Illustrate the compounding of plastics.	CLO 7	T1:3.14,3.13.12
30	Identify the preparation, properties and applications of different thermo and thermo set plastics.	CLO 8	T2:2.3,2.7,2.8
31	Identify the preparation, properties and applications of thermo set plastics. Explain about natural rubber.	CLO 8	T2:3,3.1,3.2, 3.3
32	Explain the preparation, properties and applications of synthetic rubbers.	CLO 8	T1:3.24 T2:4.2
33	Explain the preparation, properties and applications of fibers.	CLO 8	T1:3.28 R4:114
34	Generalize the process of setting and hardening reactions of cement	CLO 9	T2:9.3.2, 9.3.3
35	Define the term lubricant and it's classification.	CLO 10	T2:7.4
36	Compare the different types of lubricants based on their properties.	CLO 10	T2:7.5
37	Name the different types of refractories. Discuss the characteristics and applications of refractories.	CLO 11	T2:8.2,8.3
38	Define the fuel with examples. Categorize the different types of fuels.	CLO 12	T2:5.2,5.3
39	Analyze the different types of coals. Explain the significance of proximate analysis of coal.	CLO 12	T2:5.7,5.8,5.8.1
40	Explain the significance of Ultimate analysis of coal.	CLO 12	T2:5.8.2
41	Identify the chemical constituents of petroleum. Describe the refining of petroleum. Define the term cracking. Distinguish the fixed bed and catalytic cracking.	CLO 13	T1:2.18,2.19 2.19(a)
42	Evaluate the octane and cetane rating of the petrol and diesel.	CLO 13	T1:2.23
43	Identify the chemical constituents of the gaseous fuel. Discuss the characteristics of natural gas. Compare the LPG and CNG.	CLO 14	T1:2.28,2.26 T2:5.14.1 R4:247
44	Explain the combustion process of different chemical constituents present in the fuel. Differentiate the HCV and LCV.	CLO 15	T2:5.4,5.5
45	Evaluate the air quantity required for complete combustion of fuel.	CLO 15	T2:5.4.1, 6.5

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Galvanic cell, batteries-lead acid cells, Crevice corrosion, cathodic protection, galvanizing, Electroplating.	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
2	Softening techniques, plastics, cement, refining of petroleuim.	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
3	Thiokol rubber, EDTA method, Dissolved oxygen, Viscosity, P^H meter.	Assignments / Laboratory Practices	PO 1	PSO 1

Prepared by:
Ms. V Anitha Rani, Associate Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	APPLIED PHYSICS				
Course Code	AHS007				
Programme	B.Tech				
Semester	I	AE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. Rizwana, Professor				
Course Faculty	Mr. K Saibaba, Assistant Professor				

I. COURSE OVERVIEW:

The course matter is divided into five units covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying mathematical and logical proofs and assumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include dielectric and magnetic properties, acoustics of buildings, ultrasonic and equilibrium of system of forces, friction and dynamics of rigid bodies. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respective branches and also in their lives.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of Physics

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop the strong fundamentals of system of forces and friction.
II	Strengthen the knowledge of theoretical and technological aspects of dynamics of rigid bodies.
III	Correlate principles with applications of the dielectric and magnetic materials.
IV	Enrich knowledge in acoustics and ultrasonic.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS007.01	CLO 1	Recall the basic principles of physics.	PO 1 , PO 2	3
AHS007.02	CLO 2	Apply the concepts and principles in solving the problems of physics.	PO 1 , PO 4	2
AHS007.03	CLO 3	Acquire knowledge of basic terms related to dielectric materials and different polarization mechanisms.	PO 1 , PO 4	2
AHS007.04	CLO 4	Review properties of different magnetic	PO 1 , PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		materials and magnetization based on orientation of domains.		
AHS007.05	CLO 5	Recollect basic principles of acoustics of buildings and modern architectural acoustic techniques.	PO 1 , PO 2	2
AHS007.06	CLO 6	Explain production, properties and applications of ultrasonic waves	PO 1 , PO 2	2
AHS007.07	CLO 7	Review the basic concepts of system of forces.	PO 1 , PO 4	1
AHS007.08	CLO 8	Analyze different law of forces and condition of equilibrium.	PO 2 , PO 4	1
AHS007.09	CLO 9	Discuss different types and laws of friction.	PO 2 , PO 4	1
AHS007.10	CLO 10	Interpret applications of friction.	PO 1 , PO 2	2
AHS007.11	CLO 11	Describe rotational motion of rigid bodies and moment of inertia of some of the regular shapes.	PO 1 , PO 4	2
AHS007.12	CLO 12	Identify and apply theorems of moment of inertia.	PO 1 , PO 2	3
AHS007.13	CLO 13	Correlate different concept of physics with day to day life applications.	PO 1	2
AHS007.14	CLO 14	Understand the technical importance of moment of inertia of regular and irregular bodies.	PO 2	2
AHS007.15	CLO 15	Identify the modern engineering devices based on basic principles of forces and friction.	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	2											2		
CLO 2	2			2									1		
CLO 3	3			1									2		
CLO 4	1	3													
CLO 5	3	2													
CLO 6	3	2											2		
CLO 7	2			1									2		
CLO 8		2		1											
CLO 9		1		1									2		
CLO 10	3	2											1		
CLO 11	2			1											
CLO 12	3	2											2		

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 13	2														
CLO 14		2											1		
CLO 15				1											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2	SEE Exams	PO1,PO4	Assignments	PO4	Seminars	PO2
Laboratory Practices	PO1,PO2	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	**DIELECTRIC AND MAGNETIC PROPERTIES**
Dielectric Properties: Basic definitions, electronic, ionic and orientation polarizations-qualitative; Internal field in solids. Magnetic Properties: Basic definitions, origin of magnetic moment, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment, domain theory of ferro magnetism on the basis of hysteresis curve.	
Unit-II	**ACOUSTICS AND ULTRASONICS**
Acoustics: Reverberation, reverberation time, Sabine's formula (qualitative), absorption coefficient, measurement of absorption coefficient, factors affecting acoustics of an auditorium and their remedies; Ultrasonics: Introduction; Generation of ultrasonic waves; Magnetostriction method, piezoelectric method, properties, applications.	
Unit-III	**EQUILIBRIUM OF SYSTEM OF FORCES**
Introduction, basic concepts, system of forces, coplanar concurrent forces, force systems in plane, parallel forces in plane; Force systems in space. Couples, resultant, Lami's theorem, triangle law of forces, polygon law of forces, condition of equilibrium.	
Unit-IV	**FRICTION**
Friction: Types of friction, limiting friction, laws of friction, angle of repose, equilibrium of body laying on rough inclined plane, Application of friction: ladder friction, wedge friction, screw friction.	
Unit-V	**DYNAMICS OF RIGID BODIES - MOMENT OF INERTIA**
Rotational motion, torque, angular momentum, relation between torque and angular momentum, angular momentum of system of particles, moment of inertia, expression for moment of inertia, radius of gyration, theorems on moment of inertia, moment of inertia of thin rod, rectangular lamina, circular disc.	

Text Books:
1. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, “Modern Engineering Physics”, Chand & Co. New Delhi, 1st Edition, 2010. 2. R. C Hibbler, "Engineering mechanics", Prentice Hall, 12th Edition, 2009.
Reference Books:
1. R. K. Gaur, S. L. Gupta, “Engineering Physics”, Dhanpat Rai Publications, 8th Edition, 2001. 2. Timoshenko, D. H. Young, "Engineering mechanics", Tata Mc Graw Hill, 5th Edition, 2013. 3. Hitendra K Malik, A. K. Singh, “Engineering Physics”, Mc Graw Hill Education, 1stEdition,2009. 4. S. S. Bhavikatti, "A text book of Engineering mechanics", New age international, 1st Edition, 2012.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Acquire knowledge of basic terms related to dielectric materials.	CLO 1	T1:13.5 R1:1.3
2	Discuss different polarization mechanisms in dielectrics	CLO 2	T1:13.5 R1:1.3
3-4	Derive expression for total electric field at a given point inside dielectrics.	CLO 32	T1:13.5 R1:1.3
5	Acquire knowledge of basic terms related to magnetic materials.	CLO 3	T1:14.7 R1:3.4
6	Describe magnetic moment in an atom in terms of Bohr Magneton	CLO 3	T1:15.7 R1:4.10
7-8	Classify different magnetic materials based on electron theory.	CLO 4	T1:16.8 R1:4.15
9	Examine the spontaneous magnetization in ferromagnets based on orientation of domains	CLO 4	T1:16.9 R1:5.4
10	Explain the basic terms related to acoustics of buildings	CLO 5	T1:17.9 R1:5.8
11	Analyze the Sabine’s formula of reverberation time	CLO 5	T1:18.10 R1:6.8
12	Calculate the absorption coefficient of a surface	CLO 6	T1:19.10 R1:6.13
13	Identify remedies for factors affecting architectural acoustics	CLO 6	T1:19.9 R1:7.5
14-15	Recall basics of ultrasonics	CLO 5	T1:23.10 R1:7.5
16	Explain the production of ultrasonics by Magnetostriction method	CLO 6	T1:23.10 R1:8.1
17	Explain the production of ultrasonics by Piezoelectric method	CLO 6	T1:23.1 R1:9.2
18-19	Review the properties of ultrasonics	CLO 6	T1:23.1 R1:9.4
20	Discuss the applications of ultrasonics	CLO 6	T1:23.1 R1:9.9
21	Identify the principle of forces	CLO 7	T1:23.1 R1:9.10
22	Recall different system of forces	CLO 7	T2:27.5 R1:10.2
23	Acquire knowledge of force systems in space	CLO 7	T2:27.7 R1:11.3
24-25	Analyze parallel forces in plane	CLO 8	T2:27.8

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			R1:11.6
26	Correlate couples in systems	CLO 8	T2:27.12 R1:11.7
27-28	Apply Lami's theorem to problems	CLO 8	T2:27.12 R1:11.8
29	Analyze triangle law of forces	CLO 8	T2:27.12 R1:11.9
30	Analyze polygon law of forces	CLO 7	T2:27.12 R1:11.10
31-32	Recognize condition of equilibrium	CLO 9	T2:27.14 R1:12.3
33	Understand friction	CLO 9	T2:27.1 R1:12.7
34-35	Discuss limiting friction	CLO 9	T2:27.17 R1:12.15
36	Analyze laws of friction	CLO 10	T2:27.18 R1:12.19
37-38	Describe angle of repose	CLO 10	T2:27.19 R2:14.4
39	Identify equilibrium of body laying on rough inclined plane	CLO 10	T2:27.20 R2:14.5
40-41	Solve problems on friction	CLO 10	T2:30.19 R2:14.5
42-43	Understand ladder friction	CLO 10	T2:30.20 R2:15.5
44-45	Discuss wedge friction	CLO 10	T2:32.19 R2:16.5
46-47	Describe screw friction	CLO 10	T2:32.20 R2:16.5
48-49	Explain basic concept rotational motion	CLO 11	T2:33.1 R2:16.6
50-51	Derive relation between torque and angular momentum	CLO 11	T2:34.1 R2:17.1
52-53	Acquire the knowledge of moment of inertia	CLO 12	T2:35.2 R2:17.2
54-55	Examine radius of gyration	CLO 11	T2:36.1 R2:18.1
56-57	Understand theorems on moment of inertia	CLO 12	T2:38.19 R2:16.5
58-59	Calculate moment of inertia of thin rod, Rectangular lamina	CLO 12	T2:39.19 R2:16.5
60	Calculate moment of inertia of circular disc	CLO 12	T2:40.19 R2:16.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest Lecture	PO 2	PSO 1

Prepared by:
Mr. K Saibaba, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	ENGINEERING DRAWING				
Course Code	AME001				
Program	B.Tech				
Semester	I	AE| ME|CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	2		4	3	4
Chief Coordinator	Prof. B.V. S. N. Rao, Professor				
Course Faculty	Mr.G. Sarat Raju, Assistant Professor Mr A. Anudeep Kumar, Assistant Professor Mr M. Sunil Kumar, Assistant Professor				

I. COURSE OVERVIEW:

One of the best ways to communicate one's ideas is through some form of picture or drawing. This is especially true for the engineer. An engineering drawing course focuses on usage of drawing instruments, lettering, construction of geometric shapes, etc. Students study use of dimensioning, shapes and angles or views of such drawings. Dimensions feature prominently, with focus on interpretation, importance and accurate reflection of dimensions in an engineering drawing. Other areas of study in this course may include projected views, pictorial projections and development of surfaces. This course also gives basic concepts for studying machine drawing, building drawing, circuit drawings etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS002	I	Linear Algebra and Differential Equations	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering drawing	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The SEE is conducted for 70 marks of 3 hours duration. 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. All the drawing related courses are evaluated in line with laboratory courses. The distribution shall be 30 marks for internal evaluation (20 marks for day–to–day work, and 10 marks for internal tests) and 70 marks for semester end lab examination. There shall be ONE internal test for 10 marks in each semester.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Engineering knowledge: Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	3	Assignments
PO 2	Problem analysis: An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	2	Assignments
PO 4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams	1	Assignments
PSO 2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	Assignments
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of engineering drawing and construction of curves used in engineering field
II	Apply the knowledge of interpretation of projection in different quadrants.
III	Understand the projections of solids, when it is inclined to both planes simultaneously
IV	Convert the pictorial views into orthographic view and vice versa.
V	Create intricate details of components through sections and develop its surfaces.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME001.01	CLO 1	Understand the BIS conventions of engineering drawing with basic concepts, ideas and methodology	PO 1	3
AME001.02	CLO 2	Recognize the need of single stroke lettering in defining the components	PO 1	3
AME001.03	CLO 3	Understand the different line types according to BIS standards to engineering drawings.	PO 1	3
AME001.04	CLO 4	Sketch the various types of polygons for applying in solid modeling	PO 2	2
AME001.05	CLO 5	Discuss the various types of scales for engineering application like maps, buildings, bridges.	PO 2	2
AME001.06	CLO 6	Visualize parabolic and elliptical profiles in buildings and bridges	PO 2	2
AME001.07	CLO 7	Visualize cycloidal and involute profiles in developing new products like gears and other engineering applications.	PO 4	1
AME001.08	CLO 8	Solve specific geometrical problems in plane geometry involving points and lines.	PO 4	1
AME001.09	CLO 9	Understand the theory of projection in planes located in various quadrants and apply in manufacturing processes.	PO 2	2
AME001.10	CLO 10	Understand the orthographic projection concepts in solid modeling and apply the concepts in the areas of design.	PO 2	2
AME001.11	CLO 11	Apply the terminology of development of surfaces in the area of chimneys and chutes.	PO 1	3
AME001.12	CLO 12	Visualize the components by isometric projection by representing three dimensional objects in two dimensions in technical and engineering drawings.	PO 1	3
AME001.13	CLO 13	Interpret plumbing drawings typically found in construction by using transformation of projection.	PO 1	3
AME001.14	CLO 14	Convert the orthographic views into pictorial views by using transformation of projection.	PO 1, PO 2	3
AME001.15	CLO 15	Convert the pictorial views into orthographic views by using transformation of projection..	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4		2													
CLO 5		2													
CLO 6		2													
CLO 7				1											
CLO 8				1											
CLO 9		2											1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		2													

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	PO 2	Student Viva	-	Mini Project	-	Certification	-
Term Paper				Project			

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	FUNDAMENTALS OF ENGINEERING DRAWING, SCALES AND CURVES
Introduction to engineering drawing: Drawing instruments and accessories, types of line, lettering practice and rules of dimensioning, geometrical constructions, basic geometrical shapes; Scales: Types	

of scales, units of length and their conversion, construction of scales, plain scale, diagonal scale, vernier scale; Curves used in engineering practice and their constructions; Conic sections, construction of ellipse parabola and hyperbola, special curves, construction of cycloid, epicycloids, hypocycloid and involutes..	
UNIT-II	**ORTHOGRAPHIC PROJECTION, PROJECTION OF PLANES**
Orthographic projection: Principles of orthographic projections, conventions, first and third angle projections, projection of points, projection of lines, lines inclined to single plane, lines inclined to both the planes, true lengths and traces; Projection of planes: Projection of regular planes, planes inclined to one plane, planes inclined to both planes, projection of planes by auxiliary plane projection method.	
UNIT-III	**PROJECTION OF SOLIDS**
Projection of solids: Projections of regular solid, prisms, cylinders, pyramids, cones. Solids inclined to one plane, solids inclined to both planes, projection of solid by auxiliary Page | 5 plane projection method.	
UNIT-IV	**DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS**
Development of surfaces: Development of lateral surface of right regular solids, prisms, cylinders, pyramids and cones; Isometric projections: Principle of isometric projection, isometric scale, isometric projections and isometric views, isometric projections of planes, prisms, cylinders, pyramids, and cones.	
UNIT-V	**TRANSFORMATION OF PROJECTIONS**
Transformation of projections: Conversion of isometric views to orthographic views and conversion of orthographic views to isometric views..	
Text Books:	
1. N. D. Bhatt, "Engineering Drawing", Charotar Publications, 49thEdition, 2012. 2. C. M. Agrawal, Basant Agrawal, "Engineering Drawing'', Tata McGraw Hill, 2ndEdition, 2013.	
Reference Books:	
1. K.Venugopal, "Engineering Drawing and Graphics", New Age Publications, 2ndEdition, 2010. 2. K. C. John, "Engineering Drawing", PHI Learning Private Limited", 2nd Edition, 2009. 3. Dhananjay. A. Johle, "Engineering Drawing", Tata McGraw Hill, 1st Edition, 2008.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Principles of engineering drawing – various drawing instruments and their uses. (general exercises).	CLO 1	T1:1.1
2	Conventions in Drawing – Lettering – BIS	CLO 2	T1:1.1
3	Geometrical constructions.	CLO 2	T1: 2.1
4	Construction of various scales for engineering use-Plain and diagonal	CLO 2	T1:2.2 R1: 2.2.3
5	Construction of various scales for engineering use- Vernier scales	CLO 1	T1: 2.3
6	Construction of various curves.-general method	CLO 2	T1: 3.1
7	Construction of various curves- ellipse, parabola & hyperbola	CLO1	T1:3.3
8	Construction of various curves cycloid, epicycloids, hypocycloid and involutes.	CLO 2	T1:3.4, R1: 4.1
9	Projection of points and lines inclined to single plane.	CLO 2	T1: 4.1
10	Projection of lines inclined to both planes	CLO1	T1: 4.3
11	Projection of planes-simple position.	CLO 1	T1: 4.3.2
12	Projection of planes- inclined to a both planes.	CLO1	T1:4.3
13	Projection of solids inclined to single plane.	CLO 2	T1: 4.4
14	Projection of solids inclined to a both planes.	CLO 2	T1: 5.2
15	Projection of solids Auxiliary plane method	CLO 2	T1: 5.2.3
16	Draw the development of surfaces	CLO 1	T1: 6.1
17	Draw the isometric projections	CLO 2	T1: 8.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
18	Convert the pictorial views to orthographic views	CLO 2	T1:8.1.2

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Increase ability to communicate with people.	Seminars	PO 1, PO 2,	PSO 1
2	Learn to take data and transform it into graphic drawings	Guest Lectures	PO4, PO 5	PSO 2
3	Students will become familiar with office practices and standards.	Assignments / Laboratory Practices	PO9, PO10	PSO 3

Prepared by:
Mr. B.V.S.N. Rao, Professor

HOD, MECHANICAL ENGINEERING

II SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTER PROGRAMMING**				
Course Code	ACS001				
Programme	B.Tech				
Semester	I	CSE | IT| ECE | EEE			
	II	AE | CE| ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	4	2
Chief Coordinator	Dr. K Srinivasa Reddy, Professor & HOD, IT				
Course Faculty	Ms N Jayanthi Dr. G Ramu Dr. J Sirisha Devi Dr. K Suvarchala Ms. B Rekha Ms. B Padmaja Ms. G Geetha Reddy Ms. K Laxmi Narayanamma Mr. R M Norullah				

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
-	-	-	Basic Mathematics and Logical Thinking

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computer Programming	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 fiveunits 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Assignments
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	Assignments
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	Seminars, Viva
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	5 minutes video

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Projects
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	3	Lectures, Assignments
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	1	5 minutes video

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Learn adequate knowledge by problem solving techniques.
II	Understand programming skills using the fundamentals and basics of C Language.
III	Improve problem solving skills using arrays, strings, and functions.
IV	Understand the dynamics of memory by pointers.
V	Study files creation process with access permissions

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACS001.01	CLO 1	Identify and understand the working of key components of a computer system.	PO 1, PO 4	2
ACS001.02	CLO 2	Analyze a given problem and develop an algorithm to solve the problem.	PO 2, PO 3	3
ACS001.03	CLO 3	Describe the fundamental programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.	PO 2, PO 4	2
ACS001.04	CLO 4	Gain knowledge to identify appropriate C language constructs to write basic programs.	PO 1, PO 3	3
ACS001.05	CLO 5	Identify the right data representation formats based on the requirements of the problem.	PO 2,PO 3	3
ACS001.06	CLO 6	Describe the operators, their precedence and associativity while evaluating expressions in program statements..	PO 1, PO 4	2
ACS001.07	CLO 7	Understand branching statements, loop statements and use them in problem solving.	PO 1,PO 4	2
ACS001.08	CLO 8	Learn homogenous derived data types and use them to solve statistical problems.	PO 2, PO 3	3
ACS001.09	CLO 9	Understand procedural oriented programming using functions.	PO 2	3
ACS001.10	CLO 10	Understand how recursion works and write programs using recursion to solve problems.	PO 1, PO 2	3
ACS001.11	CLO 11	Differentiate call by value and call by reference parameter passing mechanisms.	PO 2	3
ACS001.12	CLO 12	Understand pointers conceptually and apply them in C programs.	PO 1	3
ACS001.13	CLO 13	Distinguish homogenous and heterogeneous data types and apply them in solving data processing applications.	PO 3	2
ACS001.14	CLO 14	Explain the concept of file system for handling data storage and apply it for solving problems.	PO 1, PO 3	3
ACS001.15	CLO 15	Differentiate text files and binary files and write the simple C programs using file handling functions. Searching, Sorting.	PO 2	3
ACS001.16	CLO 16	Apply the concepts to solve real-time applications using the features of C language.	PO 2	3
ACS001.17	CLO 17	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 1, PO 4	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes POs												Program Specific Outcomes PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3			1										3	
CLO 2		3	2										2		1
CLO 3		3		1									2		

CLOs	Program Outcomes POs												Program Specific Outcomes PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 4	3			1									2		
CLO 5		3	2										2	3	
CLO 6	3			1											1
CLO 7	3			1										3	
CLO 8		3	2										2		
CLO 9		3												3	
CLO 10	3	3											2		1
CLO 11		3												3	
CLO 12	3												2	3	
CLO 13			2										2		
CLO 14	3		2											3	1
CLO 15		3												3	
CLO 16		3												3	
CLO 17	3			1									2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO 3, PO 4	SEE Exams	PO 1, PO2, PO 3, PO 4	Assignments	PO 2	Seminars	PO 3
Laboratory Practices	PO 1	Student Viva	PO 3	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	INTRODUCTION
Introduction to computers: Computer systems, computing environments, computer languages, creating and running programs, algorithms, flowcharts; Introduction to C language: History of C, basic structure of C programs, process of compiling and running a C program, C tokens, keywords, identifiers, constants, strings, special symbols, variables, data types; Operators and expressions: Operators, arithmetic, relational and logical, assignment operators, increment and decrement operators, bitwise and conditional operators, special operators, operator precedence and associativity, evaluation of expressions, type conversions in expressions, formatted input and output.	
UNIT-II	**CONTROL STRUCTURES**
Control structures: Decision statements; if and switch statement; Loop control statements: while, for and do while loops, jump statements, break, continue, goto statements; Arrays: Concepts, one dimensional arrays, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi dimensional arrays; Strings concepts: String handling functions, array of strings.	
UNIT-III	**ARRAYS AND FUNCTIONS**
Functions: Need for user defined functions, function declaration, function prototype, category of functions, inter function communication, function calls, parameter passing mechanisms, recursion, passing arrays to functions, passing strings to functions, storage classes, preprocessor directives. Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers.	
UNIT-IV	**STRUCTURES, UNIONS AND POINTERS**
Structures and unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, structures and functions, passing structures through pointers, self referential structures, unions, bit fields, typedef, enumerations; Dynamic memory allocation: Basic concepts, library functions.	
UNIT-V	**FILE HANDLING AND BASICALGORITHMS**
Files: Streams, basic file operations, file types, file opening modes, file input and output functions, file status functions, file positioning functions, command line arguments.	
Text Books:	
1. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014. 2. B. A. Forouzan, R. F. Gillberg, "C Programming and Data Structures", Cengage Learning, India, 3rd Edition, 2014.	
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. E. Balagurusamy, "Programming in ANSI C", Mc Graw Hill Education, 6th Edition, 2012. 4. Schildt Herbert, "C: The Complete Reference", Tata Mc Graw Hill Education, 4th Edition, 2014. 5. R. S. Bichkar, "Programming with C", Universities Press, 2nd Edition, 2012. 6. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1 – 2	Introduction to Computers: computer systems, computing environments.	CLO 1	T2:1.1-1.2
3 – 4	Computer languages, creating and running programs, program development.	CLO 1	T2:2.1-2.2
5 – 6	Algorithms, flowcharts	CLO 2	T2:1.4-1.5
7 – 8	Introduction to C Language: background, C programs.	CLO 3	T2:2.1-2.2
9 – 10	Identifiers, data types, Input/output, variables, constants, Operators (arithmetic, relational, logical, bitwise etc).	CLO 3	T2: 2.3- 2.6,7
11 – 12	Expressions, precedence and associativity, expression evaluation, type conversions	CLO 6	T2:3.1-3.5
13 – 14	Statements - selection statements (making decisions) – if statement, switch statement.	CLO 7	T2: 5.2-5.3
15 – 16	Repetition statement (loops)-while, dowhile statements, for statements, loop examples	CLO 7	T2: 6.1-6.6
17 – 18	Other statements related to looping – break, continue, go to, simple C program examples.	CLO 7	T2: 6.7
19 – 20	Arrays- Concepts, using arrays in C, declaration and initialization of one dimensional array, C program example. Two dimensional arrays, initialization and accessing, multi dimensional arrays, C program example.	CLO 8	T2: 8.1-8.3,8.7-8.8
21-22	Strings – Strings concepts: String handling functions, array of strings, C program examples.	CLO 8	T2: 11.1-11.5
23-- 24	Functions- Need for user defined functions, function declaration, function prototype. Category of functions, inter function communication, function calls, parameter passing mechanisms.	CLO 9	T2: 4.1-4.5
25	Recursion, passing arrays to functions, passing strings to functions, Storage classes and preprocessor commands.	CLO 10	T1:7 T2:6.9 T2:G.1
26-27	Pointer basics, pointer arithmetic, pointers to pointers, generic pointers. Pointer applications-Arrays and pointers, pointer arithmetic and arrays, passing an array to a function.	CLO 12	T1:1.0
28 – 29	Array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers	CLO 12	T2:10.3-10.5
30 – 31	Structures – declaration, initialization, accessing structures, operations on structures.	CLO 13	T1:8
32 – 33	Complex structures, structures and functions, passing structures through pointers, self-referential structures.	CLO 13	T2: 12.3-12.4
34 – 35	Unions, C programming examples, Bit fields, typedef, enumerations.	CLO 13	T2:12.4 T2:12.1- 12.2
36 -- 38	Dynamic memory allocation: Basic concepts, library functions	CLO 13	T2:2.1-2.2
39 – 40	Files: Concept of a file, streams, types of files and file opening modes.	CLO 14	R3:12.1-12.3
41 – 42	File input/output functions (standard input/output functions for files).	CLO 14	R3:12.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
43 – 44	File status functions (error handling), positioning functions, C program examples.	CLO 15	R3:12.5
45	Command-line arguments.	CLO 15	R3:12.7

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Updating latest version and new features of the C language	Laboratory Sessions	PO5	PSO2
2	Familiarizing the role of C language in developing system level programs.	Assignments / Industrial visits	PO1,PO2	PSO2
3	Familiarizing different areas where C language can be used.	Seminars	PO12	PSO3
4	Solving different problems and Practicing various debugging strategies to become a good programmer	Extra Lab Sessions, Participating in Coding contests	PO2	PSO3

Prepared by:
N Jayanthi, Assistant Professor

HOD, CSE

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL MATHEMATICS AND INTEGRAL CALCULUS**				
Course Code	AHS003				
Programme	B.Tech				
Semester	I	CSE | IT| ECE | EEE			
	II	AE| ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. V Subba Laxmi Assistant Professor				
Course Faculty	Dr. S Jagadha, Professor Ms. L Indira, Assistant Professor Mr. Ch Somashekar, Assistant Professor Ms. P Rajani, Assistant Professor Ms. B Praveena, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes types of interpolation, curve fitting, numerical solutions of ordinary differential equations, multiple integrals, vector calculus and special functions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Differentiation, integration and properties of vectors

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computational Mathematics and Integral calculus	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of solving algebraic, transcendental and differential equation by numerical methods.
II	Apply multiple integration to evaluate mass, area and volume of the plane
III	Analyze gradient, divergence and curl to evaluate the integration over a vector field.
IV	Understand the Bessel's equation to solve them under special conditions with the help of series solutions.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS003.01	CLO 1	Solve the algebraic and transcendental equations using bisection method, method of false position and Newton-Raphson method.	PO 1	3
AHS003.02	CLO 2	Apply numerical methods to interpolate the functions of values for equal intervals using finite differences.	PO2	3
AHS003.03	CLO 3	Understand the Newton-Raphson method to the real-world problem for a finite barrier quantum well.	PO 4	1
AHS003.04	CLO 4	Evaluate the functional value by using Lagrange's interpolation formula for unequal intervals.	PO2	2
AHS003.05	CLO 5	Understand the Lagrange's interpolation in real-world problem for neural network learning.	PO 4	1
AHS003.06	CLO 6	Apply method of least squares to fit linear and non linear curves.	PO1, PO 2	2
AHS003.07	CLO 7	Solve differential equation using single step method- Taylor's series.	PO 1	3
AHS003.08	CLO 8	Solve differential equation using multi step methods- Euler's, Modified Euler's and Runge Kutta methods.	PO 2	2
AHS003.09	CLO 9	Understand the multistep methods in real-worl problem for real time Aircraft dynamics.	PO 4	1
AHS003.10	CLO 10	Understand the Runge-Kutta method in real-world problem for embedding the sensor signals into the iterative computation.	PO 4	1
AHS003.11	CLO 11	Evaluate double integral and triple integrals .	PO 1	2
AHS003.12	CLO 12	Utilize the concept of change order of integration to evaluate double integrals.	PO 1,PO2	2
AHS003.13	CLO 13	Determine the area and volume of a given curves using double and triple integration.	PO 2	3
AHS003.14	CLO 14	Understand transformation of co-ordinate system from plane to plane.	PO 1	3
AHS003.15	CLO 15	Analyze scalar and vector fields and compute the gradient, divergence and curl.	PO 2	3
AHS003.16	CLO 16	Understand integration of vector function .	PO 1	2
AHS003.17	CLO 17	Evaluate line, surface and volume integral of vectors.	PO 1	3
AHS003.18	CLO 18	Use Vector integral theorems to facilitate vector integration .	PO 2	2
AHS003.19	CLO 19	Analyze the concept of vector calculus in real-world problem for fluid dynamics.	PO 4	1
AHS003.20	CLO 20	Solve the Differential Equations by series solutions.	PO 1	3
AHS003.21	CLO 21	Understand Gamma function to evaluate improper integrals.	PO 1	2
AHS003.22	CLO 22	Analyze Bessel's function and study its properties	PO 1	3
AHS003.23	CLO 23	Analyze Bessel's function as a Solution to Schrödinger equation in a cylindrical function of the second kind.	PO 4	1
AHS003.24	CLO 24	Understand gamma function to find application diverse areas as quantum physics.	PO 4	1
AHS003.25	CLO 25	Possess the knowledge and skills for employability and to succeed in national and International level competitive examinations.	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2		3											1		
CLO 3				1									1		
CLO 4		2													
CLO 5				1											
CLO 6	2	2													
CLO 7	3														
CLO 8	2														
CLO 9				1									1		
CLO 10				1									1		
CLO 11	2														
CLO 12	2	2													
CLO 13		3													
CLO 14	3												1		
CLO 15		3													
CLO 16	2														
CLO 17	3												1		
CLO 18		2											1		
CLO 19				1									1		
CLO 20	3												1		
CLO 21		2													
CLO 22	3														
CLO 23				1											
CLO 24				1											
CLO 25				1											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1 PO 2 PO 4	SEE Exams	PO 1 PO 2 PO 4	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	ROOT FINDING TECHNIQUES AND INTERPOLATION
Root finding techniques: Solving algebraic and transcendental equations by Bisection method, Method of False position, Newton-Raphson method; Interpolation: Finite differences, forward differences, backward differences and central differences; Symbolic relations; Newton's forward interpolation, Newton's backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange,'s interpolation .	
UNIT-II	**CURVE FITTING AND NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**
Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares; Taylor's series method; Step by step methods: Euler's method, modified Euler's method and Runge-Kutta method for first order differential equations .	
UNIT-III	**MULTIPLE INTEGRALS**
Double and triple integrals; Change of order of integration. Transformation of coordinate system; Finding the area of a region using double integration and volume of a region using triple integration.	
UNIT-IV	**VECTOR CALCULUS**
Scalar and vector point functions; Gradient, divergence, curl and their related properties; Solenoidal and irrotational vector point functions; Scalar potential function; Laplacian operator; Line integral, surface integral and volume integral; Vector integral theorems: Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.	
UNIT-V	**SPECIAL FUNCTIONS**
Gamma function, properties of gamma function; Ordinary point and regular singular point of differential equations; Series solutions to differential equations around zero, Frobenius method about zero; Bessel"s differential equation: Bessel functions properties, recurrence relations, orthogonality, generating function, trigonometric expansions involving Bessel functions.	
Text Books:	
1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.	
Reference Books:	
1. T.K.V Iyengar, B.Krishna Gandhi, "Mathematical methods", S. Chand & Co., 6th Edition, 2014. 2. R K Jain, S R K Iyengar, "Advanced Engineering Mathematics", Narosa Publishers, 5th Edition, 2016. 3. S. S. Sastry, "Introduction Methods of Numerical Analysis", Prentice-Hall of India Private Limited, 5th Edition, 2012.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Define Algebraic and Transcendental equations	CLO 1	T1:22.5 R1:2.3
2	Explain Bisection method to find the root of an equation.	CLO 1	T1:22.5 R1:2.4
3	Explain Method of False Position to to find root an equation.	CLO 1	T1:22.6 R1:2.6
4	Explain Newton-Raphson method to find root of an equation.	CLO 3	T1:22.7 R1:4.4
5	Define interpolation of the given data.	CLO 2	T1:22.7 R1:4.10
6	Explain symbolic relations the between the operators.	CLO 2	T1:22.8 R1:4.15
7	Define Newton's forward interpolation formula for evenly spaced intervals..	CLO 2	T1:22.9 R1:5.4
8	Define Newton's backward interpolation formula for evenly spaced intervals.	CLO 2	T1:22.9 R1:5.8
9	Define Gauss forward interpolation formula for evenly spaced intervals..	CLO 2	T1:23.10 R1:6.8
10	Define Gauss backward interpolation formula for evenly spaced intervals.	CLO 2	T1:23.10 R1:6.13
11	Demonstrate Lagrange's formula for unequal intervals.	CLO 5	T1:23.9 R1:7.5
12	Describe the best fit of a straight line by method of least squares.	CLO 6	T1:23.10 R1:7.5
13	Describe the best fit of a second degree parabola by method of least squares	CLO 6	T1:23.10 R1:8.1
14	Describe the best fit of an exponential curve by method of least squares	CLO 6	T1:23.1 R1:9.2
15	Describe the best fit of a power curve by method of least squares	CLO 6	T1:23.1 R1:9.4
16	Solve the ordinary differential equation by Taylors series method.	CLO 6	T1:23.1 R1:9.9
17	Solve the ordinary differential equation by Euler's Method-Euler's modified method.	CLO 8	T1:23.1 R1:9.10
18	Solve the ordinary differential equation by Runge-Kutta Method.	CLO 8	T2:27.5 R1:10.2
19	Evaluate double and triple integrals.	CLO 8	T2:27.7 R1:11.3
20	Use the Change of order of integration cartesian and polar form.	CLO 12	T2:27.8 R1:11.6
21	Explain Transformation of co-ordinate system	CLO 11	T2:27.12 R1:11.7
22	Use double integration for finding the area.	CLO 14	T2:27.12 R1:11.8
23	Use triple integration for finding the volume.	CLO 14	T2:27.12 R1:11.9
24	Define vector calculus and vector fields and their properties	CLO 19	T2:27.12 R1:11.10
25	Determine Gradient, divergent and curl of vector fields.	CLO 19	T2:27.14 R1:12.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
26	Solve line integral along smooth path and find work done .	CLO 17	T2:27.1 R1:12.7
27	Evaluate surface integral.	CLO 17	T2:27.17 R1:12.15
28	Use Green's theorem to evaluate line integrals along simple closed contours on the plane.	CLO 17	T2:27.18 R1:12.19
29	Use Stokes' theorem to give a physical interpretation of the curl of a vector field .	CLO 17	T2:27.19 R2:14.4
30	Use the divergence theorem to give a physical interpretation of the divergence of a vector field	CLO 17	T2:27.19 R2:14.5
31	Explain gamma function s for improper integrals and gamma properties .	CLO 21	T2:27.19 R2:14.5
32	Define Ordinary and regular point of a differential equation.	CLO 23	T2:27.20 R2:14.5
33	Determine the solution of ordinary differential equations in series form.	CLO 23	T2:27.20 R2:14.5
34	Explain Frobenius Method about zero.	CLO 20	T2:27.19 R2:14.5
35	Define Bessel's Differential equation .	CLO 22	T2:27.19 R2:14.5
36-37	Explain Bessel's differential function and properties.	CLO 22	T2:27.19 R2:14.5
38-39	Explain Recurrence relations for Bessels function.	CLO 23	T2:27.19 R2:14.5
40-42	Explain Orthogonality of Bessel's function.	CLO 23	T2:27.20 R2:14.5
43-44	Explain Generating function of Bessel's function.	CLO 23	T2:27.20 R2:14.5
45	Explain trigonometric expansions of Bessels function.	CLO 23	T2:27.19 R2:14.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Newton Raphson method, Lagranges interpolation, method of least square and Runge-kutta method	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 4	PSO 1

Prepared by:
Mr. V Subba Laxmi, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MODERN PHYSICS**				
Course Code	AHS008				
Programme	B.Tech				
Semester	II	AE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. A Chandra Prakash, Assistant Professor				
Course Faculty	Dr. Rizwana, Professor Ms. S Charvani, Associate Professor Mr. K Saibaba, Assistant Professor				

I. COURSE OVERVIEW:

The course matter is divided into five units covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying mathematical and logical proofs and assumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include crystallography, X-ray diffraction, defects in crystals, lasers, sensors, fiber optics, interference and diffraction. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respective branches and also in their lives.

II. COURSE PRE-REQUISITES:

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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Modern Physics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop strong fundamentals of crystal structures and properties.
II	Meliorate the knowledge of theoretical and technological aspects of lasers.
III	Correlate principles with applications of the x-ray diffraction and defects in crystals.
IV	Enrich knowledge in modern engineering principles of interference and diffraction.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS008.01	CLO 1	Recall the basic principles of physics and apply these concepts of physics in solving the real-time problems.	PO 1 , PO 2	3
AHS008.02	CLO 2	Acquire knowledge of basic terms related to crystals, crystal systems, Bravais lattices and Miller Indices.	PO 1 , PO 4	3
AHS008.03	CLO 3	Discuss in detail different crystal structures and calculate their packing factors.	PO 1 , PO 4	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS008.04	CLO 4	Describe different X-ray diffraction in research and development for the study of internal structures of materials.	PO 1 , PO 2	2
AHS008.05	CLO 5	Identify various types of defects in crystals and their effect on structure sensitive properties.	PO 1 , PO 2	2
AHS008.06	CLO 6	Understand the basic principles involved in the production of Laser light and also real-time applications of lasers.	PO 1 , PO 2	2
AHS008.07	CLO 7	Explain the principle involved in working of different types of laser systems.	PO 1 , PO 4	1
AHS008.08	CLO 8	Analyze basic laws of physics to correlate the mechanism of sensors in day to day life. Principle of sensor along with their applications.	PO 2 , PO 4	1
AHS008.09	CLO 9	Understand the importance of various sensors in real-time applications like measurement of pressure in aeronautics, detecting submarines in acoustics.	PO 2 , PO 4	2
AHS008.10	CLO 10	Recollect basic principle, construction, types and attenuation of optical fibers.	PO 1 , PO 2	2
AHS008.11	CLO 11	Apply properties of optical fibers in various real-time applications like measurement of pressure, temperature , displacement etc.,	PO 1 , PO 4	3
AHS008.12	CLO 12	Understand the importance of optical fibers in real-time communication system.	PO 1 , PO 2	3
AHS008.13	CLO 13	Interpret phenomenon of interference in thin films using Newton's rings experiment.	PO 1 , PO 4	3
AHS008.14	CLO 14	Identify difference in diffraction phenomenon due to single slit and N-slits.	PO 2 , PO 4	1
AHS008.15	CLO 15	Apply different laws of radiation to understand the phenomenon behind production of light.	PO 1 , PO 4	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	2											1		
CLO 2	2			2									1		
CLO 3	3			1									1		
CLO 4	1	3													
CLO 5	3	2													
CLO 6	3	2											1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 7	2			1									1		
CLO 8		2		1											
CLO 9		1		1									1		
CLO 10	3	2											1		
CLO 11	2			1											
CLO 12	3	2											1		
CLO 13	2			1											
CLO 14		1		2									1		
CLO 15	3			2											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1,PO 2	SEE Exams	PO 1,PO 4	Assignments	PO 4	Seminars	PO 2
Laboratory Practices	PO 1,PO 2	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	CRYSTALLOGRAPHY AND CRYSTAL STRUCTURES
Crystallography and crystal structures: Space lattice, unit cell, lattice parameters, crystal systems, Bravais lattices, directions and planes in crystals, Miller indices, interplanar spacing of orthogonal crystal systems, atomic radius, coordination number and packing factor of SC, BCC, FCC, NaCl and diamond structures.	
UNIT-II	**X-RAY DIFFRACTION AND DEFECTS IN CRYSTALS**
X-ray diffraction: Bragg's law, Laue method, powder method and applications; Defects in crystals: Concepts of point defects, vacancies, substitutional, interstitial, frenkel, schottky defects, line defects and Burger's vector.	
UNIT-III	**LASERS AND SENSORS**
Lasers: Characteristics of lasers, spontaneous and stimulated emission of radiation, metastable	

state, population inversion, lasing action, ruby laser, semiconductor diode laser and applications of lasers. Sensors: Introduction, basic principles, sensor materials and applications: principle of pressure, optical, acoustic and thermal sensing.
UNIT-IV **FIBER OPTICS**
Fiber optics: Principle and construction of an optical fiber, acceptance angle, numerical aperture, types of optical fibers (Single mode, multimode, step index, graded index), attenuation in optical fibers, application of optical fibers and optical fiber communication system with block diagram.
UNIT-V **INTERFERENCE AND DIFFRACTION**
Interference: Phase difference, path difference, coherence, conditions for constructive and destructive interference, interference in thin films due to reflected light, Newton rings experiment. Diffraction: Introduction, differences between interference and diffraction, types of diffraction, Fraunhofer diffraction due to single slit, N-slits, diffraction grating experiment.
Text Books:
1. V. Rajendran, "Engineering Physics", Tata Mc Graw Hill Book Publishers, 1st Edition, 2010. 2. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", S. Chand & Co., New Delhi, 1st Edition, 2010.
Reference Books:
1. P. K. Palanisamy, "Engineering Physics", Scitech Publishers, 4th Edition, 2014. 2. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001. 3. A. J. Dekker, "Solid State Physics", Macmillan India ltd, 1st Edition, 2000. 4. Hitendra K. Malik, A. K. Singh, "Engineering Physics", Mc Graw Hill Education, 1st Edition, 2009.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Acquire knowledge of basic terms related to crystal structures.	CLO 2	T1:13.5 R1:1.3
2	Discuss different crystal systems.	CLO 2	T1:13.5 R1:1.3
3	Identify and sketch various planes in the crystal using the Miller indices concept.	CLO 3	T1:13.5 R1:1.3
4	Derive and calculate the distance between two adjacent parallel planes.	CLO 3	T1:14.7 R1:3.4
5	Determine co-ordination Number and packing Factor of SC structure.	CLO 3	T1:15.7 R1:4.10
6	Determine co-ordination Number and packing Factor of BCC structure.	CLO 3	T1:16.8 R1:4.15
7	Determine co-ordination Number and packing Factor of FCC structure.	CLO 3	T1:16.9 R1:5.4
8	Determine co-ordination Number and packing Factor of DC structure.	CLO 3	T1:17.9 R1:5.8
9	Discuss in detail NaCl structure.	CLO 2	T1:18.10 R1:6.8
10	Analyze the concept of X-ray diffraction in crystals	CLO 4	T1:19.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	using Bragg's law.		R1:6.13
11	Apply Bragg's law to Laue method.	CLO 4	T1:19.9 R1:7.5
12	Determine crystal structure using powder method and discuss its applications.	CLO 4	T1:23.10 R1:7.5
13	Illustrate point defects like vacancies, substitutional and interstitial defects.	CLO 5	T1:23.10 R1:8.1
14	Recall basics of Frenkel and Schottky defects.	CLO 5	T1:23.1 R1:9.2
15	Understand the concept of edge dislocation.	CLO 5	T1:23.1 R1:9.4
16	Understand the concept of screw dislocation..	CLO 5	T1:23.1 R1:9.9
17	Find the magnitude of Burger's vector.	CLO 5	T1:23.1 R1:9.10
18	Apply Bragg's law for finding parameters related to crystal structures.	CLO 5	T2:27.5 R1:10.2
19	Review basic phenomena's of laser	CLO 6	T2:27.7 R1:11.3
20	Acquire knowledge of basic terms related to lasers	CLO 6	T2:27.8 R1:11.6
21	Explain the construction of ruby laser	CLO 6	T2:27.12 R1:11.7
22	Explain the working of Ruby laser	CLO 7	T2:27.12 R1:11.8
23	Explain the principle and working of semiconductor diode laser and also Discuss the uses of lasers.	CLO 7	T2:27.12 R1:11.9
24	Understand the basic principle in sensors.	CLO 8	T2:27.12 R1:11.10
25	Analyze different sensing materials.	CLO 8	T2:27.14 R1:12.3
26	Recognize functioning of sensors in different fields.	CLO 8	T2:27.1 R1:12.7
27	Recognize functioning of sensors in different fields.	CLO 9	T2:27.17 R1:12.15
28	Recall the principle of fiber optics.	CLO 10	T2:27.18 R1:12.19
29	Derive relation for acceptance angle.	CLO 10	T2:27.19 R2:14.4
30	Calculate numerical aperture.	CLO 10	T2:27.20 R2:14.5
31	Classify optical fibers based on modes.	CLO 11	T2:30.19 R2:14.5
32	Classify optical fibers based on the refractive index profile.	CLO 11	T2:30.20 R2:15.5
33-34	Identify losses in fibers.	CLO 11	T2:32.19 R2:16.5
35-37	Examine the application of fibers.	CLO 12	T2:32.20 R2:16.5
38	Understand optical fiber communication system.	CLO 12	T2:33.1 R2:16.6
39-41	Solve problems in optical fibers.	CLO 12	T2:34.1 R2:17.1
42-43	Recall the basic principle of interference.	CLO 13	T2:35.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			R2:17.2
44-45	Describe interference in thin films.	CLO 13	T2:36.1 R2:18.1
46-48	Demonstrate the formation of Newton rings.	CLO 13	T2:38.19 R2:16.5
49	Demonstrate the formation of Newton rings.	CLO 14	T2:39.19 R2:16.5
50-53	Understand the phenomenon of diffraction.	CLO 14	T2:40.19 R2:16.5
54-55	Examine Fraunhofer diffraction due to single slit	CLO 14	T2:41.19 R2:16.5
56-57	Examine Fraunhofer diffraction due to single slit	CLO 15	T2:42.19 R2:16.5
58-59	Examine Fraunhofer diffraction due to N slits.	CLO 15	T2:42.19 R2:16.5
60	Identify Diffraction grating experiment	CLO 15	T2:42.19 R2:16.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lecture	PO 2	PSO 1

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HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENVIRONMENTAL STUDIES**				
Course Code	AHS009				
Programme	B.Tech				
Semester	II	AE | CSE | IT | ECE| EEE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. M Lakshmi Prasanna, Assistant Professor				
Course Faculty	Dr. C Mahendar, Professor Ms. V Anitha Rani, Associate Professor Mr. B Raju, Assistant Professor Ms. M Praveen, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Swathi, Assistant Professor				

I. COURSE OVERVIEW:

Environmental study is interconnected interrelated and interdependent subject. Hence, it is multidisciplinary in nature. The present course is framed by expert committee of UGC under the direction of honorable supreme court to be as a core module syllabus for all branches of higher education and to be implemented in all universities over India. The course is designed to create environmental awareness and consciousness among the present generation to become environmental responsible citizens. The course description is multidisciplinary nature of environmental studies, natural resources Renewable and non-renewable resources Ecosystems Biodiversity and its conservation Environmental pollution Social issues and the environment Human population and the environment Pollution control acts and field work. The course is divided into five chapters for convenience of academic teaching followed by field visits.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic Principles of Environmental Studies

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Environmental Studies	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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 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 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 centre. 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 section XI.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Seminar
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	Seminar
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.	1	Real-time applications
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.	1	Real-time applications

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze the interrelationship between living organism and environment
II	Understand the importance of environment by assessing its impact on the human world
III	Enrich the knowledge on themes of biodiversity, natural resources, pollution control and waste management
IV	Understand the constitutional protection given for environment

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS009.01	CLO 1	Understand and realize the importance of multi-disciplinary nature of the environment in day to day life	PO 1, PO 3	2
AHS009.02	CLO 2	Describe various types of ecosystems its components and inter-relationship between man and environment	PO 1, PO 3	2
AHS009.03	CLO 3	Examine how pollutants move through various levels in an ecosystem in our daily life	PO 1, PO 3, PO 7	2
AHS009.04	CLO 4	Explain the pathways of relevant chemical elements through the components of the biosphere in real world applications	PO 1, PO 3, PO 7	2
AHS009.05	CLO 5	Understand the relevance and importance of the natural resources in the sustenance of life on earth and living standard.	PO 1, PO 3, PO 5, PO 7	2
AHS009.06	CLO 6	Develop an understanding of the natural resources problems and ethical issues facing humans and the environment	PO 1, PO 3, PO 7	2
AHS009.07	CLO 7	Correlate the exploitation and utilization of conventional and non-conventional resources.	PO 1, PO 3, PO 5,PO 7	2
AHS009.08	CLO 8	Demonstrate the level of chemical usage in agricultural development and its impact in our daily life	PO 1, PO 5, PO 7	2
AHS009.09	CLO 9	Understand the concept of growing energy needs in the world in terms of consumption of energy	PO 1, PO 7	2
AHS009.10	CLO 10	Establish knowledge and existence of endemic, extinct, endangered and threatened species, types and values of biodiversity	PO 1, PO 5, PO 7	2
AHS009.11	CLO 11	Describe our country as mega biodiversity nation in terms of hotspots	PO 1, PO 7	2
AHS009.12	CLO 12	Explain on threats and innovative methods for conservation of biodiversity.	PO 1, PO 3, PO 7	2
AHS009.13	CLO 13	Establish a foundation on different pollutants and pollutions in the environment.	PO 1, PO 3, PO 5, PO 7	2
AHS009.14	CLO 14	Ability to use methods, and strategies to investigate and interpret the pollution problems	PO 3, PO 5, PO 7	2
AHS009.15	CLO 15	Use innovative methods to control the level of water pollution in our day to day life.	PO 3, PO 5, PO 7	2
AHS009.16	CLO 16	Acquire Knowledge on global effects and how to interpret with global environmental problem in our daily life	PO 1, PO 7	2
AHS009.17	CLO 17	Acquire knowledge and skills about health and safety protocols when working with polluted environment in day to day life	PO 1, PO 7	2

AHS009.18	CLO 18	Describe the role of government and legal aspects in environmental protection.	PO 7	1
AHS009.19	CLO 19	Knowledge of proper decontamination techniques for solid waste management.	PO 3, PO 7	2
AHS009.20	CLO 20	Understand the importance of EIA for developmental activities to have minimum negative impacts on people	PO 1, PO 7	2
AHS009.21	CLO 21	Prepare entry level for future generations to meet sustainable development.	PO 7	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3		1													
CLO 2	3		1													
CLO 3	2		2				1									
CLO 4	2		2				1									
CLO 5	3		1		1		1									
CLO 6	2		2				1									
CLO 7	3		1		1		1									
CLO 8	2				1		1									
CLO 9	3						1									
CLO 10	3				1		1									
CLO 11	2						1									
CLO 12	2		2				1									
CLO 13	3		2		2		2									
CLO 14			2		1		1						1			
CLO 15			2		1		1						1			
CLO 16	2						1									
CLO 17	2						1									
CLO 18							1									
CLO 19			1				2									
CLO 20	1						1									
CLO 21							2									

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO3 PO5,PO7	SEE Exams	PO1,PO3 PO5,PO7	Assignments	PO1	Seminars	PO1 PO3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS:

Unit-I	ENVIRONMENT AND ECOSYSTEMS
Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles; Biomagnifications	
Unit-II	**NATURAL RESOURCES**
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; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies.	
Unit-III	**BIODIVERSITY AND BIOTIC RESOURCES**
Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation; Hot spots of biodiversity Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act.	
Unit-IV	**ENVIRONMENTAL POLLUTION, POLLUTION CONTROL TECHNOLOGIES AND GLOBAL ENVIRONMENTAL PROBLEMS**
Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary; Concepts of bioremediation; Global environmental problems and global efforts: Climate change, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions / protocols: Earth summit, Kyoto protocol and Montreal protocol.	
Unit-V	**ENVIRONMENTAL LEGISLATIONS AND SUSTAINABLE DEVELOPMENT**
Environmental legislations: Environmental protection act, air act1981, water act, forest act, wild life act, municipal solid waste management and handling rules, biomedical waste management and handling rules2016, hazardous waste management and handling rules, Environmental impact assessment(EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building.	
Text Books:	
1. Benny Joseph (2005)., Environmental Studies, New Delhi, Tata McGraw Hill Publishing co. Ltd 2. Erach Bharucha (2005)., Textbook of Environmental Studies for Undergraduate Courses, Hyderabad, Universities Press.	

Reference Books:
1. Anji Reddy .M (2007), Textbook of Environmental Sciences and Technology, Hyderabad, BS Publications. 2. Anjaneyulu.(2004), Introduction to Environmental Sciences, BS Publications 3. Anubha Kaushik(2006).,Perspectives in Environmental Science, 3rd Edition, New Delhi, New age international. 4. Tyler Miller, Scott Spoolman, "Environmental Science", Cengage Learning, 14th Edition, 2012.

XIV. COURSE PLAN:

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

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1	Summarize about environment and its importance.	CLO 1	T2: 1.1.1, 1.1.2,1.1.3, 1.2.1,1.2.2 R3:1.1-1.3
2	Discuss environment and importance of ecosystems	CLO 1	R1: 1.1,1.2 R3:1.1-1.3
3	Provides the information regarding ecosystem and applicability.	CLO 1	T2:3.2 R1:1.6.1,1.6.2 R3:1.6,1.7
4	Provides the information regarding ecosystem and applicability	CLO 1	T2:3.2 R1:1.6.1,1.6.2 R3:1.6,1.7
5	Acquire knowledge of how all the animals are competing with their food requirements and also understand the various trophic levels in the food chain.	CLO 2	T2:3.6.1-3.6.3 R1:1.7.1,1.7.2, 1.7.3 R3:1.7.1,1.7.2
6	Describe the flow of energy through the various components of ecosystem	CLO 2	T2:3.4 R1:1.8 R3:1.7.5
7	Examine the importance a of nutrients and flow of nutrients in ecosystem	CLO 3	T2:3.4.1-3.4.4 R1:1.9,1.10 R3:1.7.6
8	Examine the importance a of nutrients and flow of nutrients in ecosystem	CLO 3	T2:3.4.1-3.4.4 R2:1.9,1.10 R3:1.7.6
9	Summarize about the toxicity of heavy metals on the biotic and a biotic components.	CLO 4	R1:1.11 R3:1.7.3
10	Distinguish about different types of natural resources and their applicability and illustrate the utility of renewable resources efficiency	CLO 5	R1:2.1 R3:2.1
11	Describe the impact of over utilization of underground and surface water	CLO 5	R1:2.3,2.4.1, 2.4.2,2.4.3 R3:2.2
12	Discuss the disaster manage mental plans	CLO 6	R1:2.4.4 R3:2.2.4,2.2.5
13	Describe the benefits and property dams	CLO 6	R1:2.4.5 R3:2.3
14	Illustrate the uses of mineral resources	CLO 2 CLO 6	R1:2.5 R3:2.4
15	Enumerate the application of the solar energy in modern days	CLO 6	R1:3.1 R3:2.5
16	Enumerate the application of the wind energy in modern days	CLO 6	R1:3.3.1.5 R3:2.5

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
17	Illustrate the definition and importance of biodiversity	CLO 6	T2:4.1 R1:4.1 R3:3.1
18	Acquire the genetic diversity, species and ecosystem diversity	CLO 7	T2:4.1.1,4.1.2, 4.1.3 R1:4.2 R3:3.2
19	Describe the ecological values and consumptive use of ecosystem	CLO 7	T2:4.3 R1:4.3 R3:3.3
20	Recall India is mega diversity nation	CLO 7	T2:4.5 R3:3.4
21	Discuss the hot spot center in and around	CLO 7	T2:4.6 R1:4.6 R3:3.4
22	Analyze the information regarding different causes for loss of biodiversity	CLO 7	T2:4.7 R1:4.4 R3:3.5
23	Analyze various reasons for conflict of species	CLO 7	T2:4.7 R3:3.5.3
24	Illustrate different methods to protect the biodiversity	CLO 7	T2:4.9 R1:4.5 R3:3.7
25	Correlate national biodiversity act	CLO 8	T2:4.9 R1:4.5 R3:3.7
26	Explain the meaning of environmental pollution and classification.	CLO 9	T2:5.1 R1:5.1 R3:4.1
27	Analyze the important pollutants in air pollutants	CLO 9	T2:5.2.1 R1:5.3 R3:4.2
28	Enumerate the sources types and effects of water pollution	CLO 9	T2:5.2.2 R1:5.4 R3:4.6
29	Correlate the sources types and effects of soil pollution	CLO 9	T2:5.2.3 R1:5.5 R3:4.8
30	Analyze the noise quality and permissible levels	CLO 9	T2:5.2.5 R1:5.7 R3:4.13
31	Describe the various methods commonly employed for the disposal of solid waste.	CLO 9	T2:5.3 R1:7.7
32	Identify To understand the recent trends in e- waste management practices.	CLO 10	R1:5.10.6 R3:4.16.3
33	Understand concept of climate change and impacts.	CLO 10	T2:6.6.1 R1:6.5 R3:5.5
34	Summarize the remedial measures of ozone depletion	CLO 10	T2:6.6.4 R1:6.6 R3:5.6,5.7
35	Evolve strategies to environmental issues	CLO 10	R1:6.8 R3:5.10
36	Describe the role of government and legal aspects in environmental protection	CLO 10	T2:6.9-6.14 R1:7.2,7.3,7.4, R3:7.3,7.4,7.5, 7.6,7.7

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
37	Discuss the silent features of the hazardous waste management	CLO 11	R1:7.9 R3:7.10
38	Understand the importance of EIA for developmental activities	CLO 12	T2:6.14 R3:6.3,6.4
39	Understand the importance of EIA for developmental activities	CLO 12	T2:6.14 R1:10.1 R3:6.3,6.4
40	State the aim and objectives of sustainable development	CLO 12	T2:6.1 R1:10.5 R3:8.3
41	State the aim and objectives of sustainable development	CLO 13	T2:6.1 R1:10.5 R3:8.3
42	Enumerate population and its explosion	CLO 15	T2:7.2 R1:10.3 R3:8.2
43	State the aim and objectives of sustainable development	CLO 19	T2:7.2.2.2 R1:10.8 R3:8.6
44	Acquire knowledge of environmental education	CLO 18	T2:7.3 R1:10.6 R3:8.4
45	Summarize the environmental ethics and objectives of green buildings	CLO 21	T2:6.5 R1:10.10,10.12 R3:8.10,8.12

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Types of ecosystem, Energy flow, Biomagnification	Seminars / Field visit	PO 1	-
2	Dams ,Mining Activities, Alternative energy resources	Seminars / NPTEL	PO 3	PSO 1
3	Sources of pollution EIA Methodology, Green building	Guest Lecture	PO 7	-

Prepared by:
Ms. M Lakshmi Prasanna, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING MECHANICS**				
Course Code	AME002				
Programme	B.Tech				
Semester	II	AE|ME|CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. D. Govardhan, Professor.				
Course Faculty	Mr. BDY Sunil, Associate Professor. Dr. Kasi Viswanath Associate Professor.				

I. COURSE OVERVIEW:

The aim of Engineering Mechanics is to introduce students to the fundamental concepts and principles applied by engineers -whether civil, mechanical, aeronautical, etc. This course introduces the concepts of engineering based on forces in equilibrium. Topics include concentrated forces, distributed forces, forces due to friction, inertia, work –energy principle and vibrations as they apply to machines, structures, and systems. It is the branch of science for analyzing force systems that acts upon the bodies either at rest or in motion.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic concepts of physics and mathematics

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering mechanics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Assignments
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	Term paper, Seminars
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	Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Lecture, Assignments.
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful career and entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop the ability to work comfortably with basic engineering mechanics concepts required for analyzing dynamic structures.
II	Identify an appropriate structural system to studying a given problem and isolate it from its environment, model the problem using good free-body diagrams and accurate equilibrium equations.
III	Identify and model various types of loading and support conditions that act on structural systems, apply pertinent mathematical, physical and engineering mechanical principles to the system to solve and analyze the problem.
IV	Understand the meaning of impulse and momentum, virtual work and solve the field problems.
V	Solve the problem of equilibrium by using the principle of work and energy and vibrations for preparing the students for higher level courses such as, Mechanics of Solids, Mechanics of Fluids etc.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME002.01	CLO 1	Understand the concepts of kinematics of the particles and rectilinear motion.	PO1	3
AME002.02	CLO 2	Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like motion curves, rigid body motion and fixed axis rotation.	PO1	2
AME002.03	CLO 3	Explore knowledge & ability to solve various particle motion problems.	PO2	2
AME002.04	CLO 4	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.	PO2	1
AME002.05	CLO 5	Discuss the nature of relation between force and mass under the influence of time.	PO4	2
AME002.06	CLO 6	Develop the relations for motion of body in lift and on inclined plane.	PO2	2
AME002.07	CLO 7	Determine the impact, impulse and impulsive forces occurring in the system.	PO1	3
AME002.08	CLO 8	Understand the inter relationship between impulse-momentum and virtual work and an ability to use such relationships to solve practical problems.	PO1	2
AME002.09	CLO 9	Knowledge of the lifting machines and simple framed structures equilibrium criteria, and the knowledge of the equilibrium condition systems.	PO2	2
AME002.10	CLO 10	Determine the effect of law of conservation of energy and its consideration in field problems.	PO4	1
AME002.11	CLO 11	Discuss the application of work energy method to particle motion.	PO1	2
AME002.12	CLO 12	Develop the work energy relations and apply to connected systems.	PO2	2
AME002.13	CLO 13	Understand the fixed axis rotation theory and solving the field problems by application of work energy method.	PO1	3
AME002.14	CLO 14	Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.	PO4	3
AME002.15	CLO 15	Derive the expressions for the concepts of simple, compound and torsional pendulums.	PO2	2
AME002.16	CLO 16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2	2												1			
CLO 3		2														
CLO 4		1											2			
CLO 5				2												
CLO 6		2														
CLO 7	3															
CLO 8	2															
CLO 9		2											2			
CLO 10				1												
CLO 11	2															
CLO 12		2														
CLO 13	3															
CLO 14				3									1			
CLO 15		2														
CLO 16				1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1 PO2 PO4	SEE Exams	PO1 PO2 PO4	Assignments	PO1 PO4	Seminars	PO2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO2						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	KINEMATICS OF PARTICLES- RECTILINEAR MOTION
Motion of a particle – Rectilinear motion – motion curves – Rectangular components of curvilinear motion Kinematics of Rigid Body - Types of rigid body motion - Angular motion - Fixed Axis Rotation.	
UNIT-II	**KINETICS OF PARTICLE**
Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum. Newton's law of motion. Relation Between force & mass. Motion of a particle in rectangular coordinates. D'Alembert's Principle.Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies.	
UNIT-III	**IMPULSE AND MOMENTUM, VIRTUAL WORK**
Impulse And Momentum: Introduction- Impact, Momentum, Impulse & Impulsive forces, Units. Law of conservation of Momentum, Newton's law of collision of elastic bodies- coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation. **VIRTUAL WORK:** Introduction – Principle of virtual work – Applications – Beams, Lifting machines, Simple framed structures.	
UNIT-IV	**WORK ENERGY METHOD**
Law of conservation of Energy, Application of Work Energy Method to particle motion and connected system- Work energy applied to Connected Systems - Work energy applied to Fixed Axis Rotation	
UNIT-V	**MECHANICAL VIBRATIONS**
Definitions and Concepts – Simple Harmonic Motion – Free vibrations, simple and Compound Pendulums – Torsion Pendulum – Free vibrations without damping: General cases.	
Text Books:	
1. R.C. Hibbler, "Engineering Mechanics", Prentice Hall, 12th Edition, 2009. 2. Engineering Mechanics - Statics and Dynamics by Ferdinand.L. Singer / Harper International Edition. 3. Engineering Mechanics/ S. Timoshenko and D.H. Young, Mc Graw Hill Book Company.	
REFERENCES:	
1. S. Bhavikatti, "A Text Book of Engineering Mechanics", New Age International, 1st Edition, 2012. 2. A.K Tayal ,"Engineering Mechanics", Uma Publications, 14th Edition, 2013. 3. R.K. Bansal "Engineering Mechanics", Laxmi Publications, 8th Edition, 2013. 4. Engg. Mechanics / KL Kumar / Tata McGraw Hill. 5. Engg. Mechanics / S.S. Bhavikati & K.G. Rajasekharappa. 6. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014. 7. K. Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics, Statics and Dynamics", B S Publishers, 1st Edition, 2013.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Motion of a particle – Rectilinear motion	CLO1	T2:7.3
3-5	motion curves – Rectangular components of curvilinear motion	CLO1	T2:7.5,7.6 R1:2.9.2
6-8	Kinematics of Rigid Body	CLO1	T2:7.7 R1:2.10
9	Types of rigid body motion - Angular motion	CLO2	T2:7.7 R1:2.10
10	Fixed Axis Rotation	CLO2	T2:7.11 R1:2.10.2
11	Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum.	CLO3	T2:7.11 R1:2.32

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
12-13	Newton's law of motion. Relation Between force & mass.	CLO3	T2:15.2 R1:8.2
14-15	Motion of a particle in rectangular coordinates.	CLO3	T2:15.7 R1:8.3.3
16-17	D'Alembert's Principle.	CLO4	T2:15.13 R1:8.7.2
18-20	Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies	CLO5	T2:15.13 R1:8.7.2
21	Introduction- Impact, Momentum, Impulse & Impulsive forces, Units.	CLO6	T2:15.16 R1:8.7.3
22-24	Law of conservation of Momentum	CLO6	T1:11.9 R2:12.24
25-26	Newton's law of collision of elastic bodies	CLO7	T1:11.9 R3:12.25
27-28	Coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation.	CLO8	T1:3.2 R3:3.2
29	Introduction – Principle of virtual work – Applications.	CLO8	T1:3.3.1 R3:3.2
30	Beams, Lifting machines, Simple framed structures	CLO9	T2:16.5 R1:8.10
31	Law of conservation of Energy.	CLO10	T2:16.9 R1:8.11.1
32-33	Application of Work Energy Method to particle motion and connected system.	CLO11	T2:16.9 R1:8.11.2
34-35	Work energy applied to Connected Systems.	CLO12	T2:16.8 R1:8.12.1
36-39	Work energy applied to Fixed Axis Rotation.	CLO13	T2:16.8 R1:8.12.2
40	Definitions and Concepts**.**	CLO14	T2:16.11 R1:8.14
41-42	Simple Harmonic Motion – Free vibrations	CLO15	T2:16.11 R1:8.20
43-44	Simple and Compound Pendulums – Torsion Pendulum	CLO15	T2:16.12 R1:8.19
45-48	Free vibrations without damping: General cases.	CLO16	T2:16.12 R1:8.77

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Banking angle theory for curvilinear motion	Guest lecturers/NPTEL	PO1	PSO1
2	Different types of loads on beams	Seminars	PO2	PSO1
3	Application of vibration theory to field problems	Guest lecturers/Seminars	PO4	PSO1

Prepared by:

Mr. BDY Sunil, Associate Professor.

HOD, ME

III SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Code	AEE018				
Programme	B. Tech				
Semester	III	ME | CE | AE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. N Shivaprasad, Assistant Professor				
Course Faculty	Mr. N Shivaprasad, Assistant Professor Mr. S Srikanth, Assistant Professor Mr. B Muralidhar Nayak, Assistant Professor Ms. B Manogna, Assistant Professor Ms. B Navothna, Assistant Professor				

I. COURSE OVERVIEW:

Electrical and Electronics Engineering course deals with the concepts of electrical circuits, basic law's of electricity, different methods to solve the electrical networks and the instruments to measure the electrical quantities. It also focuses on the construction, operational features of energy conversion devices such as DC and AC machines, Transformers. It also emphasis on basic electronics semiconductor devices and their characteristics and operational features.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Basic Electrical and Electronics Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 units and each unit carries equal weight age 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Seminar
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	Five Minutes Video
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	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand Kirchhoff laws and their application in series and parallel circuits.
II	Discuss principle and operation of measuring instruments.
III	Analyze the characteristics of alternating quantities, electrical machines.
IV	Illustrate the V-I characteristics of various diodes and bi-polar junction transistor.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE018.01	CLO 1	Analyze the circuits using Kirchhoff's current and Kirchhoff's voltage law.	PO1	3
AEE018.02	CLO 2	Use star delta transformation for simplifying complex circuits.	PO1	3
AEE018.03	CLO 3	Generalize operation and principle of measuring instruments.	PO2	3
AEE018.04	CLO 4	Demonstrate the working principle of DC motor, DC generator and transformer.	PO2	3
AEE018.05	CLO 5	Describe the construction of machines and transformer.	PO2	2
AEE018.06	CLO 6	Classify the types of DC machines.	PO2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE018.07	CLO 7	Derive the EMF equation of DC generator, transformer and Torque equation of DC motor.	PO2	2
AEE018.08	CLO 8	Discuss the principle of operation of induction motor.	PO2	2
AEE018.09	CLO 9	Explain the construction and characteristics of alternator.	PO4	2
AEE018.10	CLO 10	Explain the construction and characteristics of 3-phase induction motor.	PO2	1
AEE018.11	CLO 11	Compare the operation of half wave, full wave and bridge rectifiers.	PO4	2
AEE018.12	CLO 12	Differentiate the operation of Diodes and transistors.	PO2	2
AEE018.13	CLO 13	Apply the concept of diodes in converting AC to DC rectification process.	PO1	2
AEE018.14	CLO 14	Distinguish the different configurations of transistor.	PO4	2
AEE018.15	CLO 15	Examine the voltage, current and frequency of electric network using CRO.	PO1	3
AEE018.16	CLO 16	Apply the knowledge of electromagnetic laws and basic concepts of electronics.	PO2	3
AEE018.17	CLO 17	Process the knowledge and skills for employability and to succeed national and international level competitive examinations.	PO2	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	3													
CLO 2															
CLO 3		3											1		
CLO 4		3											1		
CLO 5		2											1		
CLO 6		2											1		
CLO 7		2											1		
CLO 8		2											1		
CLO 9				2											
CLO 10		1											1		
CLO 11				2									1		
CLO 12		2											1		

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 13	2														
CLO 14				2											
CLO 15	3														
CLO 16		3													
CLO 17		3													

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO4	SEE Exams	PO1,PO2 PO4	Assignments	PO4	Seminars	PO1
Laboratory Practices	PO1	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT -I	ELECTRICCIRCUITS,ELECTROMAGNETISM AND INSTRUMENTS	Classes: 10
Electrical Circuits: Basic definitions, types of elements, Ohm's Law, resistive networks, inductive networks, capacitive networks, Kirchhoff's Laws, series, parallel circuits and star delta transformations, simple problems, Faradays law of electromagnetic induction; Instruments: Basic principles of indicating instruments, permanent magnet moving coil and moving iron instruments.		
UNIT -II	**DC MACHINES**	**Classes: 10**
DC Machines: Principle of operation of DC generator, EMF equation, principle of operation of DC motors, torque equation, types of DC machines, applications, three point starter.		
UNIT -III	**ALTERNATING QUANTITIES AND AC MACHINES**	**Classes: 08**
Alternating Quantities: Sinusoidal AC voltage, average and RMS values, form and peak factor, concept of three phase alternating quantity; Transformer: Principle of operation, EMF equation, losses, efficiency and regulation. **Three Phase Induction Motor:** Principle of operation, slip, slip torque characteristics, efficiency, applications; Alternator: Principle of operation, EMF Equation, efficiency, regulation by synchronous impedance method.		

UNIT-IV	SEMICONDUCTOR DIODE AND APPLICATIONS	Classes: 09
Semiconductor Diode: P-N Junction diode, symbol, V-I characteristics, half wave rectifier, full wave rectifier, bridge rectifier and filters, diode as a switch, Zener diode as a voltage regulator.		
UNIT-V	**BIPOLAR JUNCTION TRANSISTOR AND APPLICATIONS**	**Classes: 08**
Bipolar junction: DC characteristics, CE, CB, CC configurations, biasing, load line, transistor as an amplifier.		

Text Books:

1. A Chakrabarti, "Circuit Theory", Dhanpat Rai Publications, 6th Edition, 2004.
2. K S Suresh Kumar, "Electric Circuit Analysis", Pearson Education, 1st Edition, 2013.
3. Willianm Hayt, Jack E Kemmerly S M Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 7th Edition, 2010.
4. J P J Millman, C C Halkias, Satyabrata Jit, "Millman"s Electronic Devices and Circuits", Tata McGraw Hill, 2nd Edition, 1998.
5. R L Boylestad, Louis Nashelsky, "Electronic Devices and Circuits", PEI / PHI, 9th Edition, 2006.
6. R L Boylestad, Louis Nashelsky, "Electronic Devices and Circuits", PEI / PHI, 9th Edition, 2006.

Reference Books:

1. David A Bell, "Electric Circuits", Oxford University Press, 9th Edition, 2016.
2. U A Bakshi,Atul P Godse "Basic Electrical and Electronics Engineering", Technical Publications, 9th Edition, 2016.
3. A Bruce Carlson, "Circuits", Cengage Learning, 1st Edition, 2008.
4. M Arshad, "Network Analysis and Circuits", Infinity Science Press, 9th Edition, 2016.

XIV.COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Discuss the basic definitions of voltage, current, power and energy	CLO 1	T2: 1.2-1.8 R2:1.1
2	Understand the concept of Ohm's Law	CLO 1	T2: 1.9 R2:1.5
3	Discuss different elements in power systems and sources	CLO 1	T2:1.10 R2:1.2&1.4
4-5	Describe voltage-current relationship of resistive networks, inductive networks, capacitive networks	CLO 1	T2: 2.3-2.5 R2:1.6
6	Explain Kirchhoff's laws for electrical networks	CLO 1	T2: 1.12 R2:1.14
7-8	Understand series, parallel circuits	CLO 1	T2: 2.6 R2:1.7&1.8
9	Derive the formula for Star delta and delta star transformations techniques.	CLO 2	T2: 2.7 R2:1.12
10	Analyze networks using reduction techniques.	CLO 2	T2: 2.6 R2:1.7&1.8
11	Understand the concept of faradays laws	CLO 3	T2: 1.11 R2:6.2
12	Understand working of different measuring instruments	CLO 3	T2: 10.4 R2:4.0
13-14	Understand working of different measuring instruments	CLO 3	T2: 10.5.1.1 R2:4.0

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
15-16	Understand working of different measuring instruments	CLO 3	T2: 10.5.1.3 R2:4.0
17	Discuss what is a DC machine	CLO 4	T2: 7.1 R2:5.2
18	Understand the working principle of DC machine	CLO 4	T2: 7.6 R2:5.3
19-20	Demonstrate the cross section view of a DC machine	CLO 5	T2: 7.2 R2:5.4
21-22	Derive the mathematical equation of EMF induced in a DC generator	CLO 7	T2: 7.6.1 R2:5.7
23	Classify the types of DC generator	CLO 6	T2: 7.6.3 R2:5.10,5.11,5.12 ,5.13,5.14
24	Understand the working principle of DC motor	CLO 4	T2: 7.7 R2:5.16
25	Classify the types of DC motor	CLO 6	T2: 7.7.6 R2:5.21,5.22,5.23 ,5.24
26	Derive mathematical equation of torque generated in a DC motor	CLO 7	T2:7.7.5 R2:5.20
27	Understand the applications of DC motor	CLO 4	T2: 7.7.6.1-7.7.6.3 R2:5.31
28	Understand the three point starter	CLO 4	T2: 7.7.7 R2:5.25
29	Understand the concepts of alternating quantities	CLO 4	T2: 4.1 R2:2.1
30	Understand the representation of sinusoidal quantity and analyzing	CLO 4	T2: 4.5-4.6 R2:2.2
31	Understand three phase systems	CLO 4	T2: 5.2.4.1-5.2.4.2 R2:3.2
32	Understand the working principle of Transformer	CLO 4	T2: 6.5 R2:602
33	Derive mathematical equation of EMF induced in a single phase transformer	CLO 7	T2: 6.6.1 R2:6.6
34-35	Understand the percentage efficiency and voltage regulation	CLO 7	T2: 6.9-6.10 R2:6.13&6.15
36	Understand the working principle of induction motor	CLO 8	T2: 9.3 R2:7.2
37	Analyze the speed torque characteristics	CLO 9	T2: 9.3.1 R2:7.8
38	Understand the working principle of Alternator	CLO 9	T2: 8.4 R2:7.11
39-40	Derive the mathematical equation of EMF induced in a Alternator	CLO 9	T2: 8.4 R2:7.13
41-42	Analyze the percentage efficiency of an alternator.	CLO 9	T2: 8.8 R2:7.16
42-43	Analyze the percentage voltage regulation of alternator.	CLO 9	T2: 8.8 R2:7.21
44-47	Understand the functioning of P-N Junction diode	CLO 12	T4: 4.11 R2:8.1
48–50	Understand and analyze P -N diode as half wave rectifier, full wave rectifier, bridge rectifier and filters	CLO 11	T4: 4.23 R2:8.8,8.17,8.18, 8.19

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
51-53	Understand the functioning of Zener diode as a voltage regulator.	CLO 12	T4: 4.19,5.2 R2:8.22.5
54	Analyze simple problems on diodes.	CLO 12	T4: 4.23 R2:8.23
55-56	Understand the concept of bipolar junction: DC characteristics,	CLO 14	T4: 6.4-6.5 R2:9.1
57-59	Examine CE, CB, CC configurations.	CLO 14	T4: 6.6 R2:9.21,9.22,9.23
60	Analyze biasing and load line,	CLO 14	T4: 6.3 R2:9.3
61-63	Model Transistor as an amplifier	CLO 14	T4: 6.7 R2:9.5
64-65	Analyze simple problems on transistors.	CLO 14	T4: 6.6 R2:9.7

XV.GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Guest lectures	PO2	PSO1
2	Voltage - Current relationship for passive elements for different input signals - ramp, saw tooth and triangular.	Seminars / NPTEL	PO1	PSO1
3	Resistance color coding	NPTEL	PO1	PSO1

Prepared by:
Mr. N Shivaprasad Assistant Professor

HOD, ME

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**PROBABILITY AND STATISTICS**				
Course Code	AHS010				
Programme	B.Tech				
Semester	II	CSE | IT			
	III	ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. J Suresh Goud, Assistant Professor				
Course Faculty	Ms. P Srilatha, Assistant Professor Ms. B Praveena, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes probability, random variables, probability distributions, correlation, regression, sampling distribution, testing of hypothesis and analysis of variance. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of statistics

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of probability on single random variables and probability distributions.
II	Apply the concept of correlation and regression to find covariance.
III	Analyze the given data for appropriate test of hypothesis.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS010.01	CLO 1	Understand the basic concepts of probability and random variables.	PO 1	3
AHS010.02	CLO 2	Analyze the concepts of discrete and continuous random variables, probability distributions, expectation and variance.	PO 1	3
AHS010.03	CLO 3	Use the concept of random variables in real-world problem like graph theory, machine learning, Natural language processing.	PO 1	3
AHS010.04	CLO 4	Apply the binomial distribution and poisson distribution to find mean and variance.	PO 2	2
AHS010.05	CLO 5	Understand binomial distribution to the phenomena of real-world problem like sick	PO 2	2

		versus healthy.		
AHS010.06	CLO 6	Use poission distribution in real-world problem to predict soccer scores.	PO 2	2
AHS010.07	CLO 7	Apply the inferential methods relating to the means of normal distributions.	PO 4	1
AHS010.08	CLO 8	Understand the mapping of normal distribution in real-world problem to analyze the stock market.	PO 4	1
AHS010.09	CLO 9	Explain multiple random variables and the covariance of two random variables.	PO 2	2
AHS010.10	CLO 10	Understand the concept of multiple random variables in real-world problems aspects of wireless communication system.	PO 2	2
AHS010.11	CLO 11	Calculate the correlation coefficient to the given data.	PO 1	3
AHS010.12	CLO 12	Understand the correlation and regression to the real-world such as stock price and interest rates.	PO 1	3
AHS010.13	CLO 13	Calculate the regression to the given data.	PO 1	3
AHS010.14	CLO 14	Understand the concept of sampling distribution of statistics and in particular describe the behavior of the sample mean.	PO 1, PO 2	3
AHS010.15	CLO 15	Understand the concept of estimation for classical inference involving confidence interval.	PO 2	2
AHS010.16	CLO 16	Understand the concept of estimation in real-world problems of signal processing.	PO 2	2
AHS010.17	CLO 17	Understand the foundation for hypothesis testing.	PO 1, PO 2	3
AHS010.18	CLO 18	Understand the concept of hypothesis testing in real-world problem to selecting the best means to stop smoking.	PO 1, PO 2	3
AHS010.19	CLO 19	Apply testing of hypothesis to predict the significance difference in the sample means.	PO 1, PO 2	3
AHS010.20	CLO 20	Apply testing of hypothesis to predict the significance difference in the sample proportions.	PO 1, PO 2	3
AHS010.21	CLO 21	Apply Student t-test to predict the difference in sample means.	PO 1	3
AHS010.22	CLO 22	Apply F-test to predict the difference in sample variances.	PO 1	3
AHS010.23	CLO 23	Understand the characteristics between the samples using Chi-square test.	PO 1	3
AHS010.24	CLO 24	Understand the assumptions involved in the use of ANOVA technique.	PO 4	1
AHS010.25	CLO 25	Understand the concept ANOVA to the real-world problems to measure the atmospheric tides.	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4		2													
CLO 5		2													
CLO 6		2													
CLO 7				2											
CLO 8				1											
CLO 9		3											1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		2													
CLO 16		2													
CLO 17	3	2											1		
CLO 18	3	2											1		
CLO 19	2	2											1		
CLO 20	3	1											1		
CLO 21	3														
CLO 22	3														
CLO 23	2														
CLO 24				2											
CLO 25				1											
CLO 26															

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Assignments	PO 4	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	SINGLE RANDOM VARIABLES AND PROBABILITY DISTRIBUTION
Random variables: Basic definitions, discrete and continuous random variables; Probability distribution: Probability mass function and probability density functions; Mathematical expectation; Binomial distribution, Poisson distribution and normal distribution.	
Unit-II	**MULTIPLE RANDOM VARIABLES**
Joint probability distributions, joint probability mass, density function, marginal probability mass, density functions; Correlation: Coefficient of correlation, the rank correlation; Regression: Regression coefficient, the lines of regression, multiple correlation and regression.	
Unit-III	**SAMPLING DISTRIBUTION AND TESTING OF HYPOTHESIS**
Sampling: Definitions of population, sampling, statistic, parameter; Types of sampling, expected values of sample mean and variance, sampling distribution, standard error, sampling distribution of means and sampling distribution of variance. Estimation: Point estimation, interval estimations; Testing of hypothesis: Null hypothesis, alternate hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two sided test.	
Unit-IV	**LARGE SAMPLE TESTS**
Test of hypothesis for single mean and significance difference between two sample means, Tests of significance difference between sample proportion and population proportion and difference between two sample proportions.	
Unit-V	**SMALL SAMPLE TESTS AND ANOVA**
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; Test of equality of two population variances Chi-square distribution, it's properties, Chi-square test of goodness of fit; ANOVA: Analysis of variance, one way classification, two way classification.	
Text Books:	
1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.	
Reference Books:	
1. T.K.V Iyengar, B.Krishna Gandhi, "Probability and Statistics", S. Chand & Co., 6th Edition, 2014. 2. G.C.Beri, "Business Statistics", Tata McGraw-Hill Publications, 2nd Edition, 2005. 3. Richard Arnold Johnson, Irwin Miller and John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Describe the concept of Random variables and Contrast discrete Random variables and calculate the mean and variance of discrete Random variables	CLO 1	T1:22.5 R1:2.3
2	Recall the continuous probability function	CLO 2	T1:22.5 R1:2.4
3	Identify mathematical mean	CLO 2	T1:22.6 R1:2.6
4-5	Recall characteristics of the Binomial Distribution and find mean , variance	CLO 4	T1:22.7 R1:4.4
6-7	Recognize cases where Poisson Distribution could be appropriate model to find mean and variance	CLO 4	T1:22.7 R1:4.10
8-9	Apply Normal Distributions find the probability over a set of values, mean and variance	CLO 7	T1:22.8 R1:4.15
10	Apply probability distribution	CLO 9	T1:22.9 R1:5.4
11	Apply marginal probability density function	CLO 9	T1:22.9 R1:5.8
12-13	Recognize the limitation of correlation as a summary of bivariate data.	CLO 11	T1:23.10 R1:6.8
14	Interpret the correlation between the bivariate data by allotting ranks.	CLO 11	T1:23.10 R1:6.13
15-16	Define the concept of least squares estimation in linear regression	CLO 13	T1:23.9 R1:7.5
17	Estimate the linear model to a bivariate data	CLO 11	T1:23.10 R1:7.5
18	Recognize the multiple correlation of bivariate data	CLO 9	T1:23.10 R1:8.1
19	Recall the sampling distribution of the sample mean in general situation	CLO 14	T1:23.1 R1:9.2
20	Distinguish between a population and a sample and between parameters & statistics	CLO 14	T1:23.1 R1:9.4
21	Recall the sampling distribution and define standard error	CLO 14	T1:23.1 R1:9.9
22-23	Recall the sampling distribution of the sample mean in general situation	CLO 14	T1:23.1 R1:9.10
24-25	Interpret the confidence interval and confidence level	CLO 14	T2:27.5 R1:10.2
26	Understand the foundation for classical inference involving hypothesis testing and two types of errors possible	CLO 17	T2:27.7 R1:11.3
27	Explain level of significance confidence interval	CLO 17	T2:27.8 R1:11.6
28-30	Identify the confidence interval with single mean	CLO 19	T2:27.12 R1:11.7
31-32	Identify the confidence interval with difference between the mean	CLO 19	T2:27.12 R1:11.8
33-34	Identify the confidence interval with difference between the proportions	CLO 20	T2:27.12 R1:11.9
35-36	Identify the confidence interval with difference between the proportions	CLO 20	T2:27.12 R1:11.10
37-38	Recall the definition of a t-statistics in terms of statistics of sample from a normal distribution	CLO 21	T2:27.14 R1:12.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
39	State and apply the definition of F-distribution	CLO 22	T2:27.1 R1:12.7
40-41	State and apply the definition of χ^2 –Distribution	CLO 23	T2:27.17 R1:12.15
42	Apply Chi-square distribution	CLO 23	T2:27.18 R1:12.19
43-44	Apply One way classification	CLO 24	T2:27.19 R2:14.4
45	Apply Two way classification	CLO 24	T2:27.19 R2:14.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with Pos	Relevance with Psos
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared By:
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HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING
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Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MECHANICS OF SOLIDS**				
Course Code	AME004				
Programme	B. Tech				
Semester	III	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. K. Viswanath Allamraju, Professor,				
Course Faculty	Dr. K. Viswanath Allamraju, Professor Mr. A. Somaiah, Assistant Professor.				

I. COURSE OVERVIEW:

Mechanics of Solids is the physical science that deals with the reaction of a body to movement and deformation due to mechanical, thermal, or other loads. The basis of virtually all mechanical design lies in how the material reacts to outside forces. Mechanics is the core of engineering analysis and is one of the oldest of the physical sciences. An in-depth understanding of material properties as well as how certain materials react to outside stimulus is paramount to an engineering education.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME001	I	Engineering Drawing	4

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Mechanics of Solids	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

√	Chalk & talk	√	Quiz	√	Assignments	✘	Moocs
√	Lcd / ppt	√	Seminars	✘	Mini project	✘	Videos
✘	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). 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 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.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

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).

Table 1: Assessment pattern for CIA

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

Continuous Internal Examination (CIE):
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 20 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, micro projects, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering Knowledge: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO2	Problem Analysis: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	3	Seminar
PO3	Design/ development of solutions: Competence to design a system, component or process to meet societal needs within realistic constraints.	3	Seminar
PO4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	3	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Lecture, Assignments.
PSO2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	3	Projects
PSO3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	3	Projects

3= High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	To solve real field problems through evaluating the relationship between stress and strain.
II	To understand the shear force and bending moment diagrams of symmetrical beams.
III	To determine bending and shear stresses developed in beams of various sections
IV	To understand various theories of failure, mohr's circle of stresses, principle stresses and strains.
V	To understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, shear load, bending moment and torsion.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CAME004.01	CLO1	Demonstrate the statically determinate and indeterminate problems. Use algebraic equations to determine the effect of stress	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		and strain in the bars which are made up of various materials.		
CAME004.02	CLO2	Understand extension and reduction of length of different bars. Explain the various stresses and strains and their relations, also comprehend the importance of elastic moduli.	PO 1, PO 3	3
CAME004.03	CLO3	Explore the shear force diagrams under various loads. Explain the importance of beams in the real field by understanding the types of loads.	PO 1, PO 3	3
CAME004.04	CLO4	Comprehend bending moment and its variation at various loads. Explain the bending moment diagram and its importance, understanding the supports and beams.	PO 1, PO 2, PO 4	2
CAME004.05	CLO5	Determine the resistance and deformation in members which are subjected to axial, flexural and torsional loads.	PO 1, PO 3	2
CAME004.06	CLO6	Evaluate the principal stresses, strains and apply the concept of failure theories for design of shafts and other designed products.	PO 1, PO 2, PO 4	2
CAME004.07	CLO7	Able to calculate the shear stresses developed in various sections of beams.	PO 1, PO 2, PO 3	1
CAME004.08	CLO8	Capable of understand the loads which occur in crash analysis.	PO 1, PO 2, PO 3	1
CAME004.09	CLO9	Understand the effect of gradual loads on the various materials.	PO 1, PO 2	2
CAME004.10	CLO10	Understand torsion equation	PO 1, PO 3	2
CAME004.11	CLO11	Able to calculate the flexural developed in various sections of beams of real field problems.	PO 1, PO 3	3
CAME004.12	CLO12	Find principle stresses and strains and to apply theories of failure in the design of various mechanical parts.	PO 1, PO 2	3
CAME004.13	CLO13	Determine stresses developed in a shaft and design of a shaft.	PO 1, PO 3	3
CAME004.14	CLO14	Derive the expression for Longitudinal stress	PO 1, PO 2	2
CAME004.15	CLO15	Derive the expression for volumetric strain	PO 1, PO 3, PO 4	2
CAME004.16	CLO16	Find the volumetric strain of a thin spherical shell	PO 1, PO 2	2
CAME004.17	CLO17	Derive the expression for Hoop stress	PO 1, PO 2	3
CAME004.18	CLO18	Understand the real field problems of various pressure vessels which are made up of different materials.	PO 1, PO 2	2
CAME004.19	CLO19	Able to design the thin vessels which are subjected to different stresses.	PO 1, PO 3, PO 4	1
CAME004.20	CLO20	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc	PO 1, PO 2	1

3= High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1	2	
CLO 2	3		3										1		
CLO 3	3		3										1	2	
CLO 4	2	2		2									1	2	
CLO 5	2		2										1	2	
CLO 6	2	2		2										2	
CLO 7	1	1	1										1		
CLO 8	1	1	1											2	
CLO 9	2	2												2	
CLO 10	2		2										1		
CLO 11	3		3											2	
CLO 12	3	3											1		
CLO 13	3		3										1	2	
CLO 14	2	2											1		
CLO 15	2		2	2									1	2	
CLO 16	2	2											1		
CLO 17	3	3											1		
CLO 18	2	2											1	2	
CLO 19	1		1	1										2	
CLO 20	1	1												2	

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2,PO3	SEE Exams	PO1,PO4	Assignments	-	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO4						

XII. ASSESSMENT METHODOLOGIES–INDIRECT

√	Assessment of course Outcomes (by feedback, once)	√	Student feedback on faculty (twice)
✘	Assessment of mini projects by experts		

XIII. SYLLABUS:

Unit-I	**SIMPLE STRESSES AND STRAINS**
Elasticity and plasticity – Types of stresses & strains–Hooke's law– stress – strain diagram for m – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic & the relationship between them – Bars of varying section – composite bars – Temperature s Strain energy – Resilience – Gradual, sudden, impact and shock loadings.	
Unit-II	**SHEAR FORCE AND BENDING MOMENT DIAGRAMS**
Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l., uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.	
Unit-III	**FLEXURAL STRESSES, SHEAR STRESSES**
Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R Neutral axis– Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections – Design of simple beam sections. Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.Steering gears: Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, Hooke's joint: Single and double Hooke's joint, velocity ratio, application, problems.	
Unit-IV	**PRINCIPAL STRESSES AND STRAINS, THEORIES OF FAILURE**
Introduction – Stresses on an inclined section of a bar under axial loading – compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear – Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions. Theories of Failure: Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory)..	
Unit-V	**DESIGN OF CIRCULAR SHAFTS AND STRESSES IN PRESSURE VESSELS**
Theory of pure torsion – Derivation of Torsion equations : T/J = q/r = Nθ/L – Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust – Design of shafts according to theories of failure. Thin Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses– hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells..	
Text Books:	
1. S. S Ratan, —Strength of Materials‖, Tata McGraw-Hill, 2nd Edition, 2011. 2. W.A. Nash, —Strength of Materials‖, Tata McGraw-Hill, 4th Edition, 2007.	

Reference Books:
1. Jindal, ―Strength of Materials‖, Pearson Education, 1st Edition, 2012. 2. S. Ramamrutam, R. Narayan, ―Strength of Materials‖, Dhanpat Rai Publishing Company, 18th Edition, 2014. 3. R. K. Rajput, ―Strength of Materials‖, S.Chand & Co New Delhi, 4th Edition, 2007.

XIV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1	Elasticity and plasticity	CLO1	T1-1.1 , R1- 1.31.4 ,R2.1.7
3-4	Types of stresses & strains– Hooke's law	CLO1	T1- 1.2, R1-1.8,
5-6	stress – strain diagram for mild steel – Working stress – Factor of safety	CLO1	T1- 1.15, R1- 1.16
7-8	Lateral strain, Poisson's ratio & volumetric strain	CLO2	T1- 1.6
9-10	Elastic moduli & the relationship between them	CLO2	T1- 2.2, R2-2.6
11	Bars of varying section -composite bars – Temperature stresses.	CLO2	T1-2.6, R3-2.10
12	Strain energy – Resilience – Gradual, sudden, impact and shock loadings.	CLO3	T1-3.2, R2-3.3,
13-14	Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment	CLO3	T1-3.5
15-16	S.F and B.M diagrams, point loads, u.d.l., uniformly varying loads and combination of these loads for cantilever	CLO4	T1-2.13, 2.14,R1- 2.16
17-18	simply supported beams subjected to point loads, u.d.l., uniformly varying loads and combination of these loads	CLO4	T1-2.15, R1-2.15
23-24	Overhanging subjected to point loads, u.d.l., uniformly varying loads and combination of these loads	CLO4	T1-3.9, R1-3.9
25-27	Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R	CLO5	T1-6.1, R2-6.3
27-28	Neutral axis – Determination bending stresses	CLO6	T1-6.2, R2- 6.3
29-30	Section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections	CLO6	T1-6.5, 6.6
33-34	Design of simple beam sections.	CLO7	T1-6.7, 6.8
37-38	Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.	CLO8	T1-7.1
39-40	Principal Stresses and Strains: Introduction – Stresses on a loading	CLO18	T1- 7.2, R1-7.3

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
41-42	Two perpendicular normal stresses accompanied by a state of simple shear Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions.	CLO8	T1- 7.9,R1-7.9
43-44	Theories of Failure: Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory).	CLO8	T1-7.9, R1-7.10
45-46	Torsion of Circular Shafts: Theory of pure torsion – Derivation of Torsion equations : $T/J = q/r = N\theta/L$ – Assumptions made in the theory of pure torsion	CLO9	T1- 7.11,R2-7.12
47-48	Torsional moment of resistance –Polar section modulus	CL010	T1- 10.1, R1-10.2
49-50	Power transmitted by shafts – Combined bending and torsion and end thrust	CLO11	T1-10.4,R1- 10.5
51	Design of shafts according t	CLO12	T1-10.6, 10.7and 10.8
52-53	Hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders– Thin	CLO13	T1- 10.14 and 10.15
54-55	Longitudinal stress	CLO14	T1-10.11
56-57	Volumetric strain	CLO15	T1-10.16
58-59	Thin spherical shell introduction	CLO16	T1-10.20, R4-10.22
60-61	Hoop stress of spherical shell	CLO17	T1- 11.1, R2-11.2
62-63	Problems on spherical shell	CLO19	T1- 11.6, R2-11.7
64-65	Revision of fifth unit	CLO20	T1-11.12,R3-11.12

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Equilibrium equation applications,Cetroid and centeer of gravity	Seminars	PO 1, PO 4	PSO 1
2	Moment of inertia concepts to solve for arbitrary geometries	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Encourage students to design beams by writing MATLAB code to solve problems.	NPTEL	PO 2	PSO 1

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HOD, MECHANICAL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**METALLURGY AND MATERIAL SCIENCE ENGINEERING**				
Course Code	AME005				
Programme	B.Tech				
Semester	III	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. M Prashanth Reddy, Assistant Professor				
Course Faculty	Mr. M Prashanth Reddy, Assistant Professor Mr. G Aravind Reddy, Assistant Professor				

I. COURSE OVERVIEW:

Metallurgy and material science subject is backbone to mechanical engineering discipline. The students are given inputs on fundamentals of crystallography, microstructures and relation to properties of materials. Also students acquire knowledge on phase diagrams, heat treatment which will enable them to select materials for industrial applications .Inputs are also planned on ceramics, glasses, polymers and composites as present day designs are based on many advanced materials.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS005	I	Engineering chemistry	3
UG	AHS008	II	Modern Physics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Metallurgy and Material Science	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✔	Mini Project	✔	Videos
✔	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Assignments, Practical's
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Assignments, Practical's
PO 4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignments, Practical's,
PO 12	**Life-long learning:** Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	1	Seminars, Practical's

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Lecture, Assignments.
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	1	Projects
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the physical and mechanical, metallurgical engineering concepts for metals and preparation of alloys.
II	Analyze the microstructures of metals, alloys and relationship to heat treatment.
III	Compare the properties of ceramics, glasses, composites and polymers for industrial applications.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME005.01	CLO 1	Analyze the structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, Atomic packing factor, Coordinate number etc.	PO 1	3
AME005.02	CLO 2	Explain the necessity of alloying, types of solid solution and intermediate alloy phases.	PO 1	3
AME005.03	CLO 3	Explain the concept of phase and phase diagram and understand the basic	PO 1 PO 3	3 1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		terminologies associated with metallurgy.		
AME005.04	CLO 4	Construction of phase diagrams and identification of different phases and invariant reaction.	PO 1	3
AME005.05	CLO 5	Understand and suggest the heat treatment processes and types, and significance of mechanical and metallurgical properties with respect to microstructures.	PO 1	3
AME005.06	CLO 6	Explain the concept of Hardenability and demonstrate the test used to find the Hardenability of steels.	PO 1	2
AME005.07	CLO 7	Analyze the microstructure of metallic materials using phase diagram and modify the microstructure and properties using different heat treatment processes.	PO 1 PO 4	2 1
AME005.08	CLO 8	Define and differentiate engineering materials on the basis of structure and properties for engineering applications.	PO 1	2
AME005.09	CLO 9	Explain features, classification, and application of materials like polymers like thermosetting, thermoplastics.	PO 1	2
AME005.10	CLO 10	Explain features, classification, and application of materials like ceramics.	PO 1 PO 4	3 1
AME005.11	CLO 11	Explain features, classification, and application of materials like composites.	PO 1 PO 3 PO 4	3 2 2
AME005.12	CLO 12	Differentiate the properties and application of various materials like ceramics, composites and polymers.	PO 1 PO 3 PO 4	3 2 1
AME005.13	CLO 13	Enable students to understand various material standards.	PO 1	3
AME005.14	CLO 14	Enable students for selection of material for product design	PO 1 PO 3	2 2
AME005.15	CLO 15	Enable students for selection of material for manufacture.	PO 1	2
AME005.16	CLO 16	Develop skills for lifelong learning in specialized materials in engineering areas	PO 1 PO 12	2 3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												2		
CLO 2	3												2		
CLO 3	3		1										3		

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 4	3												3		
CLO 5	3												1	1	
CLO 6	2												1		
CLO 7	2			1											
CLO 8	2												1		
CLO 9	2												2		
CLO 10	3			1										2	1
CLO 11	3		2	2									2	2	1
CLO 12	3		2	1									2	2	
CLO 13	3												2		
CLO 14	2		2										1	2	1
CLO 15	2												1	1	
CLO 16	2											3	1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	PO 1 PO 3 PO 4	Seminars	PO 12
Laboratory Practices	PO 1	Student Viva	-	Mini Project	PO 1 PO 3 PO 4	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	STRUCTURE OF METALS
Structure of metals: Crystallography, Miller indices, packing efficiency, Density calculations, Grains and grain boundaries, Effect of grain size on the properties, Determination of grain size by different methods. Constitution of alloys: Necessity of alloying, Types of solid solutions, Hume-Rothery's rules, Intermediate alloy phases	

UNIT-II	PHASE DIAGRAMS
Joint probability distributions, joint probability mass, density function, marginal probability mass, density functions; Correlation: Coefficient of correlation, the rank correlation; Regression: Regression coefficient, the lines of regression, multiple correlation and regression.Phase Diagrams: Construction and interpretation of phase diagrams, Phase rule, Lever rule. Binary phase diagrams, Isomorphous, Eutectic and Eutectoid transformations with examples.	
UNIT-III	**ENGINEERING MATERIALS-I STEELS**
Engineering Materials-I Steels: Iron –Carbon phase diagram and heat treatment: Study of iron-iron carbide phase diagram, Construction of TTT diagrams, Annealing, Normalizing, Hardening and Tempering of steels, Hardenability, Alloy steels.	
UNIT-IV	**ENGINEERING MATERIALS –II &III**
Engineering Materials –II: Cast Irons: Structure and properties of White cast iron, malleable cast iron Grey cast iron. Engineering materials –III: Non-ferrous metals and alloys: Structure and properties of aluminum copper and its alloys, Al-Cu phase diagram, Titanium and its alloys.	
UNIT-V	**ENGINEERING MATERIALS –IV**
Engineering materials –IV: Ceramics, Polymers and composites: Crystalline ceramics, glasses, cermets: Structure, properties and applications. Classification, properties and applications of composites, Classification, properties and applications of polymers.	
Text Books:	
1. Sidney H Avner, "Introduction to Physical Metallurgy", McGraw-Hill Education, 2nd Edition, 2008. 2. Donald R Askeland, Thomson, "Essentials of Material Science and Engineering", Thomson Press, 1st Edition, 2005	
Reference Books:	
1. Kodgire, "Material Science and Metallurgy", Everst Publishing House, 12th Edition, 2002 2. William, Callister, "Material science and Engineering", Wiley, 9th Edition, 2014. 3. V Raghavan, "Elements of Material Science", PHI Learning Company Pvt Ltd, 6th Edition, 2015 4. Dr. Amandeep Singh Wadhva, "Engineering Materials and Metallurgy", Laxmi Publications, 1st Edition, 2008.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction to Metallurgy and Material Science Importance to Various Engineering disciplines	CLO1	T2-1.1
3	Branches of Metallurgy , chemical , physical , Mechanical Engineering, Metals , Non-metals, composites , nano-materials	CLO 1	T1-1.2, T2-1.2
4	Atomic structure , bonding in solids, different bonds and examples Crystal structure, unit cell,7 crystal systems, 14 Bravais lattices, Miller indices, crystallographic planes of refrigeration	CLO 1	T1-1.4
5-7	Atomic radius , Coordination number , Atomic packing factor ,Density calculation	CLO 1	T1-1.7, T2-1.8
8-11	Crystallization of pure metals ; solidification of pure metals, alloysGrains , Grain boundary , ASTM grain size no	CLO 2	T1-1.9
12	Crystal imperfections - Defects ; point , line , planar defects	CLO 2	T2-1.9
13	Phase diagrams : Phase rule	CLO 3	T1-3.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
14	Binary alloys – phase diagrams: Isomorphous system. Cu-Ni	CLO 3	T1-3.3
15-16	Chemical composition of phases , Lever rule , Equilibrium cooling , Non - Equilibrium cooling	CLO 3	T1-3.4, T2-4.4
17-18	Eutectic system. I Bi-Cd , Hypo, Hyper II Pb-Sn system	CLO 4	T2-4.5
19-20	Peritectic system Pt-Ag, Eutectoid reaction, Peritectoid reaction	CLO 3	T1-3.6, T2-4.5
21-22	Engineering Materials – 1 steels	CLO 4	T1-5.1
23-24	Steel :Fe – C ; Allotropy of Fe	CLO 4	T1-5.2
25	Peritectic transformation	CLO 4	T1-5.3,
26	Eutectoid transformation	CLO 5	T1-5.4
27	Hyper eutectoid transformation	CLO 5	T1-5.5
28	Heat treatment , Annealing Normalizing , Hardening , Tempering	CLO 5	T2-5.7
29-30	Hardenability	CLO 6	T1-6.1,
31	Alloy steels – Effect of alloying elements	CLO 6	T1-6.2,
32	Low alloy steels , stainless steels , Tool steels	CLO 6	T2-6.5,
33-35	Engineering Materials – II & III	CLO 6	T1-7.1,
36-37	White Cast Iron , Malleable CI , Grey CI , SG Iron	CLO 7	T2-6.7,
38-41	Engineering materials III :Nonferrous alloys – classification	CLO 7	T1-8.1,
41-42	Copper alloys	CLO 8	T2-7.2,
43-45	Al-alloys	CLO 8	T1-8.5,
46-48	Titanium alloys	CLO 8	T2-7.9,
49-50	Ceramics , Types , properties , applications	CLO 10	T2-10.1
51-53	Glasses , Types , Properties , applications	CLO 10	T2-10.3
54-56	Cermets , Types , Properties , applications	CLO 12	T2-10.5
57-58	Composites , Types , Properties , applications	CLO 11	T2-10.6
59-60	Polymers , Types , Properties , applications	CLO 09	T2-10.9

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Crystal imperfections	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3	PSO 1
2	Solidification and crystallization, Recovery, recrystallization and grain growth.	Seminars / Guest Lectures / NPTEL	PO 2, PO 5	PSO 2
3	Material characterization	Assignments / Laboratory Practices	PO 1, PO 3, PO 4	PSO 2

Prepared By:
Mr. M Prashanth Reddy, Assistant Professor

HOD, MECHANICAL ENGINEERING

IV SEMESTER

TITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATHEMATICAL TRANSFORM TECHNIQUES**				
Course Code	AHS011				
Programme	B.Tech				
Semester	II	EEE			
	III	AE | ECE			
	IV	ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. B Praveena , Assistant Professor				
Course Faculty	Dr. S Jagadha, Associate Professor Ms. V Subba Laxmi, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced engineering mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes types of matrices, difference calculus methods and differential equations. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of integration

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mathematical Transform Techniques	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design anmanufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats..	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Epress non periodic function to periodic function using Fourier series and Fourier transforms.
II	Apply Laplace transforms and Z-transforms to solve differential equations.
III	Formulate and solve partial differential equations.

IX . COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS011.01	CLO 1	Ability to compute the Fourier series of the function with one variable.	PO 1	3
AHS011.02	CLO 2	Understand the nature of the Fourier series that represent even and odd functions.	PO 1	3
AHS011.03	CLO 3	Determine Half- range Fourier sine and cosine expansions.	PO 1	2
AHS011.04	CLO 4	Understand the concept of Fourier series to the real-world problems of signal processing	PO 2	1
AHS011.05	CLO 5	Understand the nature of the Fourier integral.	PO 2	2
AHS011.06	CLO 6	Ability to compute the Fourier transforms of the function.	PO 2	2
AHS011.07	CLO 7	Evaluate finite and infinite Fourier transforms.	PO 4	1
AHS011.08	CLO 8	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design	PO 2	3
AHS011.09	CLO 9	Solving Laplace transforms using integrals.	PO 2	1
AHS01110	CLO 10	Evaluate inverse of Laplace transforms by the method of convolution.	PO 2	2
AHS011.11	CLO 11	Solving the linear differential equations using Laplace transform.	PO 1	3
AHS011.12	CLO 12	summarize the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems	PO 1	3
AHS011.13	CLO 13	Apply Z-transforms for discrete functions.	PO 1	3
AHS011.14	CLO 14	Evaluate inverse of Z-transforms using the methods of partial fractions and convolution method.	PO 1, PO 2	3
AHS011.15	CLO 15	Apply Z-transforms to solve the difference equations.	PO 2	3
AHS011.16	CLO 16	Understand the concept of Z-transforms to the real-world problems of automatic controls in telecommunication.	PO 2	2
AHS011.17	CLO 17	Understand partial differential equation for solving linear equations by Lagrange method.	PO 1, PO 2	3
AHS011.18	CLO 18	Apply the partial differential equation for solving non-linear equations by Charpit's method.	PO 1, PO 2	3
AHS011.19	CLO 19	Solving the heat equation and wave equation in subject to boundary conditions.	PO 1, PO 2	3
AHS011.20	CLO 20	Summarize the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics	PO 1, PO 2	3
AHS011.21	CLO 21	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 1	3

3 = High; 2 = Medium; 1 = Low

X . MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	2												1		
CLO 4		1													
CLO 5		2													
CLO 6		2													
CLO 7				1											
CLO 8				3											
CLO 9		1											1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		3													
CLO 16		2													
CLO 17	3	3											1		
CLO 18	3	3											1		
CLO 19	2	3											1		
CLO 20	3	2											1		
CLO 21	3														

3 = High; 2 = Medium; 1 = Low

X1. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Assignments	PO 1, PO 2, PO 4	Seminars	PO 2

Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**FOURIER SERIES**
Definition of periodic function, determination of Fourier coefficients; 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; Half- range Fourier sine and cosine expansions.	
UNIT-II	**FOURIER TRANSFORMS**
Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.	
UNIT-III	**LAPLACE TRANSFORMS**
Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.	
UNIT-IV	**Z –TRANSFORMS**
Z-transforms: Elementary properties, inverse Z-transform, convolution theorem, formation and solution of difference equations.	
UNIT-V	**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.	
TEXT BOOKS:	
1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
REFERENCES:	
1. G. Shanker Rao, "Mathematical Methods", I. K. International Publications, 1st Edition, 2009. 2. G. Shanker Rao, "Engineering Mathematics-1", I. K. International Publications, 1st Edition, 2009.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Define periodic function	CLO 1	T1:22.5 R1:2.3
2	Solve Fourier coefficients	CLO 2	T1:22.5 R1:2.4
3	Apply Fourier series for $(0, 2\pi)$	CLO 2	T1:22.6 R1:2.6
4-5	Determine even and odd function	CLO 4	T1:22.7 R1:4.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
6-7	Determine Fourier series in $(0,2l)$, $(-l,l)$ and also half range series in $(0, l)$	CLO 4	T1:22.7 R1:4.10
8-9	Determine half range series in $(0, \pi)$	CLO 7	T1:22.8 R1:4.15
10	Apply Fourier integral theorem to find integrals	CLO 9	T1:22.9 R1:5.4
11	Apply Fourier sine and cosine integrals to find integrals	CLO 9	T1:22.9 R1:5.8
12-13	Define and apply Fourier transforms	CLO 11	T1:23.10 R1:6.8
14	Use properties to solve the given functions	CLO 11	T1:23.10 R1:6.13
15-16	Define and apply Inverse transforms	CLO 13	T1:23.9 R1:7.5
17	Define and apply Finite Fourier transforms	CLO 11	T1:23.10 R1:7.5
18	Define Laplace transform and its property	CLO 9	T1:23.10 R1:8.1
19	Define piecewise continuous function	CLO 14	T1:23.1 R1:9.2
20	Define and apply shifting theorem, change of scale property	CLO 14	T1:23.1 R1:9.4
21	Solve derivatives and integrals, multiplied by t, divided by t	CLO 14	T1:23.1 R1:9.9
22-23	Define periodic functions	CLO 14	T1:23.1 R1:9.10
24-25	Solve Inverse Laplace transform	CLO 14	T2:27.5 R1:10.2
26	Define and apply shifting theorem, change of scale property	CLO 17	T2:27.7 R1:11.3
27	Solve multiplied by s, divided by s	CLO 17	T2:27.8 R1:11.6
28-30	Define and apply Convolution theorem	CLO 19	T2:27.12 R1:11.7
31-32	Define Z-transforms, Elementary properties	CLO 19	T2:27.12 R1:11.8
33-34	Define inverse Z-transform	CLO 20	T2:27.12 R1:11.9
35-36	Define and apply convolution theorem	CLO 20	T2:27.12 R1:11.10
37-38	Formulate partial differential equations	CLO 21	T2:27.14 R1:12.3
39	Solve by lagrange's method	CLO 22	T2:27.1 R1:12.7
40-41	Solve by Charpit's method	CLO 23	T2:27.17 R1:12.15
42	Apply method of separation of variables	CLO 23	T2:18.2 R1:13.1
43-45	Solve heat and wave equations	CLO 23	T2:18.3-18.5 R1:13.2, 13.3

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S no	Description	Proposed Actions	Relevance with Pos	Relevance with Psos
1	Problem deduction, Initial and Boundary value problems	Seminars	PO 1	PSO 1
2	Fourier Integral Transforms, Convolution theorem in Fourier Transforms, Higher order difference equations	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to identify the type of transform involved in industry	NPTEL	PO 2	PSO 1

Prepared by:
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HOD,MECH

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**PRODUCTION ENGINEERING**				
Course Code	AME006				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	3	2
Chief Coordinator	Dr. G. Naveen Kumar, Professor, ME				
Course Faculty	Dr. G. Naveen Kumar, Professor, ME Mr. C. LabeshKumar, Assistant Professor , ME				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of manufacturing technology with the help of various processes widely employed in industries. The course consists of casting, welding, sheet metal forming, extrusion and forging processes with the related details of equipment and applications. Introduces the different manufacturing processes and breakeven analysis. Engineering materials, laying emphasis on ferrous and non-ferrous materials along with the heat treatment of metals. Discusses the special casting processes and metal-forming processes respectively.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME005	III	Metallurgy and material science	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Production Technology	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
PO 3	**Design / development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Assignments
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	Seminar
PO 5	**Modern tool usage:** An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Assignments
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Projects
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Guest Lectures

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Comprehensive understanding of different manufacturing processes for product development.
II	Apply casting, metal joining and forming processes for various industries.
III	Select process parameters, equipment for material processing

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME006.01	CLO 1	Understand various manufacturing processes used in various industries.	PO 1	3
AME006.02	CLO 2	Explain the steps involved in casting processes	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME006.03	CLO 3	Use design principles to incorporate sprue, runner, gates, and risers in foundry practice.	PO 1	3
AME006.04	CLO 4	Evaluate properties of sand for use in sand casting.	PO 2	2
AME006.05	CLO 5	Solve problems and find methods to rectify casting defects.	PO 2	2
AME006.06	CLO 6	Demonstrate the preparation of moulds for various casting processes	PO 2	2
AME006.07	CLO 7	Describe applications of various casting processes	PO 4	1
AME006.08	CLO 8	Explain principles of welding, brazing and soldering processes.	PO 4	1
AME006.09	CLO 9	Demonstrate use of welding equipment for various industrial applications.	PO 5	2
AME006.10	CLO 10	Demonstrate use of Brazing and soldering equipment for various industrial applications.	PO 5	2
AME006.11	CLO 11	Explain design of welded joints, residual stresses, distortion and control.	PO 3	3
AME006.12	CLO 12	Explain causes and remedies of welding defects.	PO 3	3
AME006.13	CLO 13	Compare destructive and non-destructive testing techniques.	PO 3	3
AME006.14	CLO 14	Understand the effect of heat input in welds.	PO 1, PO 5	3
AME006.15	CLO 15	Understand the importance of sheet metal forming, bending, and deep drawing.	PO 2	2
AME006.16	CLO 16	Compare extrusion and forging processes to identify advantages and limitations.	PO 2	2
AME006.17	CLO 17	Enable students to understand various manufacturing processes for industrial applications.	PO 1, PO 2	3
AME006.18	CLO 18	Enable students to understand importance of manufacturing for life long learning, Higher Education and competitive exams.	PO 1, PO 5	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	2											1		
CLO 2	3	2											1		
CLO 3		3	2											1	
CLO 4			2		2								3		
CLO 5		1	3										2		
CLO 6		1			2								2		

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 7			3	2										1	
CLO 8	3		3	2	3								2		
CLO 9		3													
CLO 10	3			3										3	
CLO 11	2	2		3										2	
CLO 12	3			3	2								2		
CLO 13	3		3	3										2	
CLO 14				3	2									2	
CLO 15	3	2	3	3									2	3	
CLO 16	3	2	3		3									2	
CLO 17	2	2			3									2	
CLO 18		3												2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO 5	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO 5	Assignments	PO 3	Seminars	PO 2, PO 4, PO 5
Laboratory Practices	PO 3	Student Viva	PO 3	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	CASTING	Classes:09
Casting: Steps involved in making a casting, it's applications, patterns and types of patterns, pattern allowances and their construction, types of casting processes, solidification of casting.		
Unit-II	**WELDING-I**	**Classes:09**
Welding: Welding types, Oxy-fuel gas welding, cutting, standard time and cost calculations, arc welding process, forge welding, resistance welding, thermit welding		

Unit-III	WELDING-II	Classes:09
Welding: Inert gas welding, TIG welding, MIG welding, friction welding, induction pressure welding, explosive welding, electron beam welding, laser welding, soldering and brazing. Heat affected zone in welding, welding defects, causes and remedies, destructive and non-destructive testing of welds.		
Unit-IV	**FORMING**	**Classes:09**
Forming: Hot working, cold working, strain hardening, recovery, re-crystallization and grain growth, comparison of properties of cold and hot worked parts, rolling fundamentals, theory of rolling, types of rolling mills and products; Forces in rolling and power requirements, stamping, forming and other cold working processes: Blanking and piercing, bending and forming, drawing and its types, wire drawing and tube drawing; coining; hot and cold spinning, types of presses and press tools, forces and power requirements for the above operations.		
Unit-V	**EXTRUSION, FORGING**	**Classes:09**
Extrusion of Metals: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, forward extrusion and backward extrusion, impact extrusion, extruding equipment, tube extrusion and Pipe making, hydrostatic extrusion, forces in extrusion; Forging processes: Forging operations and principles, tools, forging methods, Smith forging, drop forging, roll forging, forging hammers: Rotary forging, forging defects, cold forging, swaging, forces in forging operations.		
Text Books:		
1. P. N. Rao, "Manufacturing Technology", Tata McGraw-Hill, 2ndEdition,2013. 2. Hajra Chowdhary, "Workshop Technology", Asia Publishing House, 2ndEdition,2008.		
Reference Books:		
1. Sarma P C, "Production Technology", S.Chand& CO, New Delhi, 7thEdition,2006. 2. R. K. Jain, "Production Technology", Khanna Publishers, 17thEdition,2013. 3. T. V. Ramana Rao, "Metal Casting", New Age, 1stEdition,2010. 4. Philips Rosenthal, "Principles of Metal Castings", Tata McGraw-Hill, 2ndEdition,2001. 5. B. S. Raghuwamshi, "A Course in Workshop Technology", Dhanpat Rai & Sons,2014. 6. Kalpakjain S, "Manufacturing Engineering and Technology", Pearson Education,7thEdition,2014. 7. HMT, "Production Technology", McGraw-Hill Education, 1stEdition,2013.		

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-4	Define principle of casting process	CLO 1	T1:3.1 R1:3.1
5-7	Examine various types of pattern designs	CLO 1	T1:3.2.5 R1:3.3.4
8-10	Relate various types of casting processes	CLO 1	T1:3.1.5 R1:3.1.3
11-14	Describe the principles of welding processes	CLO 2	T1:9.1 R1:5.1
15-16	Compare various flames	CLO 2	T1:9.2.1 R1:5.2.3
17-20	Explain arc,forge and resistance welding	CLO 3	T1:9.4.2 R1:5.3
21-23	Explain Inert gas welding, welding processes	CLO 3	R2:9.16 R6:27.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
24-26	Discuss various types of advances welding processes	CLO 4	R2:9.16.12 R6:27.1
27-28	Define brazing and soldering	CLO 5	R2:9.64 R6:30.2
29-30	Describe defects and evaluation	CLO 5	R2:9.55 R6:29.3
31-32	Describe hot and cold working	CLO 6	T1:7.1.1 R1:4.6
33-34	Discuss recrystallization and grain growth	CLO 7	T1:7.1 R1:3.6.1
35	Compare cold and hot working	CLO 8	T1:7.1.1 R1:4.6
36-37	Discuss Rolling	CLO 8	T1:7.2 R1:4.2
38	Explain Blanking and piercing processes	CLO 9	T1:8.3 R6:6.5
39	Discuss bending and forming	CLO 9	T1:8.7 R1:4.8.12
40-41	Discuss wire and tube drawing	CLO 10	T1:8.4 R1:4.5
42	Explain coining	CLO 11	T1:8.9 R1:4.8.15
43-44	Discuss hot and cold spinning	CLO 12	T1:8.6 R1:4.8.15
45-47	Explain various types of Press tools	CLO 12	T1:8.1 R1:4.8.6
48-49	Explain extrusion process	CLO 13	T1:7.4 R1:4.4
50-52	Compare hot and cold extrusion	CLO 14	T1:7.4.2 R1:4.4.1
53-55	Explain equipment used for extrusion of pipes	CLO 15	T1:7.4.4 R1:4.4.2
56-57	Discuss forging processes	CLO 16	T1:7.3 R1:4.3
58-59	Explain drop and roll forging	CLO 17	T1:7.3.3 R1:4.3.2
59-60	Discuss forces in forging operations	CLO 18	T1:7.3.5 R1:4.3.6

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Advances in manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3	PSO 1
2	Interaction of materials and manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 2, PO 5	PSO 2
3	Recommended practices in casting, welding, and forming	Assignments / Laboratory Practices	PO 1, PO 3, PO 4	PSO 2

Prepared by:
Dr. G. Naveen Kumar, Professor

HOD, MECHANICAL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**APPILIED THERMODYNAMICS**				
Course Code	AME007				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr.P.SrinivasRao, Professor, ME				
Course Faculty	Mr. G.Aravind Reddy, Assistant Professor , ME				

I. COURSE OVERVIEW:

Applied Thermodynamics is intended to introduce basic principles of internal combustion engines, compressors and refrigeration are widely used in automobile, agriculture, industry for transport, water pumping, electricity generation, earth moving and to supply mechanical power to grinders, crushers etc. Compressors are used for supply of gases including air at higher pressure. Compressors are used to supply compressed air to all pneumatic equipments and for gases such as cooking gas, oxygen, nitrogen, neon, argon compressors are also used. Thus there is great relevance for this course for mechanical engineers. Vapour compression refrigeration cycle based on thermodynamic system is studied.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	III	Thermodynamics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Applied Thermodynamics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 fiveunits 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering and Mechanical Engineering principles related to combustion engines.	3	Presentation on Real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using Thermodynamics concepts and principles.	2	Seminar
PO 3	**Design/ development of solutions:** Design, implement, and evaluate a Mechanical Engineering component, to meet desired needs within realistic constraints	1	Assignments
PO 6	**The engineer and society**: Maintaining the engineering practices such as time, efficiency, as well as appropriate constraints related to economic, environmental, ethical, health and safety, manufacturability, and sustainability considerations	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the construction and working of internal combustion engines, compressors and refrigeration systems.
II	Develop the concept of ideal and real working of thermodynamic cycles for performance evaluation.
III	Understand the subsystems of internal combustion systems.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME007.01	CLO 1	Understand main idea and importance behind the 2-S and 4-S IC engines	PO 1	3
AME007.02	CLO 2	Analyze the working of the basic components in the IC engine	PO 1	3
AME007.03	CLO 3	Understand the combustion process and also how it does affect the performance of the IC engines.	PO 1,PO 2	3
AME007.04	CLO 4	Apply the thermodynamic principles in the design of an IC engines	PO 1,PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME007.05	CLO 5	Formulate and perform the procedures required for the maintenance and operation of IC engine	PO 2	2
AME007.06	CLO 6	Compare different IC engines and develop a system which meets the requirement	PO 1,PO 2,PO 3	2
AME007.07	CLO 7	Knowledge of Fuel Requirements and Fuel Rating.	PO 2	1
AME007.08	CLO 8	Testing and Performance of I.C Engines.	PO 2, PO 3	1
AME007.09	CLO 9	Analyze the working of the basic components in the Compressors and Refrigeration systems.	PO 2	2
AME007.10	CLO 10	Apply the thermodynamic principles in the design of Compressors and refrigeration system	PO 1,PO 2	2
AME007.11	CLO 11	Formulate and perform the procedures required for the maintenance and operation of compressors and refrigeration systems.	PO 1,PO 2,PO 3	3
AME007.12	CLO 12	Compare different compressors and refrigeration systems and develop a system which meets the requirements.	PO 3, PO 6	3
AME007.13	CLO 13	Understand the process of pressure enthalpy charts that are used in the Refrigeration systems.	PO 2, PO 6	3
AME007.14	CLO 14	Introduction to concepts of power and refrigeration cycles. Their efficiency and coefficients of performance.	PO 3,PO 2	3
AME007.15	CLO 15	Ability to use modern engineering tools, software and equipment to analyze energy transfer in required air-condition application.	PO 3, PO 6	1
AME007.16	CLO 16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 6	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3	3											1		
CLO 4	3	2													
CLO 5		2													
CLO 6	2	2	2												
CLO 7		1													
CLO 8		1	1												
CLO 9		2											1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 10	2	2											1		
CLO 12			3			3									
CLO 13		3				3									
CLO 14		3	3										1		
CLO 15			1			1									
CLO 16						1									

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2, PO3,PO6	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 3						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	IC ENGINES,FUEL INJECTION AND LUBRICATION SYSTEMS
I. C Engines: Four and two stroke engine, SI and CI engines, valve and port timing diagrams, fuel injection systems for SI engines, fuel injection systems for CI engines, ignition systems, cooling and lubrication system, fuel properties and combustion, stoichiometry.	
UNIT-II	**COMBUSTION IN SI AND CI ENGINES**
Combustion in SI engines and CI engines: Normal combustion and abnormal combustion, importance of flame speed and effect of engine variables, type of abnormal combustion, pre-ignition and knocking, fuel requirements and fuel rating, anti-knock additives, combustion chamber, requirements, types; Combustion in CI Engines: Four stages of combustion, delay period and its importance, effect of engine variables, diesel Knock, need for air movement, open and divided combustion chambers and nozzles used, fuel requirements and fuel rating	
UNIT-III	**TESTING AND PERFORMANCE,COMPRESSORS**
Testing and performance: Parameters of performance, measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, brake power, determination of frictional losses and indicated power, performance test, heat balance sheet. and chart. Compressors: Classification, of compressors, fans, blower and compressor, positive displacement and dynamic types, reciprocating and rotary types.	

UNIT-IV	ROTARY AND AXIAL CENTRIFUGAL COMPRESSORS
Rotary, dynamic and axial flow (positive displacement): Roots blower, vane sealed compressor, mechanicaldetails and principle of working efficiency considerations; Centrifugal compressors: mechanical details and principle of operation, velocity and Pressure variation, Energy transfer, impeller blade shape-losses, slip factor, and power input factor, pressure coefficient and adiabatic coefficient, velocity diagrams, power; Axial flow compressors: Mechanical details and principle of operation, velocity triangles and energy transfer per stage degree of reaction, work done factor, isentropic efficiency, pressure rise calculations, polytropic efficiency.	
UNIT-V	**REFRIGERATION**
Refrigeration: Mechanical refrigeration and types, units of refrigeration, air refrigeration system, details and principle of operation, applications of air refrigeration, vapour compression refrigeration systems, calculation of COP, effect of superheating and sub cooling, desired properties of refrigerants and common refrigerants, vapour absorption system, mechanical details, working principle, use of p-h charts for calculations.	
Text Books:	
1. V. Ganesan, "I.C. Engines", Tata McGraw-Hill, 3rd Edition, 2011 2. B. John Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill, 2nd Edition,2011. 3. K. Rajput, "Thermal Engineering", Lakshmi Publications, 1st Edition, 2011.	
Reference Books:	
1.Mathur, Sharma, "IC Engines", DhanpatRai& Sons, 3rd Edition, 2008. 2. Pulkrabek, "Engineering Fundamentals of IC Engines", Pearson Education, 2nd Edition, 2008. 3. Rudramoorthy, "Thermal Engineering", Tata McGraw-Hill, 5th Edition 2003. 4. C. P. Arora, "Refrigeration and Air Conditioning", Tata McGraw-Hill Education, 3rdEdition, 2013.	

XIV COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Define Heat engine andclassify IC Engines	CLO 1	T1:28.7 R1:2.6
3	Discuss working of SI and CI engines	CLO 2	T1:27.5 R1:2.7
4-6	Illustrate crank angle valve and port diagrams	CLO 2	T1:29.6 R1:2.6
7-8	Explain carburetor. Fuel supply for SI engine	CLO 7	T1:29.7 R1:4.4
9-10	Explain different Fuel injection systems for CI engines	CLO 4	T1:30.7 R1:4.10
11	Discuss Ignition system	CLO 6	T1:30.8 R1:4.25
12-13	Explain Cooling and Lubrication system	CLO 2	T1:22.9 R1:5.4
14	Illustrate different fuels and its properties with their stoichiometry.	CLO 7	T1:31.2 R1:5.8
15	Discuss phenomena of combustion process	CLO 3	T2:31.10 R1:6.8
16	Emphasize Normal and abnormal combustion phenomena.	CLO 6	T2:32.10 R1:6.13
17-18	Discuss Importance of flame speed andits effect on engine variables	CLO 8	T2:33.9 R1:7.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
21-22	Demonstrate Knocking and its additives	CLO 8	T2:34.10 R2:7.5
23-24	Illustrate different types of combustionchambers	CLO 6	T2:35.10 R3:8.1
25-26	Explain Four stages of combustion inC.I. Engines. Discuss delay period	CLO 6	T2:35.12 R1:9.2
27	Discuss knocking and its effect onengine variables.	CLO 8	T2:36.1 R2:9.4
28	What is the need for air movement anddiscuss different combustion chambers.	CLO 5	T2:37.1 R2:9.9
29	What are the fuel requirements	CLO 7	T1:23.1 R1:9.10
30	Definition of performance characteristics.	CLO 8	T2:27.5 R1:10.2
31-32	Determination of frictional power, efficiency, brakes power.	CLO 8	T2:27.7 R1:11.3
33-34	Discuss sankey diagram for heat balancesheet.by means of losses.	CLO 8	T2:27.8 R1:11.6
35-37	Performance analysis of IC engines.	CLO 6	T2:27.12 R1:11.7
38	Classify compressors	CLO 9	T2:27.12 R1:11.8
39-40	Discuss different types of compressors.	CLO 11	T2:27.12 R1:11.9
41-43	Explain the working of roots blower vane sealed compressor and itsmechanisms.	CLO 10	T2:27.12 R1:11.10
44	Mechanism details of centrifugalcompressors.	CLO 12	T3:27.14 R1:12.3
45	Define power input factor, pressurecoefficient and adiabatic coefficient	CLO 12	T3:27.1 R1:12.7
46	Draw velocity diagrams and find power	CLO 13	T3:27.17 R1:12.15
47-48	Discuss working principle of Axial flow compressor and find the efficiency.	CLO 11	T3:27.18 R1:12.19
49-50	Define work done factor, isentropicefficiency.	CLO 12	T3:27.19 R4:14.4
51-52	Define pressure rise calculations,polytropic efficiency	CLO 13	T3:27.19 R4:14.5
53-54	Define refrigerating effect and its principle of operation.	CLO 13	T2:27.18 R4:12.19
55	Explain Air refrigeration system	CLO 13	T2:27.18 R4:12.19
56-57	Discuss vapour compression system components and calculate cop.	CLO 14	T3:27.18 R4:12.19
58-59	Explainvapour absorption system-mechanical details- working principle.	CLO 15	T3:27.18 R4:15.20
59-60	Problems on p-h chart.	CLO 15	T2:27.18 R4:15.19

XIV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Concepts related to thermodynamic laws, Working principles of IC engines, Analysing the compressors, Concepts of power and refrigeration cycles	Seminars / NPTEL	PO 2,PO 3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6	PSO 1

Prepared by:
Dr.P.SrinivasRao, Professor
Mr. G.Aravind Reddy, Assistant Professor **HOD, MECHANICAL ENGINEERING**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MECHANICS OF FLUIDS AND HYDRAULIC MACHINES**				
Course Code	AME008				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. A. Somaiah, Assistant Professor				
Course Faculty	Dr. CH.V.K.N.S.N Moorthy, Professor Mr. A. Somaiah, Assistant Professor				

I. COURSE OVERVIEW:

The aim of this course is to introduce basic principles of fluid mechanics and it is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery. Nowadays the principles of fluid mechanics find wide applications in many situations. The course deals with the fluid machinery, like turbines, pumps in general and in power stations. This course also deals with the large variety of fluids such as air, water, steam, etc; however, the major emphasis is given for the study of water.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied Physics	4
UG	AME002	II	Engineering Mechanics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mechanics of Fluids and Hydraulic Machines	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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.	2	Seminar
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	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Seminar
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Seminar
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of fluid mechanics.
II	Understand boundary layer concepts and flow through pipes.
III	Evaluate the performance of hydraulic turbines.
IV	Understand the functioning and characteristic curves of pumps.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME008.01	CLO 1	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.	PO 1	3
AME008.02	CLO 2	Explain the hydrostatic forces on submerged	PO 1, PO 3	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		bodies, variation with temperature and height with respect to different types of surfaces.		
AME008.03	CLO 3	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacenter height.	PO 1, PO 3	3
AME008.04	CLO 4	Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.	PO 1, PO 2, PO 4	2
AME008.05	CLO 5	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.	PO 1, PO 3	2
AME008.06	CLO 6	Recognize the surface and body forces required for obtaining momentum equation and energy equation and explain types of derivatives utilized in various flow field conditions.	PO 1, PO 2, PO 4	2
AME008.07	CLO 7	Develop Bernoulli's equation from Euler's equation and explain phenomenological basis of Navier – stokes equation which are widely used in aerodynamics and gas dynamics for real time problems.	PO 1, PO 2, PO 3	1
AME008.08	CLO 8	Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.	PO 1, PO 2, PO 3	1
AME008.09	CLO 9	Demonstrate for competitive exams, the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate.	PO 1, PO 2	2
AME008.10	CLO 10	Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.	PO 1, PO 3	2
AME008.11	CLO 11	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.	PO 1, PO 3	3
AME008.12	CLO 12	Discuss fully developed flow through pipes and variation with friction factor with Reynolds number and sketch the Moody's chart.	PO 1, PO 2	3
AME008.13	CLO 13	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.	PO 1, PO 3	3
AME008.14	CLO 14	Explain types of hydraulic pumps,the basic functions and features.	PO 1, PO 2	2
AME008.15	CLO 15	Design and select pumps (single or multiple) for different hydraulic applications.	PO 1, PO 3, PO 4	2
AME008.16	CLO 16	Understand pumps classification and be able to develop a system curve used in pump selection	PO 1, PO 2	2
AME008.17	CLO 17	Analyze flow in closed pipes, and design and selection of pipes including sizes.	PO 1, PO 2	3
AME008.18	CLO 18	Understand the basic elements of pump and turbine flow, and be able to analyze and select the pump needed for pressurizing situations.	PO 1, PO 2	2
AME008.19	CLO 19	Recognize and discuss today's and tomorrow's use of turbomachines for enabling a	PO 1, PO 3, PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		sustainable society.		
AME008.20	CLO 20	Explain the working principle of various types of hydro turbines and know their application range	PO 1, PO 2	1
AME008.21	CLO 21	Determine the velocity triangles in turbomachinery stages operating at design and offdesign conditions.	PO 1, PO 2, PO 3, PO 4,	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1	2	
CLO 2	3		3										1		
CLO 3	3		3										1	2	
CLO 4	2	2		2									1	2	
CLO 5	2		2										1	2	
CLO 6	2	2		2										2	
CLO 7	1	1	1										1		
CLO 8	1	1	1											2	
CLO 9	2	2												2	
CLO 10	2		2										1		
CLO 11	3		3											2	
CLO 12	3	3											1		
CLO 13	3		3										1	2	
CLO 14	2	2											1		
CLO 15	2		2	2									1	2	
CLO 16	2	2											1		
CLO 17	3	3											1		
CLO 18	2	2											1	2	
CLO 19	1		1	1										2	
CLO 20	1	1												2	

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 21	2	2	2	2									1	2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4	SEE Exams	PO 1, PO 2 PO 3, PO 4	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	PO 3	Student Viva	-	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**FLUID STATICS**
Dimensions and units, Physical properties of fluids-specific gravity, viscosity, surface tension, vapour pressure and their influence on fluid motion, atmospheric, gauge and vacuum pressures, measurement of pressure, piezometer, U-tube and differential manometers.	
UNIT-II	**FLUID KINEMATICS, FLUID DYNAMICS**
Fluid Kinematics: Stream line, path line, streak line and stream tube, classification of flows- steady and unsteady, uniform and non uniform, laminar and turbulent, rotational and irrotational flows, equation of continuity for one dimensional flow and three dimensional flows; Fluid dynamics: Surface and body forces, Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend.	
UNIT-III	**BOUNDARY LAYER CONCEPTS, CLOSED CONDUIT FLOW**
Boundary layer Concepts: Definition, thickness, characteristics along thin plate, Laminar and turbulent boundary layers, boundary layer in transition, Separation of boundary layer, submerged objects- drag and lift. Closed Conduit flow: Reynolds's experiment, Darcy Weisbach equation, minor losses in pipes, Pipes in series and pipes in parallel, Total energy line, hydraulic gradient line, Measurement of flow, Pitot tube, venturi meter, and orifice meter, flow nozzle.	
UNIT-IV	**BASICS OF TURBO MACHINERY, HYDRAULIC TURBINES AND PERFORMANCE**
Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined vanes, curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow radial vanes; Hydraulic turbines: classification of turbines, heads and efficiencies, impulse and reaction turbines, Peloton Wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design, draft tube theory, functions and efficiency; Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.	
UNIT-V	**CENTRIFUGAL PUMPS AND RECIPROCATING PUMPS**
Centrifugal pumps: Classification, working, work done, barometric head losses and efficiencies, specific speed, performance characteristic curves, NPSH; Reciprocating pumps: working, discharge, slip, indicator diagrams.	

Text Books:
1. H Modi, Seth, "Hydraulics, Fluid Mechanics and Hydraulic Machinery", Rajsons Publications, 20th Edition, 2013. 2. Rajput, "Fluid Mechanics and Hydraulic Machines", S.Chand & Co, 6th Edition, 1998.
Reference Books:
1. Dr. R K Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 9th Edition, 2015. 2. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", Kotaria & Sons, 2013. 3. D. Rama Durgaiah, "Fluid Mechanics and Machinery", New Age International, 1st Edition, 2002. 4. Banga, Sharma, "Hydraulic Machines", Khanna Publishers, 6th Edition, 2001

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Outline of various units	CLO 1	T1:1.4 R1:1.2
2-5	Explain the fluid properties	CLO 1	T1:1.5 R1:2.4
6-7	Distinguish various pressures	CLO 1	T1:2.5 R1:2.5
8-10	Determine the pressure with different instruments	CLO 1	T1:2.5 R1:2.6
11-12	Differentiate various flow lines	CLO 4	T1:22.7
13-14	Classify and describe various flows	CLO 6	T1:6.3 R1:5.3
15-16	Formulate continuity equation for 1 and 3-d flow	CLO 7	T1:6.6 R1:5.3.6
18	List various forces	CLO 7	R1:6.2
19-20	Formulate Euler's and Bernoulli's equations	CLO 7	T1:7.5 R1:6.3
21-22	Apply momentum equation for a pipe bend	CLO 7	T1:8.5 R1:6.8
23	Define boundary layer	CLO 7	T1:12.2 R1:13.1
24-25	Distinguish boundary layer of laminar, turbulent and transition	CLO 9	T1:12.3 R1:13.2
26-27	Explain separation of boundary layer	CLO 10	T1:12.10 R1:13.7
28	Demonstrate Reynold's experiment	CLO 11	T1:11.2 R1:10.2
29-30	Formulate the Darcy's equation	CLO 12	T1:11.5 R1:10.3
31-32	Discuss the series and parallel connections of pipes	CLO 12	T1:11.12 R1:11.9
33-35	Construct total energy and hydraulic gradient lines	CLO 12	T1:11.8 R1:11.5
36-38	Measurement the discharge	CLO 12	T1:9.9
39-41	Discuss the effect of hydrodynamic force on flat vanes	CLO 18	T1:20.3 R1:17.2
42-44	Draw the velocity triangles for curved vanes	CLO 19	T1:20.4 R1:17.4.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
45	Classify the turbines	CLO 20	T1:21.4 R1:18.5
46-48	Evaluate the performance of turbines	CLO 21	T1:22 R1:18.6.1
49	Describe the functions of draft tube	CLO 21	T1:21.12 R1:18.10
50-51	Define unit quantities and Draw characteristic curves	CLO 20	T1:22.5 R1:18.13
52	Illustrate the governing of turbines	CLO 21	T1:21.21 R1:18.14
54-55	Explain Cavitation, water hammer, surge tank	CLO 21	T1:21.23
56-57	Classify and Explain the working of centrifugal pump	CLO 14	T1:24.3 R1:19.2
58-59	Compare the characteristic curves of centrifugal pump	CLO 16	T1:24.16 R1:19.10
60	Describe and Evaluate the performance of reciprocating pumps	CLO 17	T1:23.4 R2:20.2

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1, PO 4	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
Mr. A Somaiah, Assistant Professor

HOD, MECHANICAL ENGINEERING

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

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**KINEMATICS OF MACHINES**				
Course Code	AME009				
Programme	B.Tech				
Course Type	Core				
Semester	IV	ME			
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. K. Viswanath Allamraju, Professor,				
Course Faculty	Dr. K. Viswanath Allamraju, Professor, Prof. V.V.S.H. Prasad, Professor.				

I. COURSE OVERVIEW:

Mechanical devices are designed to have mobility to perform certain functions. The theory behind the study of Kinematics of Machine leads us to design machines by understanding the relationship between the geometry and the motion of various parts of machine. This course will provide the knowledge on how to analyze the motions of mechanisms and design synthesis mechanisms to give required mobility. This includes relative motion analysis and design of gears, gear trains, cams, linkages and steering mechanism gears by adopting simultaneously both graphical and analytical approaches to estimate displacement, velocity and acceleration of links in a machine.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME001	I	Engineering Drawing	4

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Kinematics of machines	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

√	Chalk & talk	√	Quiz	√	Assignments	✘	Moocs
√	Lcd / ppt	√	Seminars	✘	Mini project	✘	Videos
✘	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). 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 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.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

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).

Table 1: Assessment pattern for CIA

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

Continuous Internal Examination (CIE):
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 20 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, micro projects, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering Knowledge: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO2	Problem Analysis: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	3	Seminar
PO3	Design/ development of solutions: Competence to design a system, component or process to meet societal needs within realistic constraints.	3	Seminar
PO4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	3	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Lecture, Assignments.
PSO2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	3	Projects
PSO3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	3	Projects

3= High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of kinematics and the related terminology of machines.
II	Identify mobility; enumerate links and joints in the mechanisms.
III	Explain the concept of analysis of different mechanisms.
IV	Understand the working of various straight line mechanisms, gears, gear trains, steering gear mechanisms, cams and a Hooke's joint.
V	Determine the mechanisms for displacement, velocity and acceleration of links in a machine.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CAME009.01	CLO1	Classifications of the kinematic links, kinematic pairs and formation of the kinematic chain.	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CAME009.02	CLO2	Distinguish between mechanism and machine	PO 1, PO 3	3
CAME009.03	CLO3	Design and develop inversions of quadratic cycle chain, slider cranck mechanism, double slider cranck mechanism and cross slider mechanism.	PO 1, PO 3	3
CAME009.04	CLO4	Demonstrate type synthesis, number synthesis and dimensional synthesis.	PO 1, PO 2, PO 4	2
CAME009.05	CLO5	Construct Graphical methods of velocity polygon and acceleration polygons for a given configuration diagram.	PO 1, PO 3	2
CAME009.06	CLO6	Understand other methods of acceleration diagrams like Klien's construction.	PO 1, PO 2, PO 4	2
CAME009.07	CLO7	Develop secondary acceleration component i.e Correli's component involving quick return mechanisms	PO 1, PO 2, PO 3	1
CAME009.08	CLO8	Alternative approach for determining velocity by using I centres and centriods methods.	PO 1, PO 2, PO 3	1
CAME009.09	CLO9	Significance of exact and approximate straight line mechanisms.	PO 1, PO 2	2
CAME009.10	CLO10	Application of straight line mechanism in steam engine indicators.	PO 1, PO 3	2
CAME009.11	CLO11	Applications of Ackerman's and Davi's steering mechanisms in automobiles.	PO 1, PO 3	3
CAME009.12	CLO12	Develop the condition for exact steering.	PO 1, PO 2	3
CAME009.13	CLO13	Develop the polar velocity diagram for a single hook joint and double hook joint and develop condition for unity for higher and lower speeds.	PO 1, PO 3	3
CAME009.14	CLO14	Study different displacement profiles applicable in I.C engines cam shafts.	PO 1, PO 2	2
CAME009.15	CLO15	Plot the displacement, velocity and acceleration profiles with respect to time.	PO 1, PO 3, PO 4	2
CAME009.16	CLO16	Understand the geometry of gears and deduce the expression for arc of contact.	PO 1, PO 2	2
CAME009.17	CLO17	Derive the expression for minimum number of teeth to avoid interference in case of pinion and gear as well as rack and pinion.	PO 1, PO 2	3
CAME009.18	CLO18	Application of different gear trains including epicyclic and deduce the train value using tabular and relative velocity method.	PO 1, PO 2	2
CAME009.19	CLO19	Significance of differential gear box in an automobile while taking turn	PO 1, PO 3, PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		on the road.		
CAME009.20	CLO20	Enable the students to understand the importance of theory of machines for lifelong learning, Higher Education and competitive exams.	PO 1, PO 2	1

3= High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1	2	
CLO 2	3		3										1		
CLO 3	3		3										1	2	
CLO 4	2	2		2									1	2	
CLO 5	2		2										1	2	
CLO 6	2	2		2										2	
CLO 7	1	1	1										1		
CLO 8	1	1	1											2	
CLO 9	2	2												2	
CLO 10	2		2										1		
CLO 11	3		3											2	
CLO 12	3	3											1		
CLO 13	3		3										1	2	
CLO 14	2	2											1		
CLO 15	2		2	2									1	2	
CLO 16	2	2											1		
CLO 17	3	3											1		
CLO 18	2	2											1	2	
CLO 19	1		1	1										2	

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 20	1	1												2	

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2,PO3	SEE Exams	PO1,PO4	Assignments	-	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO4						

XII. ASSESSMENT METHODOLOGIES–INDIRECT

√	Assessment of course Outcomes (by feedback, once)	√	Student feedback on faculty (twice)
✘	Assessment of mini projects by experts		

XIII. SYLLABUS:

Unit-I	MECHANISMS
Mechanisms: Elements or links, classification, rigid link, flexible and fluid link, types of kinematic pairs constrained motion, kinematic chain, mechanism, machine, structure, inversion of mechanism, inversions of cycle chain, single and double slider crank chains, mechanical advantage, Grubler's Criterion.	
Unit-II	**KINEMATICS, PLANE MOTION OF BODY, ANALYSIS OF MECHANISMS**
Kinematics: Velocity and acceleration, motion of link in machine, determination of velocity and acceleration, Graphical method, application of relative velocity method, plane motion of body: Instantaneous center of rotation, centroids and axodes, three centers in line theorem, graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method. Klein's construction, Coriolis acceleration, determination of Coriolis component of acceleration; Analysis of mechanisms: Analysis of slider crank chain for displacement, velocity and acceleration of slider, acceleration diagram for a given mechanism.	
Unit-III	**STRAIGHT LINE MOTION MECHANISMS, STEERING GEARS, HOOKE'S JOINT**
Straight-line motion Mechanisms: Exact and approximate copied and generated types, Peaucellier, Hart and Scott Russul, Grasshopper, Watt, TChebicheff and Robert mechanisms, pantograph. Steering gears: Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, Hooke's joint: Single and double Hooke's joint, velocity ratio, application, problems.	
Unit-IV	**CAMS, ANALYSIS OF MOTION OF FOLLOWERS**
Cams: Definitions of cam and followers, their uses, types of followers and cams, terminology, types of follower motion, uniform velocity, simple harmonic motion and uniform acceleration; Maximum velocity and maximum acceleration during outward and return strokes in the above three cases; Analysis of motion of followers: Tangent cam with roller follower, circular arc cam with straight, concave and convex flanks.	
Unit-V	**HIGHER PAIRS, GEAR TRAINS**
Higher Pairs: friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, velocity of sliding, form of teeth, cycloidal and involute profiles, phenomena of interferences, methods of interference; Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact of pinion and gear pinion and rack arrangements; Introduction to helical, bevel and worm gearing; Gear trains: Introduction, types, simple and reverted gear trains, epicyclic gear train; Methods of finding train value or velocity ratio of epicyclic gear trains,	

selection of gear box, differential gear for an automobile.
Text Books:
1. Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, 2010. 2. Thomas Bevan, "Theory of Machines", Pearson, 3rd Edition, 2009.
Reference Books:
1. Jagadish Lal, "Theory of Mechanisms and Machines", Metropolitan Book Company, 8st Edition, 2016. 2. S.S. Rattan, "Theory of Machines", Tata McGraw-Hill Education, 1st Edition, 2009. 3. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 3rd Edition, 2008. 4. Sadhu Singh, "Theory of Machines", Pearson, 2nd Edition, 2006. 5. J. S Rao, R. V Duggipati, "Mechanisms and Machine Theory", New Age Publishers, 2nd Edition, 2008. 6. R. K. Bansal, "Theory of Machines", Lakshmi Publications, 1st Edition, 2013.

XIV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1	Kinematics of Machinery -Introduction Link- Rigid Link, flexible and fluid link Types of kinematic pairs	CLO1	T1-1.1 , R1- 1.31.4 ,R2.1.7
3-4	Types of constrained motion. kinematic chain , Mechanism, Machine and Structure	CLO1	T1- 1.2, R1-1.8,
5-6	inversion of mechanism – inversions of quadric cycle chain, single and double slider crank chains	CLO1	T1- 1.15, R1- 1.16
7-8	Mechanical Advantage and Grubler's Criterion	CLO2	T1- 1.6
9-10	Velocity of link in machine, Vector diagram for velocity.	CLO2	T1- 2.2, R2-2.6
11	Determination of Velocity using Graphical method using relative velocity method.	CLO2	T1-2.6, R3-2.10
12	Acceleration of link in machine, Vector diagram for Acceleration.	CLO3	T1-3.2, R2-3.3,
13-14	Determination of Acceleration using Graphical method	CLO3	T1-3.5
15-16	Instantaneous center of rotation, centroids & axodes and Three centers in line theorem.	CLO4	T1-2.13, 2.14,R1- 2.16
17-18	Graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method	CLO4	T1-2.15, R1-2.15
23-24	Kleins construction, Coriolis acceleration and determination of Coriolis component of acceleration.	CLO4	T1-3.9, R1-3.9
25-27	Exact and approximate copied and generated types straight line mechanisms Peaucellier, Hart, Scott Russul and Grasshopper mechanisms.	CLO5	T1-6.1, R2-6.3

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
27-28	Watt, T.Chebicheff and Robert Mechanisms - Pantograph.	CLO6	T1-6.2, R2- 6.3
29-30	Conditions for correct steering – Davis Steering gear, Ackerman's steering gear.	CLO6	T1-6.5, 6.6
33-34	Single and double Hooke's joint – Velocity Ratio – application – problems.	CLO7	T1-6.7, 6.8
37-38	Definitions of cam and followers, their uses	CLO8	T1-7.1
39-40	Types of followers and cams, Terminology, Types of follower motion,	CLO18	T1- 7.2, R1-7.3
41-42	Uniform velocity, Simple harmonic motion	CLO8	T1- 7.9,R1-7.9
43-44	Uniform acceleration. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.	CLO8	T1-7.9, R1-7.10
45-46	Analysis of motion of followers: Tangent cam with Roller follower, circular arc cam with straight concave and convex flanks	CLO9	T1- 7.11,R2-7.12
47-48	Friction wheels and toothed gears and types of gears.	CL010	T1- 10.1, R1-10.2
49-50	Law of gearing -Condition for constant velocity ratio for transmission of motion - Velocity of sliding.	CLO11	T1-10.4,R1- 10.5
51	Form of teeth, cycloidal and involute profiles	CLO12	T1-10.6, 10.7and 10.8
52-53	Phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference	CLO13	T1- 10.14 and 10.15
54-55	expressions for arc of contact and path of contact of Pinion & Gear	CLO14	T1-10.11
56-57	Pinion and Rack arrangements	CLO15	T1-10.16
58-59	Introduction to Helical, Bevel and worm gearing.	CLO16	T1-10.20, R4-10.22
60-61	Gear trains-Introduction – Types – Simple and reverted gear trains	CLO17	T1- 11.1, R2-11.2
62-63	Epicyclic gear train.Methods of finding train value or velocity ratio of Epicyclic gear trains.	CLO19	T1- 11.6, R2-11.7
64-65	Selection of gear box-Differential gear for an automobile.	CLO20	T1-11.12,R3-11.12

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Design of coupler curves for four bar mechanism and slider crank mechanism	Seminars	PO 1, PO 4	PSO 1
2	Design and development of differential gear box for an automobile negotiating a turn	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Synthesis of mechanisms	NPTEL	PO 2	PSO 1

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
	using Frudenstein's equation using Chebyshev spacing			

Prepared by:
Dr. K. Viswanath Allamraju, Professor
Prof. V.V.S H Prasad, Professor

HOD, MECHANICAL ENGINEERING

V SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**BUSINESS ECONOMICS AND FINANCIAL ANALYSIS**				
Course Code	AHS015				
Programme	B.Tech				
Semester	V	ECE | IT | CSE | MECH |CIVIL | EEE			
Course Type	Skill				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	2	1	3	-	-
Chief Coordinator	Ms E. Sunitha, Assistant Professor, MBA				
Course Faculty	Ms E.Sunitha, Assistant Professor, MBA Ms S.Lakshmi , Assistant Professor, MBA Ms G.Joseph Mary, Assistant Professor, MBA Mr. P.Nagesh Assistant Professor, MBA				

I. 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.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-----

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Business Economics and Financial Analysis	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 units and each unit carries equal weight age 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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.	1	Assignments.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice**.**	1	Assignments.
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	Seminars.
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	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	---	----
PSO 2	**Software Engineering Practices**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	---	---
PSO 3	**Successful Career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	2	Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the concepts of managerial economics and financial analysis for optimal decision making in business environment.
II	Analyze the market dynamics namely demand, elasticity of demand and pricing in different market structures
III	Gain the knowledge on the production theories and cost analysis while dealing with the production and factors of production.
IV	Study the various pricing methods which are adopted in attracting the potential customers for the different commodities.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS015.01	CLO 1	Describe the economic activities performed by the businessmen in the business for profit earning.	PO 11	3
AHS015.02	CLO 2	Understand the significance of demand, its analysis, measurement of demand and its forecasting .	PO 2	1
AHS015.03	CLO 3	Write the production function through the Cobb Douglas Production Function.	PO 8	1
AHS015.04	CLO 4	Design and implement different structures of market covering how price is determined under different market structures	PO 8, PO 9	2
AHS015.05	CLO 5	Analyze different forms of business organizations existing in the modern business.	PO 2	3
AHS015.06	CLO 6	Describe the allocation of capital which plays a vital role in a business organization.	PO 11	3
AHS015.07	CLO 7	Demonstrate the concept of capital budgeting and allocations of the resources through capital budgeting methods	PO 9, PO11	3
AHS015.08	CLO 8	Apply the Principle of double entry to give an exposure to the maintenance of books of records and allocation of profits in an enterprise.	PO 2, PO8	1
AHS015.09	CLO 9	Explain the significance and objectives of trial balance and final accounts for knowing arithmetical accuracy of books of accounts	PO 2	1
AHS015.10	CLO 10	Understand the Ratio analysis to give an idea about financial forecasting	PO 11	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO1											3				
CLO2		1													
CLO3								1							
CLO4								1	3						2
CLO5									3						2
CLO6											3				2
CLO7									3		3				2
CLO8		1						1							
CLO9		1													
CLO10											3				

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 2, PO8, PO 9, PO11	SEE Exams	PO 2, PO8, PO 9, PO11	Assignments	PO 2	Seminars	PO9,PO11
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-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	
UNIT-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, Opportunity cost, Fixed vs. Variable costs, Explicit costs vs. Implicit costs, out of pocket costs vs. Imputed costs, Break-even analysis, Determination of Break – Even point (Simple Problems) , Managerial Significance of BEA.	
UNIT-III	**MARKETS& NEW ECONOMIC ENVIRONMENT**
Market 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,	
UNIT-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).	
UNIT-V	**INTRODUCTION TO FINANCIAL ACCOUNTING AND FINANCIAL ANALYSIS**
Accounting Concepts and Conventions, Introduction to IFRS– Double – Entry Book keeping, Journal, Ledger, Trial balance, Final accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments.) Financial Analysis through Ratios: Significance, limitations of Ratio Analysis and Ratios Computation, Analysis and Interpretation of Liquidity Ratios (Current Ratio and quick ratio). Activity Ratios (Inventory turnover ratio and Debtor Turnover ratio), Capital structure Ratios (Debt-Equity ratio, Interest Coverage ratio) and profitability ratios (Gross profit Ratio, Net profit ratio, Operating Ratio, P/E Ratio and EPS), Du Pont Chart.	
Text Books:	
1. Aryasri, "Managerial Economics and Financial Analysis", TMH publications, 4 th Edition, 2012. 2. M. Kasi Reddy, Saraswathi, "Managerial Economics and Financial Analysis", PHI Publications, New Delhi, 2 nd Edition, 2012. 3. Varshney, Maheswari, "Managerial Economics", Sultan Chand Publications, 11th Edition, 2009.	

Reference Books:
1. D.N. Dwivedi, "Managerial Economics", Vikas Publication House Pvt.Ltd, 2nd Edition, 2012. 2. S.N. Maheshwari & S.K.Maheshwari, "Financial Accounting", Vikas Publication House Pvt.Ltd, 4th Edition, 2012. 3. R.Narayana Swamy, "Financial Accounting- A managerial Perspective", Pearson publications, 1st Indian Reprint Edition, 2012. 4. J.V.Prabhakar Rao & P.V.Rao, "Managerial Economics & Financial Analysis", Maruthi Publishers, 1st Revised Edition, 2011. 5. .Kasi Reddy & Saraswathi, "Managerial Economics and Financial Analysis", PHI Publications, New Delhi, 10th Revised Edition, 2012. 6. Varshney & Maheswari, "Managerial Economics", Sulthan Chand Publishers, 1st Revised Edition, 2009.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Explain about managerial economics according to the business	CLO 1	T1- 1.3-1.8
3-4	Describe about demand analysis, the Law of Demand and Demand Function.	CLO 2	T1-2.2-2.11
5-6	Understand elasticity of the demand of the product, different types, Measurement of Elasticity of Demand and Factors influencing on Elasticity of Demand.	CLO 2	T1-3.3-3.20
6-7	State different methods of Demand Forecasting and the factors governing Demand Forecasting.	CLO 4	T1-4.6-4.19
8-9	Demonstrate the Production function, features of Iso-Quants and Iso-Costs,	CLO 4	T1- 5.3-5.18
10-12	Different types of Internal Economies, External Economies and Law of Returns with appropriate examples	CLO 4	T1- 5.3-5.18
13-14	Illustrate different types of costs	CLO 5	T1- 5.29-6.8
15-16	Explain the Significance and Limitations of Break-Even Analysis	CLO 5	T1- 7.13-7.14
17-18	Calculate Break-Even Point (Simple Problems)	CLO 6	T1- 7.1-7.12
19-20	Illustrate the features, price-output determination under Perfect Competition, Monopoly and Monopolistic competition Markets.	CLO 6	T1- 8.4-8.16
22-23	Demonstrate the Objectives, Policies and Methods of Pricing Strategies and Price Methods.	CLO 7	T1- 8.21-8.25
24-25	Describe Features of business, Definitions of Various forms of Business Units.	CLO 7	T1-9.3-9.15
26-27	State the Merits & Demerits of Different types of Public	CLO 8	T1- 9.2-10.23
28-29	Enterprises Changing Business Environment to Post Liberalization Scenario.	CLO 8	T1- 9.2-10.23
30-31	Explain the significance and classification of capital, Methods	CLO 9	T1- 11.3-11.5
32-33	Demonstrate the concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems.	CLO 9	T1-12.1-12.26
34-35	Illustrate the Significance of Financial Accounting, Double Entry, Accounts.	CLO 8	T1-13.4-13.15
36-37	Accounting Concepts and Conventions	CLO 8	T1-13.4-13.15
38-39	Explain the meaning, advantages and Limitations of the Journal, Ledger and Trial Balance	CLO 10	T1-13.5-13.68
40-41	Final Accounts and Solve simple Problems.	CLO 8	T1-13.4-13.15
42-43	Describe Meaning, Definitions and Limitations of Ratio Analysis	CLO 10	T1-14.1-14.8
44-45	Compute different types of Financial Ratios (Problems)	CLO 10	T1-14.4-14.18

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No	Description	Proposed actions	Relevance with PO's	Relevance with PSO's
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lectures	PO 2	PSO 1

Prepared by:
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HOD, MBA

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(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**MACHINE TOOLS AND METROLOGY**				
Course Code	AME010				
Programme	B.Tech				
Semester	V	ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. G. Naveen Kumar, Professor, ME				
Course Faculty	Dr. G. Naveen Kumar, Professor, ME				

I. COURSE OVERVIEW:

Machine Tool Technology is an instructional program that prepares individuals to shape metal parts on machines such as lathes, grinders, drill presses, milling machines and shapers. This program includes instruction in safety, making computations related to work dimensions testing feeds and speeds of machines using precision measuring instruments. Metrology is highly valuable for the students and practitioners, specifically from mechanical and allied engineering stream. This course is designed to impart the knowledge to develop measurement procedures, conduct metrological experiments.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME006	IV	Production Technology	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Machine Tools and Metrology	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering Knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	2	Assignments
PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Mini project
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Industrial/ Seminars
PO 4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	2	Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Assignments
PSO 2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Projects
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	2	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Visualize the generation of surface profiles using the relative motion between directrix and generatrix.
II	Understand the basic mechanism involved in metal cutting processes using different cutting tools.
III	Understand the measurement of different attributes of metal cutting using various measuring instruments.
IV	Analyze surface topography, establish geometrical dimensioning and tolerancing.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME010.01	CLO 1	Understand the concepts various metals cutting machines like lathe describe various driving mechanisms of lathe.	PO 1	1
AME010.02	CLO 2	Demonstrate knowledge with sketches the constructional features and Describe the various operations related to the shaper and planer machines.	PO 1	3
AME010.03	CLO 3	Explore knowledge & ability to describe the indexing mechanism for a milling machine and also calculate simple indexing values	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME010.04	CLO 4	Derive the constructional features and the terminologies related to grinding, broaching and honing machines	PO 2	2
AME010.05	CLO 5	Discuss the nature of steady and unsteady processes under the influence of time	PO 2	3
AME010.06	CLO 6	Develop the fundamentals of casting and foundry and discuss metal cutting tool theory.	PO 4	2
AME010.07	CLO 7	Determine simple numerical on related concepts discuss in detail various materials used for cutting tools	PO 3	2
AME010.08	CLO 8	Understand the various principles and applications of Non-traditional machining (NTM) processes. Look into the concepts related to NTM processes.	PO 4	3
AME010.09	CLO 9	Knowledge to operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality	PO 3	1
AME010.10	CLO 10	Knowledge to identify the uncertainties in dimensional metrology and the define the measurement standards.	PO 4	3
AME010.11	CLO 11	Discuss the measure length and angles using line graduated instruments, i.e. vernier calipers, micrometers, bevel protractor, sine bar and surface plates	PO 3	2
AME010.12	CLO 12	Develop measure dimensions of shafts, bearings and linear surfaces in metric and imperial units using calibers, micrometers, and scales.	PO 2	3
AME010.13	CLO 13	Understand Principles of measuring instruments and gauges and their uses.	PO 3	3
AME010.14	CLO 14	Introduction to Inspection of engineering parts with various precision instruments.	PO 1, PO 3	3
AME010.15	CLO 15	Ability to use comparative length measuring instruments, i.e. dial indicator, to measure variations in the distance between two or more surfaces.	PO 2	1
AME010.16	CLO 16	Explore the use of appropriate method for determination of accuracy based on product function and manufacturing capability.	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3			2										3	
CLO 2			1										3		3
CLO 3	3			3										3	
CLO 4	2													3	

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 5	3			1									3		2
CLO 6	1	2													3
CLO 7	2		3											3	
CLO 8				3										1	
CLO 9													3		3
CLO 10	1		1												
CLO 11	2													3	3
CLO 12				1									3		
CLO 13	1														2
CLO 14	2			2										2	
CLO 15	1												3		2
CLO 16															2
CLO 17	3			3										2	
CLO 18			2										3		3

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4	SEE Exams	PO 1, PO 2, PO 3, PO 4	Assignments	PO 1, PO 4	Seminars	PO 3
Laboratory Practices	PO 3	Student Viva	PO 3	Mini Project	PO 2	Certification	-

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	BASIC MECHANISM OF METAL CUTTING	Classes:09
Elementary treatment of metal cutting theory, element of cutting process, geometry of single point tool and angles chip formation and types of chips, built up edge and its effects, chip breakers: Mechanics of orthogonal cutting, Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, coolants, machinability, tool materials.		
UNIT-II	MACHINE TOOL-I	Classes:09

Engine lathe, Principle, specification, types, work and tool holding devices, Automatic lathes, classification: Single spindle and multi-spindle automatic lathes and its tool layouts; Shaping, slotting and planning machines, Principles of working, specification, operations performed, Kinematic scheme.		
UNIT-III	**MACHINE TOOL-II**	**Classes:09**
Milling machine, classifications, specifications, working principles of milling machines; Geometry of milling cutters, methods of indexing, kinematic scheme of milling machines. Drilling and boring machines, principles of working, specifications, types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines.		
UNIT-IV	**GEOMETRICAL DIMENSIONING AND TOLERANCES**	**Classes:09**
Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types, unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly; Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers: Bevel protractor, angle slip gauges, spirit levels, sine bar.		
UNIT-V	**MEASURING INSTRUMENTS**	**Classes:09**
Optical measuring instruments: Tool maker's microscope and its uses, collimators, optical projector, interferometer; Screw thread measurement: Element of measurement, errors in screw threads, measurement of effective diameter, angle of thread and thread pitch, profile thread gauges; Surface roughness measurement**:** Numerical assessment of surface finish: CLA, R.M.S Values, Rz values, methods of measurement of surface finish: profilograph, talysurf - ISI symbol for indication of surface finish.		
Text Books:		
1. Dr. R. Kesavan, Dr. R. Kesavan, "Machine Tools" Laxmi publications, 2nd Edition, 2016. 2. N. K Mehta**,** "Metal Cutting and Design of Cutting Tools, Jigs & Fixtures**",** McGraw-Hill Education, 1st Edition, 2014. 3. T. L. Chaudhary, "Metal Cutting and Mechanical Tool Engineering", Khanna Publishers, 5th Edition, 2013. 4. R. K. Jain, Engineering Metrology, Khanna Publishers, 1stEdition, 2013.		
Reference Books:		
1. B.L. Juneja, G.S. Sekhon, Nitin Seth "Fundamentals of Metal Cutting and Machine Tools ", New Age Publishers, 2ndEdition, 2014. 2. Geofrey, "Fundamentals of metal machining and machine tools", Tata McGraw Hill Education, 1stEdition, 2013. 3. R. S. Sirohi, H. C. Radha Krishna, "Mechanical Measurements", New Age Publishers, 3rdEdition, 2011. 4. M Mahajan "A Textbook of Metrology ", Dhanpatrai and Co, 2ndEdition, 2013.		

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-4	Elementary treatment of metal cutting theory, element of cutting process	CLO 1	T1:1.7 R1:3.7
5-7	Geometry of single point tool and angles chip formation and types of chips, built up edge and its effects, chip breakers	CLO 1	T1:1.8 R1:3.12
8-10	Mechanics of orthogonal cutting, Merchant's force diagram.	CLO 1	T1:3.1 R1:3.13
11-14	Cutting speeds, feed, depth of cut, tool life, coolants, Machinability, tool materials.	CLO 2	T1:3.3 R1:3.14
15-16	Engine lathe, Principle, specification, types, work and tool holding devices	CLO 2	T1:2.1 R1:4.2
17-20	Automatic lathes, classification Single spindle and multi-spindle automatic lathes and its tool layouts	CLO 3	T1:4.1 R1:4.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
21-23	Shaping, slotting and planning machines, Principles of working, specification, operations performed, Kinematic scheme.	CLO 3	T1:5.1 R1:5.2
24-26	Milling machine, classifications, specifications, working principles of milling machines	CLO 4	T1:6.1 R1:7.2
27-28	Geometry of milling cutters	CLO 4	T1:6.6 R:7.4
29-30	Methods of indexing, kinematic scheme of milling machines, Drilling and boring machines, principles of working, specifications	CLO 4	T1:6.11 R1:8.5
31-32	Types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines.	CLO 5	T1:7.1 R1:6.5
33-34	Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types	CLO 5	T1:8.1 R3:3.2
35	Unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly	CLO 6	T1:9.1 R3:3.4
36-37	Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers	CLO 6	T1:9.5 R3:4.4
38	Bevel protractor, angle slip gauges, spirit levels, sine bar.	CLO 7	T1:10.1 R3:5.3
39	Optical measuring instruments	CLO 7	T1:10.4 R3:7.2
40-41	Tool maker's microscope and its uses	CLO 8	T1:10.8 R3:7.6
42	Collimators, optical projector, interferometer	CLO 9	T1:10.9 R3:7.7
43-44	Screw thread measurement: Element of measurement	CLO 10	T1:10.10 R3:7.8
45-47	Errors in screw threads, measurement of effective diameter	CLO 11	T1:15.1 R3:7.9
48-49	Angle of thread and thread pitch	CLO 12	T1:13.5 R3:9.2
50-52	Profile thread gauges; Surface roughness measurement	CLO 12	T1:13.7 R3:9.4
53-55	CLA, R.M.S Values, Rz values	CLO 13	T1:13.8
56-57	Profilograph, Talysurf	CLO 14	T1:13.6 R3:10.3
58-59	Methods of measurement of surface finish	CLO 15	T1:13.9 R3:12.3
59-60	ISI symbol for indication of surface finish.	CLO 16	T1:14.8 R3:12.6

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Automatic 5 axis machines	Industrial visit	PO1, PO2, PO4	PSO2
2	Gear cutting machine and process	Seminar/ industrial visit	PO4	PSO2, PSO3
3	Co-ordinate measuring machine	Seminar/ industrial visit	PO3	PSO1, PSO3

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HOD, MECHANICAL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	DYNAMICS OF MACHINERY				
Course Code	AME011				
Programme	B.Tech				
Semester	V	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Prof. B.V. S. N. Rao, Professor				
Course Faculty	Prof. V.V.S.H.Prasad, Professor				

I. COURSE OVERVIEW:

This course focuses on mechanical devices that are designed to have mobility to perform certain functions. In this process they are subjected to some forces. The study of Dynamics of machinery leads us to design machines by understanding the relationship between the movement of various parts of machine and the different forces that are acting on them. This course will provide the knowledge on how to analyze the motions of mechanisms and design mechanisms to give required strength. This includes relative static and dynamic force analysis and consideration of gyroscopic effects on aero planes, ships, automobiles like two wheelers and four wheelers. Balancing of rotating and reciprocating masses, friction effect in brakes clutches and dynamometers are also studied. Mechanical vibrations give an insight into the various disturbances while designing vibratory systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME009	IV	Kinematics of Machinery	4
UG	AME001	I	Engineering Drawing	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Dynamics of machinery	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering Knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on Real-world problems
PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminars
PO 4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Term Paper
PO 6	**The engineer and society:** To utilize the engineering practices,techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	2	Project's

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to becometechnocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the concept of equilibrium of a body subjected to static and dynamic forces.
II	Apply the phenomenon of friction for automobile application.
III	Analyze the significance of governors and its application in turning moment diagram.
IV	Determine the fundamental frequency of mechanical system.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME011.01	CLO 1	Understand dynamic analysis like gyroscopic forces and moments, rotation of rigid bodies.	PO 1	3
AME011.02	CLO 2	Understand the gyroscopic effect on ships, planes and road vehicles.	PO 1	3
AME011.03	CLO 3	Understand static force analysis of mechanisms.	PO 1	3
AME011.04	CLO 4	Understand dynamic force analysis of mechanisms	PO 2	2
AME011.05	CLO 5	Determine the dynamic behavior	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		principle and operations of clutches, brakes, dynamometers.		
AME011.06	CLO 6	Compute frictional losses, torque transmission of mechanical systems such as clutches, brakes.	PO 2	2
AME011.07	CLO 7	Compute frictional losses, torque transmission of mechanical systems such as dynamometers.	PO 4	1
AME011.08	CLO 8	Understand the design of centrifugal governors.	PO 4	1
AME011.09	CLO 9	Determine the dynamic behavior principles and operations of flywheels and governors.	PO 2	2
AME011.10	CLO 10	Understand dynamic balancing of point masses.	PO 2	2
AME011.11	CLO 11	Understand dynamic balancing of rotating masses.	PO 1	3
AME011.12	CLO 12	Understand the torque calculations in turning moment diagrams.	PO 1	3
AME011.13	CLO 13	Understand dynamic balancing of reciprocating parts.	PO 1	3
AME011.14	CLO 14	Understand how to determine the natural frequencies of continuous systems starting from the general equation of displacement.	PO 1, PO 2	3
AME011.15	CLO 15	Apply the different methods to solve the equation of motion in damped forced vibrations.	PO 2	2
AME011.16	CLO 16	Understand the concepts of free and forced vibrations of single degree freedom systems.	PO 2	2
AME011.17	CLO 17	Remember the concepts of vibration modes and natural frequencies and their measurement and estimation for multi-degree-of-freedom systems.	PO 1, PO 2	3
AME011.18	CLO 18	Interpret the behaviour of vibrating systems through an understanding of basic principles and the role of mass, stiffness and damping.	PO 1, PO 2	3
AME011.19	CLO 19	Develop the equations of motion for free and forced vibration of simple systems.	PO 1, PO 2	3
AME011.20	CLO 20	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 1, PO 2	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 3	3												1		
CLO 4		2													
CLO 5		2				1									
CLO 6		2													
CLO 7				1											
CLO 8				1											
CLO 9		2											1		
CLO 10		2											1		
CLO 11	3					1									
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		2													
CLO 16		2													
CLO 17	3	2											1		
CLO 18	3	2											1		
CLO 19	3	2											1		
CLO 20	3	2											1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	PO2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4			Project	PO6		

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	PRECESION, STATIC AND DYNAMIC FORCE ANALYSIS OF PLANAR MECHANISMS
Precession: Gyroscopes, effect of processional motion on the stability of moving vehicles such as motor car, motor cycle, aero-planes and ships, static and dynamic force analysis of planar mechanisms: (Neglecting friction), Introduction to free body diagrams, conditions of equilibrium, two and three force members, inertia forces and D'Alembert's principle, planar rotation about a fixed centre.	
UNIT-II	**CLUTCHES, BRAKES AND DYNAMOMETERS**
Clutches: Friction clutches, Single disc or plate clutch, multiple disc clutches, cone clutch and centrifugal clutch; Brakes and dynamometers: Simple block brakes, internal expanding brake, band brake of vehicle; Dynamometers absorption and transmission types, general description and method of operation.	
UNIT-III	**TURNING MOMENT AND GOVERNORS**
Turning moment diagrams and flywheels: turning moment: Inertia torque, angular velocity and acceleration of connecting rod, crank effort and torque diagrams, fluctuation of energy; Design of flywheels. Governors: Watt,PorterandProellgovernors,springloadedgovernors,HartnellandHartungwithauxiliarysprings,sensitiveness, isochronisms and hunting	
UNIT-IV	**BALANCING OF ROTATORY AND RECIPROCATING MASSES**
Balancing: Balancing of rotating masses, single and multiple-single and different planes-balancing of reciprocating masses, primary and secondary balancing-analytical and graphical methods; unbalanced forces and couples: Balancing of V-engines, multi cylinder, inline and radial engines for primary, secondary balancing and locomotive balancing.	
UNIT-V	**MECHANICAL VIBRATIONS**
Vibrations: Free vibration of mass attached to a vertical spring, simple problems on forced damped vibration; Vibration isolation and transmissibility, whirling of shafts, critical speeds, torsional vibrations, two and three rotor systems.	
Text Books:	
1. Thomas Bevan, "Theory of Machines", Pearson Education, 3rd Edition, 2009. 2. S.S Ratan, "Theory of Machines", Tata McGraw-Hill, 4th Edition, 2014. 3. R. L. Norton, "Kinematics and Dynamics of Machinery", McGraw-Hill, 1st Edition, 2009. 4. P.L. Balleny, "Theory of Machines and Mechanisms", Khanna publishers, 2013.	
Reference Books:	
1. J. S. Rao, R.V. Dukkipati, "Mechanism and Machine Theory", New Age Publication, 1st Edition, 2013. 2. Uiker, Penock, Shigley, "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition,2013. 3. R.S. Khurmi, Gupta, "Theory of Machines", S.Chand& Co, New Delhi, 14th Edition, 2013.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to Gyroscopes, angular motion, precession.	CLO 1	T2 17.2
2	Determination of Gyroscopic couple, problems.	CLO 2	T2 17.1
3	Effect of gyroscopic couple on stability of moving car.	CLO 2	T2 17.8
4	Effect of gyroscopic couple on stability of moving motorcycle.	CLO 2	T2 17.6
5	Effect of gyroscopic couple on stability of aero-plane.	CLO 1	T2 17.3
6	Effect of gyroscopic couple on stability of moving ship.	CLO 2	T2 17.4
7	Static and dynamic force analysis of planar mechanisms.	CLO1	T2 12.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
8	Free body diagrams, problems.	CLO 2	T2 12.6
9	Friction circle, Boundary friction.	CLO 2	T2 8.2
10	Introduction to Clutches, types.	CLO1	T2 8.9
11	Introduction to Brakes, classification.	CLO 1	T2 15.1
12	Introduction to dynamometers, types.	CLO1	T2 15.8
13	Methods of operation of dynamometers power, Performance test.	CLO 2	T2 15.9
14	Calculation of brake torque, problems.	CLO 2	T2 15.13
15	Turning moment diagrams explanation.	CLO 5	T2 13.12
16	Inertia torque calculation for connecting rod.	CLO 4	T2 13.11
17	Problems on inertia torque calculation for connecting rod.	CLO 5	T2 13.7
18	Fluctuation of energy.	CLO 3	T2 13.13
19	Flywheel and its function.	CLO 3	R3 16.12
20	Flywheel design	CLO 3	R3 16.18
21	Problems on flywheel	CLO3	R3 16.21
22	Introduction to governors and their classification	CLO 1	T2:16.1
23	Watt governor and Porter governor	CLO 2	T2 16.3,4
24	Proell governor, Hartnell and Hartung governors	CLO 2	T2:16.5,6
25	Problems on governors	CLO 3	T2:16.14
26	sensitiveness, isochronisms and hunting, effort and power of governors	CLO 3	R318.12
27	Balancing of rotating masses	CLO 1	T2:21.2
28	Problems on balancing of rotating masses.	CLO2	T2:21.1
29	Primary balancing of reciprocating masses.	CLO 2	T2:22.1
30	Secondary balancing of reciprocating masses.	CLO 2	T2:22.2
31	Higher balancing of reciprocating masses.	CLO2	R3 22.10
32	Locomotive balancing.	CLO1	R322.4
33	Graphical method of calculating forces and couples.	CLO4	R3 22.3
34	Balancing of Multi cylinder and V- Engines.	CLO2	R3 22.13
35	Balancing of radial engines.	CLO2	R3 22.12
36	Introduction to vibrations and their classification.	CLO1	T2.18.1
37	Free vibrations of mass attached to vertical springs.	CLO1	T2 18.6
38	Transverse vibrations-Problems.	CLO2	R3 23.9
39	Frequency of transverse vibration for concentrated and distributed loads	CLO2	R3 23.11
40	Dunkerley's method for calculating frequency.	CLO 14	R3 23.4
41	Raleigh's method for frequency calculations.	CLO 15	R3 23.5
42	Critical speeds, Whirling of shafts, problems.	CLO 14	R3 23.12
43	Torsional vibrations- one rotor system.	CLO 15	R3 24.4
44	Torsional vibrations- two rotor system.	CLO 16	R3 24.5
45	Torsional vibrations- three rotor system.	CLO 16	R3 24.6
46	Problems on torsional vibrations.	CLO 17	R3 24.4
47	Vibration isolation	CLO 16	R3 23.18
48	Vibration transmissibility	CLO 17	R3 23.18
49	Problems on vibration isolation and transmissibility.	CLO 16	R323.23
50	Damping ratio	CLO 17	R3 23.14
51	Problems on damping.	CLO 16	R3 23.10

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Solve problems on frequency	Seminars	PO 1	PSO 1
2	Discuss dynamometers	Seminars / NPTEL	PO 4	PSO 1
3	Discuss the vibration analysis.	NPTEL	PO 2	PSO 1

Prepared by:
Mr. B.V.S.N. Rao, Professor

HOD, MECHANICAL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	DESIGN OF MACHINE MEMBERS				
Course Code	AME012				
Programme	B.Tech				
Semester	V	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. GVR Seshagiri Rao, Professor				
Course Faculty	Mr. VKVS Krishnam Raju, Associate Professor				

I. COURSE OVERVIEW:

Machine design occupies an important role in the mechanical engineering course. The design of machine members focus mainly on design of machine elements subjected to various types of loads and components include joints; Riveted, Welded, threaded joints shafts and springs. Design basis is strength and stiffness of the parts and selection of material for manufacture of machine elements.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME005	III	Metallurgy and material science	3
UG	AME004	III	Mechanics of solids	4
UG	AME009	IV	Kinematics of machinery	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Design of Machine Members	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Project work
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	Seminar
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Assignment
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	Publication

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Seminar/ Project reviews
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Project works major and mini
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	2	Internship/ Industrial visit/work shops

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understanding design and analysis of load transmitting elements and selection of suitable materials and manufacture of these components.
II	Analyzing the forces acting on various components and their design.
III	Enhance the knowledge to applying the theories of failure and select optimum design size for various machine elements.
IV	Understanding need for joints and their application for different purposes in transmission of static loads.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME012.01	CLO 1	Understand various design variables and factors in the study of machine elements.	PO 2	2
AME012.02	CLO 2	Explain the steps involved in design process, BIS Codes of Steels.	PO 2	2
AME012.03	CLO 3	Understand the various Theories of failure, Design for Strength and rigidity.	PO 2	2
AME012.04	CLO 4	Understand theories of failures, stress concentration and fluctuating stresses.	PO 2	2
AME012.05	CLO 5	Explain estimation of endurance strength.	PO 2	2
AME012.06	CLO 6	Ability to design lap and butt joints in riveted joints.	PO 3	2
AME012.07	CLO 7	Explain design of welded joints, effects various stresses.	PO 2	2
AME012.08	CLO 8	Explain the design procedure of various joints.	PO 2	2
AME012.09	CLO 9	Understand the applications and comparison of various joints.	PO 3	2
AME012.10	CLO 10	Explain bolts of uniform strength.	PO 2	2
AME012.11	CLO 11	Understand various stresses in keys.	PO 3	2
AME012.12	CLO 12	Ability to design procedure for keys.	PO 1	3
AME012.13	CLO 13	Ability to design spigot and socket joint.	PO 1	3
AME012.14	CLO 14	Understand Jib and Cotter joint and design procedure.	PO 3	2
AME012.15	CLO 15	Ability to design knuckle joints.	PO 1	3
AME012.16	CLO 16	Explain the design of shafts for complex loads.	PO 3	2
AME012.17	CLO 17	Explain the design procedures of various shaft couplings.	PO 4	2
AME012.18	CLO 18	Ability to design shafts for various types of loading.	PO 1	3
AME012.19	CLO 19	Compare various shaft couplings and applications.	PO 1	3
AME012.20	CLO 20	Ability to Design of various shaft couplings.	PO 1	3
AME012.21	CLO 21	Understand of the basic features of springs.	PO 1	3
AME012.22	CLO 22	Explain the design procedure for various springs.	PO 3	2
AME012.23	CLO 23	Ability to design the various springs.	PO 1	3
AME012.24	CLO 24	Compare applications of Extension springs.	PO 1	3
AME012.25	CLO 25	Explain different types of end styles for helical compression and tension springs.	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1		2											3		
CLO 2		2												2	
CLO 3		2												2	
CLO 4		2												2	
CLO 5		2											3		
CLO 6			2										3		
CLO 7		2											3		
CLO 8		2													2
CLO 9			2										3		
CLO 10		2												2	
CLO 11			2											2	
CLO 12	3												3		
CLO 13	3												3		
CLO 14			2										3		
CLO 15	3												3		
CLO 16			2										3		
CLO 17				2									3		
CLO 18	3												3		
CLO 19	3													2	
CLO 20	3												3		
CLO 21	3														2
CLO 22			2												2
CLO 23	3												3		
CLO 24	3													2	
CLO 25		2												2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4	SEE Exams	PO 1, PO 2 PO 3, PO 4	Assignments	PO 3	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	FUNDANTAMENTALS OF MACHINE DESIGN
Introduction: General considerations in the design of Engineering Materials and their properties Selection – Manufacturing consideration in design. Tolerances and fits – BIS codes of steels. Theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. Fatigue loading: Stress concentration –Theoretical stress Concentration factor – Fatigue stress concentration factor – Notch Sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Goodman's life – Soderberg"s line.	
UNIT-II	**DESIGN OF FASTENERS AND WELDED JOINTS**
Design Of Fasteners: Riveted joints-methods of failure of riveted joints – strength equations – efficiency of riveted joints – eccentrically loaded riveted joints. Welded Joints: Design of fillet welds-axial loads-circular fillet welds-bending-bolts of uniform strength	
UNIT-III	**DESIGN OF KEYS, COTTERS AND KNUCKLE JOINTS**
Keys, Cotters and Knuckle Joints: Design of Keys-stress in keys. Cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints-Knuckle joints	
UNIT-IV	**DESIGN OF SHAFTS AND SHAFT COUPLINGS**
Design of Shafts: Design of solid and hollow shafts for strength and rigidity –Design of shafts for complex loads – Shaft sizes –BIS code – Design of shafts for gear and belt drives. Shaft couplings: Rigid couplings – Muff, Split muff and Flange couplings. Flexible couplings-PIN-Bush coupling.	
UNIT-V	**DESIGN OF MECHANICAL SPRINGS**
Mechanical Springs: Stresses and deflections of helical springs-extension compression springs-springs for static and fatigue loading-natural frequency of helical springs-energy storage capacity-helical torsion springs-co-axial springs.	
Text Books:	
1. P. Kannaiah, "Machine Design", 2nd Edition, Scitech Publications India Pvt. Ltd, New Delhi, 2012 2. V.B Bandari, "A Text Book of Design of Machine Elements", 3rd Edition, Tata McGraw Hill Education (P) Ltd, New Delhi, India. 2011.	
Reference Books:	
1. Richard G. Budynas, J. Keith Nisbett, "Shiegly"s Mechanical Engineering Design", 10th Edition, 2014. 2. S. Md. Jalaluddine, "Machine Design", Anuradha Publishers, 1st Edition, 2004. 3. R.L. Norton, "Machine Design-An Integrated approach", Person Publisher, 2nd Edition, 2012. 4. U.C. Jindal, "Machine Design", Pearson, 1st Edition, 2010. 5. R.S. Khurmi, A. K. Gupta, "Machine Design", S. Chand & Co, New Delhi, 1st Edition, 2014. 6. PSG College, "Design Data: Data Book of Engineers", 1st Edition, 2012.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction, General considerations in the design	CLO 1	T1:1.2 R6:1.5
2-3	Identify Engineering Materials and their properties. Tolerances and fits BIS codes of steels.	CLO 1	T1:3.1 R4:3.16
4	Explain theories of failure	CLO 1	T1:7.59 R4:5.9
5-7	Explain Reversed Stresses	CLO 2	T2:5.11 R4:6.3
8	Explain Factor of safety – Design for strength and rigidity – preferred numbers	CLO 3	T2:7.3 R4:3.21
9	Understand Stress concentration –Theoretical stress Concentration factor Fatigue stress concentration factor Notch Sensitivity	CLO 4	T1:7.63 R4:6.11
10-11	Explanation and problems on stress concentration. Endurance limit – Estimation of Endurance strength	CLO 5	T1:7.89 R6:6.4
12-15	Explain Goodman's life – Soderberg"s line. Solutions of problems on various types of loading.	CLO 2	T1:7.9 R4:6.20
16-17	Compare Fasteners methods	CLO 6	T1:11.2 R4:11.6
18	Explanation about Lap and but joints and various parameters involved in design of riveted joints.	CLO 6	T1:9.2 R4:9.8
19	Understand efficiency of riveted joints Calculate stress induced in rivets	CLO 7	T1:9.5 R4:9.14
20-21	Analyze Eccentrically loaded riveted joints. Problems in design of riveted joints.	CLO 8	T2:8.3 R6:9.21
22-23	Understand design of fillet welds-axial loads-circular fillet welds	CLO 8	T1:106 R6:10.17
24	Analyze Bending-bolts of uniform strength Construction design and proportions of bolts	CLO 9	T1:11.9 R6:11.16
25	Explanation of various stresses induced in bolted joints and solution of problems in various applications	CLO 10	T2:11.5 R6:11.10
26	Explanation of the procedure for finding size of bolts	CLO 9	T2:11.9 R1:11.12
27	Bolted joints and associated parts for locking purpose	CLO 11	T2:11.21 R1:11.7
28	Sketches for keys, cotters, knuckle joints and explanation of the purpose of each joint	CLO 12	T1:12.1 T^
29	Estimate Design of Keys, stress in keys	CLO 12	T2:9.9 R4:13.8
30-32	Describe Cotter joints, Spigot and socket	CLO 13	T1:12:10 R4:12.4
33	Compare Jib and cotter joints, knuckle joint	CLO 14	T1:12.15 R4:12.7
34	Solution of problems under application load	CLO 15	T1:12.16 R4:12.20
35-36	Apply Formulas for determining size of both hollow and solid shafts and various conditions of loading for strength and Rigidity criteria	CLO 16	T1:13.2 R4:14.6
37	Analyze Design of shafts for complex loads	CLO 17	T1:13.8, R4:14.11
38-39	Distinguish Shaft size –BIS codes. Applications and solution of problems for transmission of power by shafts loaded with belt and gear drives	CLO 18	T1:13.9 R4:14:13

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
40	Sketches of different couplings and various parameters to be explained	CLO 18	T2:15.1 R4:14.16
41-42	Rigid couplings – Muff, Split muff and Flange couplings	CLO 19	T2:15.2 R4:13.14.
43	PIN-Bush coupling.	CLO 20	T2:9.24 R6:13.19
44	Problems of different couplings	CLO 18	T2:9.30
45	Sketches of different springs with relevant parameters Stresses and deflections of helical springs	CLO 21	T2:16.2 R4:23.8
46	Extension compression springs-springs for static and fatigue loading	CLO 22	T2:10.3 R6:23.18
47	Natural frequency of helical springs- energy storage capacity	CLO 22	T2:10.5 R7:23.19
48-49	Helical torsion springs	CLO 23	T2:10.10 R7:23.19
50-51	Co-axial springs.	CLO 24	T1:10.15 R6::23.15
52	Design of Helical Torsional Springs	CLO 25	T2:10.21 R723.17:

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Advances in Designing processes	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3	PSO 1
2	Advanced topics	Seminars / Guest Lectures / NPTEL	PO 2, PO 4	PSO 2
3	Recommended practices in design and analysis using software's.	Assignments / Laboratory practices	PO 1, PO 3, PO 4	PSO 3

Prepared by:
Dr. GVR Seshagiri Rao, Professor
Mr.VKVS Krishnam Raju, Associate Professor

HOD, ME

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THERMAL ENGINEERING**				
Course Code	AME013				
Programme	B.Tech				
Semester	V	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. S. Srikrishnan, Assistant Professor				
Course Faculty	Mrs. N. Santhisree, Assistant Professor Mr. S. Srikrishnan, Assistant Professor				

I. COURSE OVERVIEW:

Thermal engineering is a course which comprise the combination of mechanical power systems used in automotive, power generation and aerospace industries. Extensive study is done based on the different cycles in vapor power. Steam generators of different class and different utilities are explored. Critical knowledge about aircraft and space propulsion methods are analyzed and a detailed study is made on the significant parts and the performance parameters of the propulsion systems. Introduction to rocket and space propulsion is studied comprising of the various types of space vehicle propulsion motors and the fuels that may be used in said motors with physical and chemical properties are expertly taken into account and briefly discussed.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	III	Thermodynamics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Thermal Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✘	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO 2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminar
PO 4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand ideal and air standard vapor cycle and evaluate the performance in open systems like steam power plant, gas turbine etc.
II	Analyse different air standard cycles specifically related to IC engines and solve problems on the intricacies of performance of the cycle
III	Understand the direction law and concept of entropy increase of the universe.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME013.01	CLO 1	Discuss the basic concepts of thermodynamics in the analysis for Carnot vapor power cycle.	PO 1	3
AME013.02	CLO 2	Determine the efficiency and output of a basic and modern Rankine cycle steam power plant from given data.	PO 4	1
AME013.03	CLO 3	Determine the efficiency of a modified Rankine cycle including superheat, reheat, and regeneration techniques.	PO 1	3
AME013.04	CLO 4	Discuss the concept of stoichiometric analysis of fuels and combustion.	PO 2	2
AME013.05	CLO 5	Discuss different types of steam generators and its working principles.	PO 4	1
AME013.06	CLO 6	Discuss mountings and accessories of boilers.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME013.07	CLO 7	Understand the working of different types of steam nozzles and its applications, conditions for maximum discharge of steam through it.	PO 4	1
AME013.08	CLO 8	Classify different types of steam turbines and working of impulse turbine and its performance parameters and methods of compounding to reduce rotor speed of an impulse turbine.	PO 4	1
AME013.09	CLO 9	Explain the blade shapes, and calculate work output of typical turbine stages with its velocity diagrams.	PO 4	1
AME013.10	CLO 10	Demonstrate different types of condensers and its working principles.	PO 2	2
AME013.11	CLO 11	Recognize the different gas turbine arrangements, their advantages and disadvantages and different applications application.	PO 1	3
AME013.12	CLO 12	Applying the relation between gas turbine design, application and environment.	PO 1	3
AME013.13	CLO 13	Applying the basic thermodynamic and heat transfer principles in performance calculation of industrial gas turbines	PO 4	1
AME013.14	CLO 14	Recognizing the differences of a real cycle (from the theoretical ones)	PO 1, PO 2	3
AME013.15	CLO 15	Carry out performance calculations of real Gas turbines	PO 2	2
AME013.16	CLO 16	Examine the effect of various design parameters on the GT performance (pressure ratio, temperature ratio, pressure drop, polytrophic efficiency ...etc.).	PO 4	1
AME013.17	CLO 17	Explain the fundamentals of jet propulsion and basic propulsion cycle	PO 1, PO 2	3
AME013.18	CLO 18	Examine the effect of various design parameters of the jet propulsion performance and its efficiency etc.	PO 2	3
AME013.19	CLO 19	Discuss the concepts of Rocket propulsion and its classification.	PO 1	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2				1											1
CLO 3	3												1		
CLO 4		2													
CLO 5				1											
CLO 6		2													1

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 7				1											
CLO 8				1											
CLO 9				1											
CLO 10		2											1		
CLO 11	3														1
CLO 12	3														
CLO 13				1											
CLO 14	3	2											1		
CLO 15		2													
CLO 16				1											1
CLO 17	3	2											1		
CLO 18		2													
CLO 19	3												1		1

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Assignments	PO 2	Seminars	PO 4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	BASIC CONCEPTS OF RANKINE CYCLE	Classes:12
Rankine cycle schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance, regeneration and reheating. Combustion: fuels and combustion, adiabatic flame temperature, stoichiometry, flue gas analysis.		
UNIT-II	**BOILERS AND STEAM NOZZLES**	**Classes:12**
Boilers: Classification, working principles with sketches including, high pressure boilers, mountings and		

accessories, working principles, steam nozzles: Function of nozzle, applications, types, flow throughnozzles, thermodynamic analysis.		
UNIT-III	**STEAM TURBINE AND CONDESERS**	**Classes:12**
Steam turbines: Classification, impulse turbine, mechanical details, velocity diagram, effect of friction, power developed, axial thrust, blade or diagram efficiency, condition for maximum efficiency; Reaction turbine: Mechanical details, principle of operation, thermodynamic analysis of a stage, degree of reaction, velocity diagram, Parson's reaction turbine, condition for maximum efficiency. Steam condensers: Requirements of steam condensing plant, classification of condensers, working principle of different types.		
UNIT-IV	**GAS TURBINES**	**Classes:12**
Gas turbines: Simple gas turbine plant, ideal cycle, essential components, parameters of performance, actual cycle, regeneration, inter cooling and reheating, closed and Semi-closed cycles, merits anddemerits, brief concepts of compressors combustion chambers and turbines of gas turbine plant.		
UNIT-V	**JET PROPULSION AND ROCKETS**	**Classes:12**
Jet propulsion: Principle of operation, classification of jet propulsive engines, working Principles with schematic diagrams and representation on T-S diagram, thrust, thrust power and propulsion efficiency, turbo jet engines, needs and demands met by turbo jet, schematic diagram, thermodynamic cycle, performance evaluation thrust augmentation methods; Rockets: Application, working Principle,classification, propellant type, thrust, propulsive efficiency, specific impulse, solid and liquid propellant rocket engines.		
Text Books:		
1. R. K. Rajput, "Thermal Engineering", Lakshmi Publications, 8th Edition, 2015 2. V. Ganesan, "Gas turbines", Tata McGraw-Hill, 3rd Edition, 2010.		
Reference Books:		
1. P. Khajuria, S. P Dubey, "Gas Turbines and Propulsive systems", Dhanpat Rai Publishers., 1st Edition, 2012. 2. Ballaney, "Thermal Engineering", Khanna Publishers, 1st Edition, 2012. 3. R. Yadav, "Thermodynamics and Heat Engines", Central Book Depot, 1st Edition, 2002.		

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Describe the processes of Rankine cycle	CLO 1	T1 1.1 ,
2-3	Analyze Thermodynamic Analysis of cycle on T-S diagram	CLO 2	T1 1.2
4-6	Concept of Mean Temperature of Heat addition	CLO 2	T1 1.3
7	Evaluate cycle performance	CLO 4	T1 1.4
8-9	Explain Regeneration & reheating processes	CLO 4	T1 1.5
10-11	Explain different types of fuels and its classification.	CLO 7	T1 1.6
12	Analyze the Concept of adiabatic flame temperature	CLO 9	T1 1.7
13	Concept of stoichiometry	CLO 9	T1 1.8
14	Concept of flue gas analysis	CLO 11	T1 1.8

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
15-17	Classify boilers	CLO 11	T1 2.1
18-24	Working principles of boilers	CLO 13	T1 2.2
25-26	Functions of Nozzle and its applications	CLO 11	T1 2.3
27	Function of nozzle flow	CLO 9	T1 2.4
28	Determine the Thermodynamic properties	CLO 14	T1 2.5
29	Classify Steam Turbines	CLO 14	T1 3.1
30	Working of Impulse Turbines	CLO 14	T1 3.2
31-32	Evaluate the performance using velocity diagram	CLO 14	T1 3.2
33	Derive condition for maximum efficiency	CLO 14	T1 3.3
34-35	Working Principle of Reaction Turbine	CLO 15	T1 3.4
36	Define the Degree of Reaction	CLO 15	T1 3.5
37-38	Obtain the Conditions for maximum efficiency with velocity diagrams	CLO 16	T1 3.5 R1
39	List out the Requirements of condenser plant	CLO 16	T1 3.6 R2
40	Classify the condensers	CLO 16	T1 3.7
41-43	Classify Gas Turbines and its process	CLO 16	T1 4.1 R1
43-45	Explain Improving efficiency methods	CLO 17	T1 4.3
45-47	Analyze Cycle operation	CLO 17	T1 4.5
47-52	Classify jet propulsive engines	CLO 18	T1 5.1 R3
53	Evaluate the Performance of propulsive engines	CLO 18	T1 5.2
54-56	Analyze the Thermal analysis of Turbojets	CLO 19	T1 5.4 R3
57-63	Classify the Rockets and its working Principles	CLO 19	T1 5.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Directional law applied to automobile sector	GUEST LECTURE /SEMIAR	PO1,PO2,PO4	PSO2
2	Gas laws applied to cooling of electronic chips	SEMINAR	PO2	PSO3
3	cooling of spindle bearings by using chillers	SEMINAR	PO1	PSO3

Prepared by:
Mr. S. Srikrishnan, Assistant Professor **HOD, ME**

INSTITUTE OF AERONAUTICAL ENGINEERING

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INSTRUMENTATION AND CONTROL SYSTEMS**				
Course Code	AME019				
Programme	B.Tech				
Semester	V	ME			
Course Type	Core -Accelerated				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	2	1
Chief Coordinator	Dr. Paidi Raghavulu, Professor, ME				
Course Faculty	Dr. Paidi Raghavulu, Professor, ME				

I. COURSE OVERVIEW:

The Present course concentrates on developing basic understanding about various instruments that are involved in measuring. This course enables the student to understand the working of various measuring instruments. The course focuses on all principles, working, advantages, disadvantages and applications of various measuring instruments. In this course; students also will gain a broad understanding of the control systems. Student can learn in detail about how to measure displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME010	V	Machine Tools and Metrology	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Instrumentation And Control Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	**3**	Assignments
PO2	**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**	Seminars
PO3	**Design/development of solutions:** Design solutions for complex engineering problems anddesign 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**	Assignments
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	**2**	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	**2**	Assignments
PSO 2	**Problem Solving Skills:**An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	**2**	Seminars
PSO 3	**Successful career and entrepreneurship:**To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Visualize the concepts of measurement and dynamic performance characteristics of measuring instruments.
II	Understand the measurement of typical physical quantities like displacement, temperature, pressure, discharge, and speed.
III	Comprehend for machine condition monitoring systems by using seismic instruments.
IV	Develop electronic servo and interfacing systems for analogue to digital measurement.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME019.01	CLO 1	Understand the basic principles and performance characteristics of measurement	PO1,PO2	3
AME019.02	CLO 2	Apply the working principles and identify the measurands for displacement	PO1,PO2	2
AME019.03	CLO 3	Understand the temperature and importance of maintaining in various applications	PO2, PSO3	3
AME019.04	CLO 4	Evaluate the temperature measuring methods in various equipment for knowing the ranges	PO3	3
AME019.05	CLO 5	Visualize the areas affected with pressure in equipment and calibrate the pressure measuring devices	PO2,PO3	2
AME019.06	CLO 6	Understand the fluid pressure and the importance of pressure measurement	PO2	2
AME019.07	CLO 7	Comprehend the level of liquid in any container and the measuring devices available for liquid level	PO3	3
AME019.08	CLO 8	Visualize the importance of flow measurement and know various flow measuring devices along with obstruction devices	PO1,PO3	2
AME019.09	CLO 9	Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation	PO2	3
AME019.10	CLO 10	Comprehend the importance of acceleration and vibration measurements in various equipment and understand the instruments used for measurement of vibration	PO1,PO6	3
AME019.11	CLO 11	Visualize the stress & strain experienced by various elements and to understand the importance of strain measurement with various techniques	PO1, PO2	2
AME019.12	CLO 12	Understand the concept of humidity in atmosphere as well as the storage applications and maintenance of humidity by measurement	PO1,PO6	3
AME019.13	CLO 13	Apply the basic principles and characteristics for force in engineering applications	PO1,PO3	2
AME019.14	CLO 14	Understand the instrumentation for force measurement in various fields of engineering	PO6	2
AME019.15	CLO 15	Visualize the concept of torque and power in various equipment in engineering applications	PO1,PO2,PO3	3
AME019.16	CLO 16	Apply the principles to gather the data regarding measurement of torque and power	PO1,PO2,PO3	2
AME019.17	CLO 17	Comprehend the instrumentation techniques in solving the engineering measuring applications for torque	PO1, PO2,PO6	3
AME019.18	CLO18	Apply the techniques used for measurement of power and evaluate the power for general requirements of engineering	PO2,PO6	2
AME019.19	CLO19	Understand the control systems for instrumentation in various practical applications	PO3	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME019.20	CLO20	Classify the control systems with their advantages and limitations	PO3	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3		3										2		
CLO 2	3		3										2		
CLO 3		3	3											2	
CLO 4			3										3		
CLO 5		2	2										2		
CLO 6		2											2		
CLO 7			3			3								2	
CLO 8	2		2										2		
CLO 9		3													
CLO 10	3					3								3	
CLO 11	2	2												2	
CLO 12	3					3							2		
CLO 13	2		2											2	
CLO 14						3								2	
CLO 15	3	2	3										2	3	
CLO 16	3	2	3											2	
CLO 17	3	3				3								2	
CLO 18		2				2								2	
CLO 19			2												
CLO 20			3										3		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES-DIRECT

CIE Exams	PO1, PO 2, PO 3, PO 6	SEE Exams	PO 1, PO 2, PO 3, PO 6	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	PO 3	Student Viva	PO 1	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES–INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS:

UNIT -I	**PRINCIPLES OF MEASUREMENT**	**Classes:09**
Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, Classification and elimination of error.		
UNIT -II	**MEASUREMENT OF DISPLACEMENT, TEMPERATURE, PRESSURE**	**Classes:09**
Measurement of Displacement: Theory and construction of various transducers to measuredisplacement – Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures. Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators. Measurement of Pressure: Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.		
UNIT-III	**MEASUREMENT OF LEVEL, FLOW, SPEED, ACCELERATION AND VIBRATION**	**Classes:09**
Measurement of Level: Direct method – Indirect methods – capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – Bubler level indicators. Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA). Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer.Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle.		
UNIT -IV	**MEASUREMENT OF STRESS–STRAIN, HUMIDITY, FORCE, TORQUE AND POWER**	**Classes:09**
Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, Strain gauge Rosettes. Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter. Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.		
UNIT -V	**ELEMENTS OF CONTROL SYSTEMS**	**Classes:09**
Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems Servomechanisms–Examples with block diagrams–Temperature, speed & position control systems.		
Text Books:		
1. D S Kumar, “Measurement Systems: Applications & Design”, Anuradha Agencies, 1st Edition, 2013. 2. C Nakra& K. K. Choudhary, “Instrumentation, Measurement & Analysis”, Tata McGraw-Hill, 4th Edition, 2010.		

Reference Books:
1. K Padma Raju, Y J Reddy, "Instrumentation and Control Systems", McGraw Hill Education1st Edition, 2016. 2. S W. Bolton, "Instrumentation and Control Systems", Newnes Publisher, 1st Edition, 2004. 3. K Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd Edition, 2015.

XIV. COURSE PLAN:

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

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction	CLO 1	T1: 1.1- 1.16
2	Definition – Basic principles of measurement	CLO 1	T1: 1.1- 1.16
3	Measurement systems	CLO 1	T1: 1.1- 1.16
4-5	generalized configuration and functional descriptions of measuring instruments – examples	CLO 1	T1: 1.1- 1.16
6-8	Dynamic performance characteristics	CLO 1.	T1: 1.1- 1.16
9	sources of error	CLO 1	T1: 1.1- 1.16
10	Classification and elimination of error	CLO1	T1: 1.1- 1.16
11	Theory and construction of Piezo electric, Inductive transducer for measurement of displacement.	CLO2	T1: 14.1- 14.2
12	Theory and construction of capacitance transducer for measurement of displacement.	CLO2	T1: 14.1- 14.2
13-14	Theory and construction of Resistancetransducers to measure displacement.	CLO2	T1: 14.1- 14.2
15	Theory and construction of ionizationand photo electric transducer for measurement of displacement.	CLO3	T1: 14.1- 14.2
16	Calibration procedure	CLO3	T1: 14.1- 14.2
17	Measurement of Temperature: Classification – Ranges	CLO3 CLO4	T1: 20.1- 20.3
18	Various principles of measurement – Expansion, Electrical Resistance	CLO3 CLO4	T1: 20.1- 20.3
19	Thermistor – Thermocouple	CLO3 CLO4	T1: 20.1- 20.3
20	Pyrometers – Temperature Indicators	CLO3 CLO4	T1: 20.1- 20.3
21	Measurement of Pressure: Units – classification – different principles used	CLO5	T1: 18.1- 18.3
22	Manometers, Piston	CLO5	T1: 18.1- 18.3
23	Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement	CLO6	T1: 18.1- 18.3
24	Thermal conductivity gauges	CLO6	T1: 18.1- 18.3
25	ionization pressure gauges, Mcleod pressure gauge	CLO6	T1: 18.1- 18.3
26	Measurement of Level: Direct method – Indirect methods	CLO7	T1: 24.1- 24.2

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
27	Capacitive, ultrasonic level measurement	CLO7	T1: 24.1- 24.2
28	Magnetic, cryogenic fuel level indicators	CLO7,	T1: 24.1- 24.2
29	Bubbler level indicators	CLO7	T1: 24.1- 24.2
30	Flow Measurement: Rotameter, magnetic flow meter	CLO8	T1: 21.1- 21.2
31	Ultrasonic, Turbine flow meter	CLO8	T1: 21.1- 21.2
32	Hot – wire anemometer	CLO8	T1: 21.1- 21.2
33	Laser Doppler Anemometer (LDA)	CLO8	T1: 21.1- 21.2
34	Measurement of Speed: Mechanical Tachometers	CLO9	T1: 15.1 - 15.3
35	Electrical tachometers	CLO9	T1: 15.1 - 15.3
36	Stroboscope	CLO9	T1: 15.1 - 15.3
37	Noncontact type of tachometer	CLO9	T1: 15.1 - 15.3
38	Measurement of Acceleration and Vibration: Different simple instruments	CLO10	T1: 16.1- 16.2
39	Principles of Seismic instruments	CLO10	T1: 16.1- 16.2
40-41	Vibrometer and accelerometer using this principle	CLO10	T1: 16.1- 16.2
42-44	Stress Strain Measurements: Various types of stress and strain measurements	CLO11	T1: 9.1- 9.5
45	Electrical strain gauge	CLO11	T1: 9.1- 9.5
46	gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains	CLO11	T1: 9.1- 9.5
47	usage for measuring torque, Strain gauge Rosettes	CLO11	T1: 9.1- 9.5
48	Measurement of Humidity: Moisture content of gases, sling psychrometer	CLO12	T1: 10.1- 10.6
49	Absorption psychrometer, Dew point meter	CLO12	T1: 10.1- 10.6
50	Measurement of Force, Torque and Power: Elastic force meters	CLO13	T1: 10.1- 10.6
51	Measurement of Force, Torque and Power: Elastic force meters	CLO14 CLO15	T1: 11.1- 11.5
52	load cells, Torsion meters	CLO16 CLO17	T1: 11.1- 11.5
53-54	Dynamometers	CLO18	T1: 11.1- 11.5
55	Elements of Control Systems: Introduction, Importance, Classification	CLO19	T1: 11.1- 11.5
56	Open and closed systems	CLO19	T1: 28.1- 28.16
57-58	Servomechanisms–Examples with block diagrams	CLO20	T1: 28.1- 28.16
59	Temperature control systems, Speed control system	CLO20	T1: 28.1- 28.16

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
60	position control systems	CLO20	T1: 28.1- 28.16

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Advances in Designing processes	Seminars and Laboratory Practice	PO2	PSO1
2	Advanced topics	Guest Lectures and Laboratory Practice	PO3	PSO2
3	Recommended practices in design and analysis using software's.	Seminars and Laboratory Practice	PO3	PSO1

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	UNCONVENTIONAL MACHINING PROCESSES				
Course Code	AME507				
Programme	B.Tech				
Semester	V	ME			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. M. Sunil Kumar, Assistant Professor				
Course Faculty	Mr. M. Sunil Kumar, Assistant Professor				

I. COURSE OVERVIEW:

This course focuses on the various unconventional machining processes, the process parameters associated with them. Selection of an appropriate machining process for a particular application, properties of the work material and shape to be machined, process capability and economic considerations of these processes.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Production Technology	3
UG	AHS002	III	Metallurgy and Material Science	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Unconventional machining processes	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering Knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on Real-world problems
PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminars
PO 4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignments
PO 6	**The engineer and society:** To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	2	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the need and importance of non-traditional machining methods and process selection.
II	Gain the knowledge to remove material by thermal evaporation, mechanical energy process.
III	Apply the knowledge to remove material by chemical and electro chemical methods.
IV	Analyze various material removal applications by unconventional machining process.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME507.01	CLO 1	Understand of fundamentals of the non-traditional machining methods and industrial applications.	PO 1	3
AME507.02	CLO 2	Compare Conventional and Non-Conventional machining and analyze the different elements of Ultrasonic Machining and its applications.	PO 1	3
AME507.03	CLO 3	Identify and utilize fundamentals of metal cutting as applied to machining.	PO 1	3
AME507.04	CLO 4	Understand a problem and apply the	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		fundamental concepts and enable to solve problems arising in metal removal process.		
AME507.05	CLO 5	Explore the ability to define and formulate the properties of cutting tool materials and characteristics.	PO 2	2
AME507.06	CLO 6	Illustrate the variables in Abrasive Jet Machining.	PO 2	2
AME507.07	CLO 7	Explain the different elements of Chemical and Electro chemical Machining and its applications.	PO 4	1
AME507.08	CLO 8	Comparison between non-traditional machining process with the traditional parameters, energy sources, economics of processes, shape and size of the material.	PO 4	1
AME507.09	CLO 9	Illustrate different parameters of Electrical Discharge Machining.	PO 2	2
AME507.10	CLO 10	Develop methods of working for minimizing the production cost.	PO 2	2
AME507.11	CLO 11	Apply the best suitable advanced manufacturing process for processing of unconventional materials employed in modern manufacturing industries.	PO 1	3
AME507.12	CLO 12	Study the parametric influences during processing of materials using developed models.	PO 1	3
AME507.13	CLO 13	Analyze the different elements of Laser and Electronic Beam machining	PO 1	3
AME507.14	CLO 14	Apply unconventional machining process in various industrial applications.	PO 1, PO 6	3
AME507.15	CLO 15	Analyze and simulate various industrial problems in advanced machining processes using EBM and LBM	PO 2	2
AME507.16	CLO 16	Understand the applications of plasma machining and chemical machining.	PO 2	2
AME507.17	CLO 17	Explain the process and mechanism in Plasma Arc Machining	PO 1, PO 2	3
AME507.18	CLO 18	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 1, PO 2	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4		2													
CLO 5		2				2									

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 6		2													
CLO 7				1											
CLO 8				1		2									
CLO 9		2											1		
CLO 10		2											1	1	
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		2													
CLO 16		2													1
CLO 17	3	2											1		
CLO 18	3	2											1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, P0 4, PO 6	SEE Exams	PO 1, PO 2, PO 6	Assignments	PO 4	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	INTRODUCTION
Need for non-traditional machining methods, classifications of modern machining processes, considerations in process selection, materials application, Ultrasonic machining: Elements of the process, mechanics of metal removal, process parameters, economic considerations, application and limitations, recent developments.	

UNIT-II	ABRASIVE JET MACHINING
Abrasive jet machining, water jet machining and abrasive water jet machining: basic principles, equipments process variables, mechanics of metal removal, MRR, applications and limitations; Electro chemical processes: Fundamentals of electro chemical machining, electro chemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, tool design, surface finish and accuracy, economic aspect of ECM, simple problem for estimation of metal removal rate.	
UNIT-III	**THERMAL METAL REMOVAL PROCESSES**
General principle and applications of Electric discharge machining, electric discharge grinding, electric discharge wire cutting processes, power circuits in EDM, mechanism of metal removal in EDM, process parameters. Selection of tool electrodes and dielectric fluids, surface finish and accuracy, characteristics of spark eroded surface and machine tool selection, wire EDM principle and applications.	
UNIT-IV	**ELECTRON BEAM MACHINING**
Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non thermal processes, general principle and applications of laser beam machining, thermal features, cutting speed and accuracy of cut.	
UNIT-V	**PLASMA MACHINING**
Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries; Chemical machining principle, maskants, etchants, applications.	
Text Books:	
1. V. K. Jain, "Advanced Machining Processes", Allied Publishers, 1st Edition, 2013. 2. Pandey P. C., Shah H.S., "Modern Machining Processes", Tata McGraw-Hill, 1st Edition, 2013.	
Reference Books:	
1. Bhattacherya A, "New Technology", The Institute for Engineers, 1st Edition, 1973. 2. C. Elanchezhian, B. VijayaRamnath, M. Vijayan, "Unconventional Machining processes", Anuradha Publication, 1st Edition, 2005. 3. M. K. Singh, "Unconventional Machining processes", New Age International Publishers, 1st Edition, 2010.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Explain the need for non-traditional machining methods.	CLO 1	T1: 1.1, R1: 1.1
2	Discuss Classification of modern machining processes.	CLO 2	T2 1.2, R3 1.2
3	Illustrate considerations in process selection, Materials, applications and overview of the unit.	CLO 2	T1, 1.2 R: 1.3
4-5	Demonstrate ultrasonic machining, elements of the process	CLO 4	T1: 1.3.3
6-7	Emphasize process and mechanics of metal removal process parameters, economic considerations.	CLO 4	T1,1.3.2
8-9	Visualize mechanics of metal removal process parameters, economic considerations.	CLO 6	T1, 1.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
10	Summarize applications and limitations, recent development.	CLO 6	T2:2.1, R1: 3.4
11	Explain the overview of abrasive jet machining.	CLO 6	T1: 2.3
12-13	Explain the water jet machining processes	CLO 7	T2: 3.1
14	Discuss abrasive water jet machining.	CLO 7	T1: 3.1
15-16	Summarize basic principles, equipment, process variables.	CLO 7	T1: 3.2
17	Illustrate mechanics of metal removal.	CLO 8	T2:3.3
18	Explain MRR, application and limitations and overview of the unit.	CLO 8	R3: 3.1, T1:4.1
19	Discusselectro-chemical processes, electro-chemical grindingelectro-chemical honing and deburring process.	CLO 9	R3: 4.1 T2: 5.1
20	Explain the phenomena metal removal rate in ECM, tool design, surface finish and accuracy.	CLO 9	T2: 5.1 R2: 4.1
21-22	Discuss economic aspects of ECM, solve simple problems for estimation of metal removal rate.	CLO 10	R3: 4.3 T2: 5.1
21-22	Discuss economic aspects of ECM, solve simple problems for estimation of metal removal rate.	CLO 10	R3:4.3 T1: 4.3
23-24	Discuss economic aspects of ECM, Simple problems for estimation of metal removal rate.	CLO 14	R3: 3.1, T1:4.1
25-26	Explain fundamentals of chemical, machining, thermal metal removal processes.	CLO 14	R3: 4.1 T2: 5.1
27-28	Discuss general Principle and applications of electric discharge machining.	CLO 14	T2: 5.1 R2: 4.1
27-28	Explain general Principle and applications of electric discharge machining.	CLO 15	R3: 4.3 T2: 5.1
31-32	Explain electric discharge grinding process.	CLO 15	R3:4.3 T1: 4.3
33-34	Discuss electric discharge wire cutting processes.	CLO 16	R3: 3.1, T1:4.1
35-36	Explain power circuits for EDM, mechanics of metal removal in EDM.	CLO 14	R3: 4.1 T2: 5.1
37-38	Demonstrate process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy.	CLO 14	T2: 5.1 R2: 7.1
39	Discuss characteristics of spark eroded surface and machine tool selection.	CLO 14	R3: 4.3 T2: 7
40-41	Explain wire EDM principle and applications.	CLO 15	R3:4.3 T1: 4.3
42	Emphasize Generation and control of electron beam for machining.	CLO 16	R3: 3.1, T1:8.1
43-44	Discuss theory of electron beam machining.	CLO 16	R3: 4.1 T2: 8.3.1
45	Comparison of thermal and non -thermal processes.	CLO 16	T2: 5.1 R2: 8.3
46	Explain general principles and applications of laser beam machining.	CLO 15	R3: 4.3 T2: 8.3.1
47	Discuss thermal features, cutting speed and accuracy of cut, application of plasma for machining	CLO16	R3: 4.3 T1: 8.3.2
48	Discuss metal removal mechanism, process parameters, accuracy and surface finish, applications of plasma in manufacturing industries.	CLO 17	R3: 3.1, T2:8.4
49	Discuss chemical machining principle and process.	CLO17	R3: 4.1 T2: 8.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Machining of high hardened material using EDM	Guest Lecture	PO 1	PSO 2
2	Plasma cutting for Aerospace applications	Seminars / NPTEL	PO 4	PSO 2, PSO 3
3	Recent development in Ultrasonic machining.	NPTEL	PO 2	PSO 1

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**TOOL DESIGN**				
Course Code	AME509				
Programme	B.Tech				
Semester	V	ME			
Course Type	Professional Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr.CH. Sandeep, Associate Professor, ME				
Course Faculty	Dr.CH. Sandeep, Associate Professor, ME				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of tool design technology selection of tooling materials for cutting operations with the help of various processes widely employed in industries. To design Jigs and Fixtures and selection of drills for various operations are studies in this course. The course consists of tool material, design of cutting tools, design of jigs and fixtures, design of sheet metal forming-I and design of sheet metal forming- II.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME004	III	Mechanics of Solids	4
UG	AME005	III	Metallurgy and Material Science	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Tool Design	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 units and each unit carries equal weight age 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering and Mechanical Engineering principles related to design and manufacturing works.	3	Presentation on Real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using manufacturing technology concepts and principles.	2	Seminars
PO 3	**Design/ development of solutions:** Design, implement, and evaluate a Mechanical Engineering component, to meet desired needs within realistic constraints	1	Assignments
PO 6	**The engineer and society**: Maintaining the engineering practices such as time, efficiency, as well as appropriate constraints related to economic, environmental, ethical, health and safety, manufacturability, and sustainability considerations	1	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminars
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats. Provide mechanical engineering solutions to green and sustainable development.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Compare the characteristics of various tool materials for cutting operations.
II	Demonstrate the design of cutting tools and its importance in manufacturing industry.
III	Understand the design of jigs and fixtures for holding the different components.
IV	Illustrate the design for sheet metal forming-I in the field of design aspects.
V	Compare the design for sheet metal forming-II in the manufacturing industry.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME509.01	CLO 1	Understand various tool materials used in various industries.	PO 1	3
AME509.02	CLO 2	Explain the characteristics of different tool materials	PO 1	3
AME509.03	CLO 3	Evaluate the properties of Non Metallic and Non Ferrous materials.	PO 1	3
AME509.04	CLO 4	Use design principles to incorporate in cutting tools.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME509.05	CLO 5	Explain design of Point cutting tools: Milling, Drilling	PO 2	2
AME509.06	CLO 6	Demonstrate the selection of carbide tool steels for cutting operations.	PO 1	3
AME509.07	CLO 7	Solve problems and find methods to determine the shank size.	PO 2	1
AME509.08	CLO 8	Explain principles of Jigs and Fixtures.	PO 2	2
AME509.09	CLO 9	Demonstrate the general considerations in the design of drill jigs and drill bushing.	PO 2	2
AME509.10	CLO 10	Explain design of sheet metal blanking and piercing dies.	PO 2	2
AME509.11	CLO 11	Demonstrate the methods of construction of fixtures, vice, milling and boring.	PO 1	3
AME509.12	CLO 12	Explain the fundamentals of die cutting operation, power press types.	PO 3	1
AME509.13	CLO 13	Explain about material handling equipment.	PO 2	2
AME509.14	CLO 14	Solve problems on punches and dies.	PO 2	2
AME509.15	CLO 15	Understand the importance of sheet metal forming, bending, and deep drawing.	PO 3	1
AME509.16	CLO 16	Compare extrusion and forging processes to identify advantages and limitations.	PO 6	1
AME509.17	CLO 17	Enable students to understand various sheet metals forming for industrial applications.	PO 6	1
AME509.18	CLO 18	Enable students to understand importance of tool design for lifelong learning, Higher Education and competitive exams.	PO 3	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4	3														
CLO 5		2													
CLO 6	3														
CLO 7		2													
CLO 8		2													
CLO 9		2											1		
CLO 10		2											1		
CLO 11	3														

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 12			1												
CLO 13		2													
CLO 14		2											1		
CLO 15			1												
CLO 16						1									
CLO 17						1									
CLO 18			1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2, PO3,PO6	Assignments	PO 3	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	TOOL MATERIAL
Tool materials: Properties of materials: Tools steels, Cast Iron, Mild or low carbon steels, Non metallic and nonferrous materials, Heat treating.	
UNIT-II	**DESIGN OF CUTTING TOOLS**
Design of cutting tools: Point cutting tools: Milling cutters, drills, selection of carbide steels, determination of shank size for single point carbide tools, determining the insert thickness for carbide tools.	
UNIT-III	**DESIGN OF JIGS AND FIXTURES**
Design of jigs and fixtures: Basic principles of location and clamping; Locating methods and devices, jigs, definition types. General considerations in the design of drill jigs, drill bushing, methods of construction; Fixtures, vice fixtures, milling, boring lathe grinding fixtures.	
UNIT-IV	**DESIGN FOR SHEET METAL FORMING – I**
Design of sheet metal blanking and piercing dies: Fundamentals of die cutting operation, power press types, general press information, materials handling equipment, cutting action in punch and die operations, die clearance, types of die construction, die design fundamentals, banking and piercing die construction, pilots, stripper and pressure pads presswork material, strip layout, short run tooling for piercing.	

UNIT-V	DESIGN FOR SHEET METAL FORMING – II
Design of sheet metal bending, forming and drawing dies: Bending dies, drawing dies, forming dies, drawing operations, variables that effect metal flow during drawing, determination of blank size, drawing force, single and double action draw dies	
Text Books:	
1. Donaldson, "Tool Design", Tata McGraw-Hill, 1stEdition, 2013. 2. HMT, "Production Technology", Tata McGraw-Hill, 1st Edition, 2012. 3. R.K. Jain, S. C. Gupta, "Production Technology", Tata McGraw-Hill, 1stEdition, 2013.	
References:	
1. George F Dieter, "Mechanical Metallurgy", Tata McGraw-Hill, 1stEdition, 2015. 2. C. Elanchezhian, M.Vijayan, "Machine Tools", Anuradha Publications, 1stEdition, 2010	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	CLOs	Reference
1-4	Define principle of tool materials	CLO 1	T1:28.7 R1:2.6
5-7	Examine various types of tool materials	CLO 2	T1:27.5 R1:2.7
8-10	Relate various types of Non metallic and non ferrous materials and heat treatment process	CLO 2	T1:29.6 R1:2.6
11-14	Describe the design of cutting tools	CLO 3	T1:29.7 R1:4.4
15-16	Compare various cutting operations	CLO 4	T1:30.7 R1:4.10
17-20	Explain the selection of carbide tools	CLO 5	T1:30.8 R1:4.25
21-23	Explain jigs and fixtures	CLO 6	T1:22.9 R1:5.4
24-26	Discuss various types of clamping	CLO 7	T1:31.2 R1:5.8
27-28	Define the location methods of jigs	CLO 7	T2:31.10 R1:6.8
29-30	Describe the considerations of drill jigs and bushing	CLO 8	T2:32.10 R1:6.13
31-32	Describe the methods of constructions	CLO 8	T2:33.9 R1:7.5
33-34	Discuss the sheet metal design	CLO 9	T2:34.10 R2:7.5
35	Compare different types of cutting operations and material handling equipments	CLO 9	T2:35.10 R3:8.1
36-37	Die constructions	CLO 10	T2:35.12 R1:9.2
38	Explain Blanking and piercing processes	CLO 11	T2:36.1 R2:9.4
39	Discuss stripper and pressure work	CLO 12	T2:37.1 R2:9.9
40-41	Discuss tooling for piercing	CLO 12	T1:23.1 R1:9.10
42	Explain the design of sheet metal bending	CLO 13	T2:27.5 R1:10.2
43-44	Discuss forming and drawing	CLO 14	T2:27.7 R1:11.3
45	Explain various types of dies	CLO 15	T2:27.8 R1:11.6
46	Explain the drawing process and its effects	CLO 16	T2:27.12 R1:11.7

Lecture No	Topics to be covered	CLOs	Reference
47-48	Describes the design of blank size	CLO 17	T2:27.12 R1:11.8
49-50	Explain equipment used for single and double action draw	CLO 18	T2:27.12 R1:11.9

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Concepts related to Jigs and fixtures, tooling material, Working principles of quality control, Analysing cutting tools and their design concepts	Seminars / NPTEL	PO 2,PO 3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest Lectures	PO 2,PO 6	PSO 1

Prepared by:
Dr.CH. Sandeep, Associate Professor

HOD, ME

VI SEMESTER

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AEROSPACE PROPULSION AND COMBUSTION**				
Course Code	AAE551				
Programme	B. Tech				
Semester	VI	ME|AE			
Course Type	Open Elective - I				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. M Vijay Kumar , Assistant Professor				
Course Faculty	Mr. M Vijay Kumar , Assistant Professor				

I. COURSE OVERVIEW:

The aim of Aerospace propulsion and combustion is to introduce students to the analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of air breathing and non air breathing engines and know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors. To be able to describe the principal figures of merit for aircraft engine and rocket motor performance and explain how they are related to vehicle performance. To be able to describe the principal design parameters and constraints that set the performance of gas turbine engines and to apply ideal-cycle analysis to a gas turbine engine to relate thrust and fuel burn to component-level performance parameters and flight conditions. It is the branch of rocket science for analyzing the performance of an engine.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Thermodynamics	4
UG	AME007	V	Aircraft propulsion	3

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Aerospace propulsion and combustion	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world 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	2	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	2	Presentation on current challenges
PSO 2	**Problem solving skills:** imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	-	-
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of all air breathing engines.
II	Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors
III	Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
IV	Explain different types of compressors and turbines, work done, efficiency calculations.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE551.01	CLO 1	Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.	PO 1	3
AAE551.02	CLO 2	Understand the basic function of all aircraft engine components and how they work.	PO 1	3
AAE551.03	CLO 3	Analyze the engine performance parameters and parameters influencing them.	PO 2	2
AAE551.04	CLO 4	Understand the impact of performance parameters on endurance and range how they affect the aircraft performance.	PO 1	2
AAE551.05	CLO 5	Demonstrate different types of aircraft engine operating principle.	PO 1	1
AAE551.06	CLO 6	Understand step by step procedure of engine parametric cycle analysis.	PO 2	2
AAE551.07	CLO 7	Understand steps involved in performance analysis of all aircraft engine.	PO 2	2
AAE551.08	CLO 8	Describe operational modes of subsonic inlets and parameters influencing it.	PO 1	2
AAE551.09	CLO 9	Analyze diffuser performance, losses in it and their impact on engine performance.	PO 2	2
AAE551.10	CLO 10	Describe supersonic inlets, starting problem in it and their operating modes.	PO 1	1
AAE551. 11	CLO 11	Understand different types of combustion chamber and functions of all the components.	PO 1	2
AAE551. 12	CLO 12	Analyze combustion chamber performance and parameters influencing them.	PO 3	1
AAE551. 13	CLO 13	Describe principle of operation of axial and centrifugal compressor.	PO 1	2
AAE551. 14	CLO 14	Understand the different nozzle operating conditions for C-D nozzle	PO 1	2
AAE551. 15	CLO 15	Describe principle of operation of axial and centrifugal compressor.	PO 1	1
AAE551. 16	CLO 16	Understand different design of compressor and limitations of each method.	PO 3	2
AAE551. 17	CLO 17	Analyze performance characteristics of axial and centrifugal compressor.	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2	3												2			
CLO 3		2														
CLO 4	2															
CLO 5	1												2			
CLO 6		2														
CLO 7		2														
CLO 8	2															
CLO 9		2											2			
CLO 10	1															
CLO 11	2															
CLO 12			1													
CLO 13	2															
CLO 14	2												1			
CLO 15	1															
CLO 16			2													
CLO 17		2														

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3	SEE Exams	PO 1, PO 2 PO 3	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feed Back
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	ELEMENTS OF AIRCRAFT PROPULSION	Classes: 10
Classification of power plants, methods of aircraft propulsion, propulsive efficiency, specific fuel consumption, thrust and power, factors affecting thrust and power, illustration of working of gas turbine engine, characteristics of turboprop, turbofan and turbojet engines and performance.		
UNIT-II	**COMPONENTS OF JET ENGINES**	**Classes: 08**
Ram jet, scram jet engines construction and nomenclature, theory and performance, methods of thrust augmentation, atmospheric properties, introduction to compressors, turbines, combustors and after burners for aircraft engines.		
UNIT-III	**INLETS, NOZZLES AND PROPERLLER THEROY**	**Classes: 10**
Propeller performance parameters, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts. Subsonic and supersonic inlets, relation between minimum area ratio and external deceleration ratio. Starting problem in supersonic inlets, modes of inlet operation, jet nozzle, efficiencies, over expanded, under and optimum expansion in nozzles, thrust reversal.		
UNIT-IV	**THERMODYNAMICS OF REACTING SYSTEMS**	**Classes: 09**
Classification of combustion chambers, combustion chamber performance, flame tube cooling, flame stabilization, effect of operating variables on performance.		
UNIT-V	**PREMIXED FLAMES**	**Classes: 08**
Rankine hugoniot relations, theories of laminar premixed flame propagation, quenching and flammability limits; Diffusion flames: Burke-Schumann theory, laminar jet diffusion flame, droplet combustion, turbulent combustion, closure problem, premixed and non-premixed turbulent combustion, introduction to DNS and LES.		
Text Books:		
1. Stephen R. Turns, "An Introduction to Combustion", McGraw-Hill, 3rd Edition, 2012. 2. Thomas A. Ward, "Aerospace Propulsion Systems", John Wiley and Sons, 1st Edition, 2010.		
Reference Books:		
1. M. H. Sadd, "Elasticity: Theory, Applications, and Numerics", Academic Press, 2nd Edition, 2009. 2. R. G. Budynas "Advanced Strength and Applied Stress Analysis", McGraw-Hill, 2nd Edition, 1999. 3. A.P. Boresi, R.J. Schmidt, "Advanced Mechanics of Materials", John Willey & Sons, 5th Edition, 2003.		

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to aerospace engineering	CLO 1	T2:5.5 R1:1.12.1
2	Define function of gas generator, Classify gas turbine engines	CLO 1	T2:5.6 R1:1.12.3
3	Operational envelops	CLO 1	T2:5.10 R1:1.15
4	Turbojet performance	CLO 1	T2:5.15 R1:1.16
5	Turbo fan performance	CLO 1	T2:5.17 R1:1.13.1
6	Turbo prop performance characteristics	CLO 1	T2:5.18 R1:1.13.2
7	Define engine thrust, takeoff thrust	CLO 2	T2:5.19 R1:1.13.3
8	Thrust equation, installed thrust	CLO 2	T2:5.20 R1:1.17.1
9	Methods of aircraft propulsion	CLO 2	T2:5.24 R1:1.17.3
10	Propulsive efficiency, efficiency of a turbo prop	CLO 3	T2:6.1 R1:2.3
11	Efficiency of a turbo fan and turbo jet	CLO 3	T2:6.3 R1:2.6.1
12	Explanation of performance parameters	CLO 4	T2:6.5 R1:2.6.2
13	Specific fuel consumption, specific impulse	CLO 4	T2:7.3 R1:2.8
14	Components of jet engines	CLO 5	T2:15.13 R1:8.7.2
15	Working principle of ramjet and Scram jet operating principle	CLO 5	T2:15.13 R1:8.7.2
16	Methods of thrust augmentation in aircrafts engines	CLO 5	T2:15.16 R1:8.7.3
17	Atmospheric properties influence on when aircrafts are flying	CLO 6	T1:11.9 R2:12.24
18	Use of after burner in an engine	CLO 6	T1:11.9 R3:12.25
19	Explanation of principle of operation of turbine	CLO 6	T1:3.2 R3:3.2
20	Operation of axial flow turbines	CLO 6	T1:3.3.1 R3:3.2
21	Design of a turbine blade and nomenclature	CLO 7	T2:16.5 R1:8.10
22	Explain principle of operation of compressor	CLO 7	T2:16.9 R1:8.11.1
23	Operation of centrifugal compressor and axial flow compressor	CLO 7	T2:16.9 R1:8.11.2
24	Stage efficiency calculations, cascade testing	CLO 7	T2:16.8 R1:8.12.1
25	Design of velocity triangles of a turbine blade	CLO 5	T2:16.8 R1:8.12.2
26	Define degree of reaction of a compressor	CLO 8	T2:16.11 R1:8.14
27	Internal flow and stall in subsonic inlets	CLO 8	T2:16.11 R1:8.20

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
28	Relation between minimum area ratio and eternal deceleration ratio	CLO 8	T2:16.12 R1:8.19
29	Working phenomenon of subsonic and supersonic inlets	CLO 8	T2:16.12 R1:8.77
30	Diffuser performance	CLO 9	T2:1.2 R1:7.2
31	Starting problem of subsonic inlets	CLO 9	T2:1.16 R1:7.7
32	Shock swallowing by area variation	CLO 9	T2:1.20 R1:7.8
33	Starting problem of supersonic inlets	CLO 9	T2:1.20 R1:7.8
34	Definition of propeller and working principle	CLO 10	T2:2.1 R1:7.9.2
35	Performance of propeller in an engine	CLO 10	T2:16.11 R1:8.14
36	Types of propellers – ducted, prop fans etc	CLO 10	T2:16.8 R1:8.12.1
37	Calculated efficiency of a sub sonic and supersonic inlets of an engine	CLO 10	T2:5.17 R1:1.13.1
38	Definition of nozzle and its importance	CLO 11	T2:5.18 R1:1.13.2
39	Over expanded, under and optimum expansion in nozzles	CLO 11	T2:5.19 R1:1.13.3
40	Concept of thrust reversal in a nozzle	CLO 12	T2:5.20 R1:1.17.1
41	Classification of combustion chambers	CLO 12	T2:5.24 R1:1.17.3
42	Combustion chamber performance	CLO 12	T2:6.1 R1:2.3
43	Effect of operating variables on performance	CLO 12	T2:6.3 R1:2.6.1
44	Flame stabilization	CLO 13	T2:6.5 R1:2.6.2
45	Effect of operating variables on performance and cooling	CLO 13	T2:5.24 R1:1.17.3
46	Combustion chamber types – annular and circular	CLO 13	T2:6.1 R1:2.3
47	Combustion types , combustion inlet temperature and pressure variations	CLO 14	T2:6.3 R1:2.6.1
48	Definition of pre mixed flames	CLO 14	T2:15.13 R1:8.7.2
49	Rankine hugoniot relations for pre mixed flows	CLO 14	T2:15.13 R1:8.7.2
50	Theories of laminar premixed flame propagation	CLO 15	T2:15.16 R1:8.7.3
51	Quenching and flammability limits	CLO 15	T2:15.16 R1:8.7.3
52	Diffusion flames: Burke-Schumann theory	CLO 15	T1:11.9 R3:12.25
53	Laminar jet diffusion flame, droplet combustion	CLO 16	T1:3.2 R3:3.2
54	Turbulent combustion, closure problem	CLO 16	T1:3.3.1 R3:3.2
55	Premixed for turbulent combustion	CLO 16	T2:16.5 R1:8.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
56	Non-premixed turbulent combustion	CLO 16	T2:16.9 R1:8.11.1
57	Introduction to DNS	CLO 16	T2:16.9 R1:8.11.2
58	Introduction to LES	CLO 17	T2:15.13 R1:8.7.2
59	Discussion of laminar jet diffusion flame	CLO 17	T2:15.13 R1:8.7.2
60	Application of numerical techniques in visualizing mixed flows	CLO 17	T2:15.16 R1:8.7.3

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lectures	PO 2	PSO 1

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FINITE ELEMENT MODELLING**				
Course Code	AME014				
Programme	B. Tech				
Semester	VI	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. B.D.Y. Sunil, Associate Professor, ME				
Course Faculty	Mrs. V. Prasanna, Assistant Professor, ME Mr. P. Sadanandam, Assistant Professor, ME				

I. COURSE OVERVIEW:

The Finite Element Method (FEM) is widely used in industry for analyzing and modeling structures and continua, whose physical behavior is described by ordinary and partial differential equations. The FEM is particularly useful for engineering problems that are too complicated to be solved by classical analytical methods. The main objective of this course is to introduce the mathematical concepts of the Finite Element Method for obtaining an approximate solution of ordinary and partial differential equations. In this course you will attend lectures on the fundamentals of the Finite Element Method. The learning process will be enhanced by completing assignments using mathematical software. You will also be introduced to a commercial Finite Element software package

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME004	III	Mechanics of Solids	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Finite Element Modelling	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering Knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	**3**	Assignments
PO2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	**2**	Assignments
PO3	**Design/development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	**2**	Seminars
PO5	**Modern tool usage:** An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	**2**	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	**2**	Assignments
PSO2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	**3**	Seminars
PSO3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	**2**	Guest Lectures

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Introduce basic concepts of finite element methods including domain discretization, polynomial interpolation and application of boundary conditions.
II	Understand the theoretical basics of governing equations and convergence criteria of finite element method.
III	Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.
IV	Understand to improve or refine the approximate solution by spending more computational effort by using higher interpolation continuities unlike expensive experimental methods/exact solutions.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME014.01	CLO 1	Understand the numerical methods and development of mathematical models for physical system	PO 1	3
AME014.02	CLO 2	Identify mathematical model for solution of common engineering problems in the field of aeronautical, mechanical and civil	PO 1	3
AME014.03	CLO 3	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions	PO 1	3
AME014.04	CLO 4	Remember the steps involved in finite element methods while solving the model of physical problem	PO 2	2
AME014.05	CLO 5	Apply numerical methods for solving one dimensional bar problems	PO 2	2
AME014.06	CLO 6	Identify the mathematical models for two-dimensional, three-dimensional truss and beam elements	PO 2	2
AME014.07	CLO 7	Solve the equations of truss and beam elements	PO 2	1
AME014.08	CLO 8	Calculate stress strain and strain energy for common engineering problems	PO 3	1
AME014.09	CLO 9	Derive element matrix by different methods by applying basic laws in mechanics and integration by parts	PO 3	2
AME014.10	CLO 10	Demonstrate the ability to evaluate and interpret FEA analysis results for design and development purposes	PO 3	2
AME014.11	CLO 11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	PO 1	3
AME014.12	CLO 12	Derive the element stiffness matrices for triangular elements and axisymmetric solids and estimate the load vector and stresses	PO 5	3
AME014.13	CLO 13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate	PO 5	3
AME014.14	CLO 14	Understand the concepts of mass and spring system and derive the equations for various structural problems	PO 1	3
AME014.15	CLO 15	Calculate the mass matrices; Eigen values Eigen vectors and natural frequency for dynamic problems	PO 5	2
AME014.16	CLO 16	Model multi-dimensional structural and heat transfer problems by using automatic and fully automatic software such as ANSYS, NISA, NASTRAN	PO 5	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												2		
CLO 2	3													3	2
CLO 3	3												2		
CLO 4		2												3	
CLO 5		2													2
CLO 6		2												3	2
CLO 7		1											2		
CLO 8			1										2		
CLO 9			2											3	
CLO 10			2											3	
CLO 11	3													3	
CLO 12					3								2		2
CLO 13					3										
CLO 14	3													3	
CLO 15					2								2		
CLO 16					2								2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PO5	SEE Exams	PO1, PO2, PO3, PO5	Assignments	PO 1, PO 2	Seminars	PO 3, PO 5
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	**INTRODUCTION TO FEM**
Introduction to fem for solving field problems, basic equations of elasticity, stress–strain and strain-displacement relations for 2D-3D elastic problems, boundary conditions, one dimensional problem, finite element modeling coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, quadratic shape functions.	
Unit-II	**ANALYSIS OF TRUSSES AND BEAMS**
Analysis of trusses stiffness matrix for plane truss elements, stress calculations and problems analysis of beams: element stiffness matrix for two nodes, two degrees of freedom per node beam element and simple problems.	
Unit-III	**2-D ANALYSIS**
Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, estimation of load vector, stresses. Finite element modeling of axisymmetric solids subjected to axisymmetric loading with triangular elements, two-dimensional four node iso parametric elements.	
Unit-IV	**STEADY STATE HEAT TRANSFER ANALYSIS**
Steady state heat transfer analysis: 1-D heat conduction of slab 1D fin elements, 2D heat conduction, analysis of thin plates, analysis of a uniform shaft subjected to torsion, problems.	
Unit-V	**DYNAMIC ANALYSIS**
Dynamic analysis: Dynamic equations, lumped and consistent mass matrices, Eigen values and Eigen vectors for a stepped bar, beam; Finite element, formulation to 3D problems in stress analysis, convergence requirements, mesh generation, techniques such as semi-automatic and fully automatic use of software such as ANSYS, NISA, NASTRAN.	
Text Books:	
1. Tirupathi K., Chandrapatla, Ashok D. Belagundu, ―Introduction to Finite Elements in Engineering, 1st Edition, 2013.	
2. S. S. Rao, ―The Finite Element Methods in Engineering, Elsevier, 4th Edition, 2013.	
3. J. N. Reddy, ―An Introduction to Finite Element Methods, McGraw-Hill, 1st Edition, 2013.	
Reference Books:	
1. Alavala, ―Finite Element Methods‖, TMH, 1st Edition, 2012.	
2. O.C. Zienkowitz, ―The Finite Element Method in Engineering Science‖, McGraw-Hill, 1st Edition, 2013.	
3. Robert Cook, ―Concepts and Applications of Finite Element Analysis‖, Wiley, 1st Edition, 2013.	
4. S. Md. Jalaludeen, ―Introduction of Finite Element Analysis‖, Anuradha publications, 1st Edition, 2010.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction to Finite Element Method for solving field problems	CLO 1	T1:1.4 R1:1.2
3-5	Stress and Equilibrium. Boundary conditions. Strain - displacement relations	CLO 1	T1:1.5 R1:2.4
6-7	One Dimensional Problems: Finite element modeling coordinates	CLO 2	T1:2.5 R1:2.5
7-8	Shape functions, Quadratic shape functions	CLO 3	T1:2.5 R1:2.6

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
9-11	Assembly of Global stiffness matrix and load vector	CLO 4	T1:22.7
12-13	Finite element equations – Treatment of boundary conditions	CLO 4	T1:6.3 R1:5.3
14-16	Analysis of Trusses: Stiffness matrix for plane Truss Elements stress calculations and problems	CLO 5	T1:6.6 R1:5.3.6
17-19	Analysis of beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element	CLO 6	R1:6.2
20-22	Finite element modeling of two-dimensional stress analysis with constant strain triangles	CLO 7	T1:7.5 R1:6.3
23-25	Treatment of boundary conditions. Estimation of load vector and stresses	CLO 8	T1:8.5 R1:6.8
26-29	Finite element modeling of Axisymmetric solids	CLO 9	T1:12.2 R1:13.1
30-31	Axisymmetric solids subjected to Axisymmetric loading with triangular elements	CLO 10	T1:12.3 R1:13.2
32-34	Two dimensional four noded isoparametric elements, Problems	CLO 11	T1:12.10 R1:13.7
35-36	Steady state Heat Transfer Analysis One dimensional analysis of slab	CLO 12	T1:11.2 R1:10.2
37-38	Fin and two-dimensional analysis of thin plate Analysis of a uniform shaft subjected to torsion	CLO 13	T1:11.5 R1:10.3
39-41	Evaluation of Eigen values and Eigen Vectors for a stepped bar, truss	CLO 14	T1:11.12 R1:11.9
42-43	Finite element-formulation to 3D problems in stress analysis convergence requirements, mesh generation	CLO 15	T1:11.8 R1:11.5
44-45	Techniques such as semi-automatic and fully automatic use of software such as ANSYS, NISA, NASTRAN	CLO 16	T1:9.9

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Gain information about space frames used in the modeling of car body and bicycle frames.	Seminars	PO 1, PO 2	PSO 3
2	Encourage students to perform analysis on composite materials using FEM applications.	Guest Lectures	PO 1, PO 3, PO 5	PSO 2

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MACHINE DESIGN**				
Course Code	AME015				
Programme	B.Tech				
Semester	VI	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr.G.V.R.Seshagiri Rao, Professor, ME				
Course Faculty	Mr. V.K.V.S.Krishnam Raju, Associate Professor , ME				

I. COURSE OVERVIEW:

The Machine design focus mainly on design of power transmitting elements like gears, connecting rod, crankpin, crankshafts, pistons, cylinders, bearings, belts, ropes, chain's, pulleys, Power screws and nuts. Design basis is strength and stiffness of the parts and selection of material for manufacture of machine elements.

Mechanical design is creating new devices or improving existing ones in an attempt to provide the "best" or "optimum "design. In other words, mechanical design may be de need as an iterative decision-making process that has as its objective the creation and optimization of a new or improved mechanical engineering system or device for the fulfillment of a human need or desire, with due regard for conservation of resources and environmental impact

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME005	III	Mechanics of solids	4
UG	AME003	V	Design of Machine Members	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Machine Design	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering and Mechanical Engineering principles related to combustion engines.	3	Presentation on Real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using Thermodynamics concepts and principles.	2	Seminar
PO 3	**Design/ development of solutions:** Design, implement, and evaluate a Mechanical Engineering component, to meet desired needs within realistic constraints	1	Assignments
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	Publication

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Seminar/Project reviews
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	2	Project works/Major and Mini
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	2	Internship/Industrial visit/Work shops

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Ability to identify design variables and performance factors in the study of journal bearings.
II	Ability to identify different types of rolling contact bearings, their basic features, related terminology and designations
III	Ability to select rolling contact bearings for a given application
IV	Awareness of the basic features of prime movers and the means of power transmission commonly used in mechanical engineering
V	Ability to analyze and design all types of gears for given application

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME015.01	CLO 1	Understand various design variables and factors in the study of bearings	PO 1	3
AME015.02	CLO 2	Explain various lubrication process	PO 1	3
AME015.03	CLO 3	Illustrate various parts of bearing	PO 1	3
AME015.04	CLO 4	Analyze heat dissipation in bearings	PO1	3
AME015.05	CLO 5	Select the lubricants for various applications	PO 1	3
AME015.06	CLO 6	Discuss types of bearings for required application.	PO 1	3
AME015.07	CLO 7	Describe static and dynamic rating of roller bearings	PO 2	2
AME015.08	CLO 8	Explain various parts of connecting Rod	PO 2	2
AME015.09	CLO 9	Illustrate about thrust acting on a connecting Rod	PO1	3
AME015.10	CLO 10	Categorize & Describe about stresses induced and find suitable cross section	PO 2	2
AME015.11	CLO 11	Classify the various types of Crankshafts.	PO 1	3
AME015.12	CLO 12	Calculate the sizes of different parts of crankshaft and crank pin	PO 1	3
AME015.13	CLO 13	Explain the various parts of the piston and forces acting on each of these parts	PO 1	3
AME015.14	CLO 14	Construct the piston diagram and generate formulae	PO 1	3
AME015.15	CLO 15	Describe the various types of belt drives and transmission power and V.R	PO 1	3
AME015.16	CLO 16	Describe the construction of ropes	PO 1	3
AME015.17	CLO 17	Define the efficiency of power transmission and explain factors effecting efficiency	PO 2	2
AME015.18	CLO 18	Distinguish different pulleys for belt and rope drives	PO 1	3
AME015.19	CLO 19	Describe load transmission between gear teeth and Illustrate dynamic load factors	PO 1	3
AME015.20	CLO 20	Compare the equations for compressive and bending strength	PO 1	3
AME015.21	CLO 21	Explain the Procedure design of spur gears	PO 1	3
AME015.22	CLO 22	Describe the governing equation and find the dynamic and wear strength	PO 2	2
AME015.23	CLO 23	Explain Procedure for design of helical and bevel gears	PO 1	3
AME015.24	CLO 24	Describe the terminology of power screws	PO 1	3
AME015.25	CLO 25	Describe construction and explain failure mechanism	PO 2	2

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												3		
CLO 2	3													2	
CLO 3	3													2	
CLO 4	3													2	
CLO 5	3												3		
CLO 6	3												3		
CLO 7		2											3		
CLO 8		2													2
CLO 9	3												3		
CLO 10		2												2	
CLO 11	3													2	
CLO 12	3														
CLO 13	3														
CLO 14	3														
CLO 15	3														
CLO 16	3														
CLO 17		2													
CLO 18	3														
CLO 19	3														
CLO 20	3														
CLO 21	3														
CLO 22		2													
CLO 23	3														
CLO 24	3														
CLO 25		2													

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2, PO3,PO6	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 3						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**BEARINGS**
Bearings: Types of journal bearings, basic modes of lubrication, bearing modulus, full and partial bearings, Clearance ratio, Heat dissipation of bearings, bearing materials, Journal bearing design. Ball and roller bearing, Static load- dynamic load, equivalent radial load-design and selection of ball and roller bearings.	
UNIT-II	**DESIGN OF IC ENGINE PARTS**
Connecting rod: thrust in connecting rod-stress due to whipping action on connecting rod ends-cranks and crank shafts, strength and proportions of over hung and center cranks-crank pins, crank shafts, piston, forces acting on piston-construction design and proportions of piston.	
UNIT-III	**POWER TRANSMISSION SYSTEMS, PULLEYS**
Transmission of power by belt and rope drives, transmission efficiencies, Belts-Flat and V belts-ropes-pulleys for belt and rope drives, materials- chain drives.	
UNIT-IV	**SPUR GEAR**
Load concentration factor-dynamic load factor, surface compressive strength-bending strength-design analysis of spur gear, check for plastic deformation, check for dynamic and wear considerations. Helical and Bevel Gear Drives: Load concentration factor-dynamic load factor, Analysis of helical and bevel gears, check for plastic deformation, check for dynamic and wear considerations. Design of Worm gears: worm gear-properties of worm gears-selections of materials-strength and wear rating of worm gears-force analysis-friction in worm gears-thermal considerations	
UNIT-V	**DESIGN OF POWER SCREWS**
Design of screw, design of nut, compound screw, differential screw, ball screw-possible failures	
Text Books:	
1. P. Kannaiah, (2012), Machine Design, 2nd Edition, Scitech Publications India Pvt. Ltd, New Delhi, India. 2. V. Bandari (2011), A Text Book of Design of Machine Elements, 3rd edition, Tata McGraw hill education (P) ltd, New Delhi, India.	
Reference Books:	

1. Shigley, J.E, (2011), Mechanical Engineering Design, 9th Edition, Tata McGraw-Hill, New Delhi, India.
2. S. M.D. Jalaludin, (2011), Machine Design, 3rd Edition, Anuradha Publishers, Kumbakonam, Chennai, India.
3. R. L. Norton (2006), Machine Design (An Integrated approach), 2nd edition, Pearson Publishers, Chennai, India.
4. R.S. Khurmi, A. K. Gupta, "Machine Design", S. Chand & Co, New Delhi, 1st Edition, 2014.
5. PSG College, "Design Data: Data Book of Engineers", 1st Edition, 2012.

XIV COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Types of journal bearings	CLO 1	T1:19.1 R1:1.6
3	Basic modes of lubrication	CLO 2	T1:19.5 R1:1.7
4-6	Bearing modulus-full and partial bearings,	CLO3	T1:19.2 R1:1.6
7-8	Clearance ratio	CLO 4	T1:19.7 R1:4.4
9-10	Heat dissipation in bearing	CLO 5	T1:19.6 R1:4.7
11	Bearing materials, Journal bearing design	CLO 4	T1:19.8 R1:4.8
12-13	Types of rolling contact bearings	CLO 4	T1:19.3 R1:5.4
14	Selection of bearing type	CLO 5	T1:19.5 R1:5.8
15	Static and dynamic loading of ball and roller bearings	CLO5	T219.1 R1:6.8
16	Transmission of power by belt drives	CLO 6	T2:202
17	Construction of rope drives	CLO 7	R1:6.8
18	Transmission efficiencies.	CLO 8	T2:20.
19	Belts-Flat and V belts	CLO 9	R1:6.8
20	Pulleys for belt and rope drives, materials	CLO10	T2:20.4
21	Design of Chain drives	CLO10	T2:21.4
22	Thrust in Connecting Rod	CLO11	T2:28.12 R1:7.5
22-23	Stress due to Whipping action on Connecting rod ends.	CLO11	T2:28.13 R2:7.5
24-25	Cranks and crankshafts, Strength and proportions of crankshafts	CLO12	T2:28.14 R1:7.5
26-27	Design of Piston, Forces acting on piston	CLO12	T2:28.14 R2:7.5
28	Construction design and proportions of piston	CLO13	T2:28.15 R2:9.4
29	Spur Gear Drives: Design of spur gears	CLO13	T2:28.17
30	Load concentration factor-dynamic load factor	CLO14	T2:28.17
31	Surface compressive strength-bending strength	CLO15	T2:28.18
32-33	Design analysis of spur gear	CLO15	T2:28.18
34-35	Estimation of center distance, module and face width, check for plastic deformation	CLO15	T2:28.22
36-37	Check for dynamic and wear considerations	CLO15	T2:28.24
38	Helical and Bevel Gear Drives: Load concentration factor-	CLO15	T2:28.25

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	dynamic factor		
39-40	Design analysis of Helical and Bevel gear	CLO15	T2:28.27
41-43	Check considerations for dynamic strength	CLO16	T2:28.28
44	Design of Worm gears: worm gear- properties of worm gears-selections of materials	CLO17	T2:28.29 R1:12.3
45	Strength and wear rating of worm gears- force analysis	CLO18	T2:28.31 R1:12.7
46	Friction in worm gears-thermal considerations	CLO19	T1:28.29
47-48	Design of power screws : Design of screw	CLO20	T1:25.1
49-50	Square, ACME, Buttress screws	CLO21	T1:25.2
51	Design of nut	CLO22	T1:25.2
52-53	Design of Compound screw	CLO23	T1:25.3
54	Design of differential screw	CLO24	T2:25.3
55	ball screw-possible failures	CLO25	T3:25.3

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1,PO 2	PSO 1
2	Concepts related to design of combustion chambers	Seminars / NPTEL	PO 2,PO 3	PSO 2
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6	PSO 3

Prepared by:
Dr. GVR Seshagiri Rao, Professor
Mr. VKVS Krishnam Raju, Associate Professor

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**HEAT TRANSFER**				
Course Code	AME016				
Programme	B.Tech				
Semester	VI	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. K Ch Apparao, Associate Professor				
Course Faculty	Dr. Ch Sandeep, Associate Professor Mr. S Srikrishnan, Assistant Professor				

I. COURSE OVERVIEW:

Heat transfer is the flow of thermal energy driven by thermal non-equilibrium, commonly measured as a heat flux, i.e. the heat flow per unit time at a control surface. This course focuses on the problems and complexities of heat transfer and emphasizes on analysis using correlations. The course assumes basic understanding of thermodynamic and fluid mechanics and exposure to differential equations and methods of solutions. Topics include modes of heat transfer and their laws, boundary conditions, conduction heat transfer – three dimensional, one dimensional steady and unsteady without heat generation, variable thermal conductivity, fin analysis, lumped heat capacity systems, free and forced convection with dimensional analysis, laminar boundary layer theory, heat exchangers, heat transfer with phase change and radiation heat transfer.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	III	Thermodynamics	4
UG	AME008	IV	Mechanics of Fluids and Hydraulic Machines	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Heat Transfer	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO 2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminar
PO 4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Lecture, Assignments and Seminars
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic modes of heat transfer like conduction, convection and radiation with and without phase change in solid liquids and gases.
II	Design and analyze thermal fluidic components in engineering systems to energy mechanisms (in the form of heat transfer) for steady and unsteady state.
III	Conduct experiments in laboratories and analyze the results with theoretical ones to evolve research oriented projects in the field of heat transfer as well as propulsion.
IV	Apply the concepts of heat transfer with convective mode in internal and external flows involved in engineering components and work in real time problems in Industry.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CAME016.01	CLO 1	Understand basic concepts of heat transfer modes, Fourier Law and First law of thermodynamics.	PO 1	3
CAME016.02	CLO 2	Remember the basic laws of energy involved in the heat transfer mechanisms.	PO 1	3
CAME016.03	CLO 3	Understand the physical system to convert into mathematical model depending upon the mode of Heat Transfer.	PO 1	3
CAME016.04	CLO 4	Understand the thermal response of engineering systems for application of Heat Transfer mechanism in both steady and unsteady state problems.	PO 1	3
CAME016.05	CLO 5	Understand heat transfer process and systems by applying conservation of mass and energy into a system.	PO 1	3
CAME016.06	CLO 6	Understand the steady state condition and mathematically correlate different forms of heat transfer	PO 1	3
CAME016.07	CLO 7	Analyse finned surfaces, and assess how fins can enhance heat transfer	PO 2	2
CAME016.08	CLO 8	Remember dimensionless numbers which are used for forced and free convection phenomena.	PO 2	2
CAME016.09	CLO 9	Understand the applications of Buckingham Pi Theorem in deriving various non dimensional numbers and their applications in heat transfer	PO 4	1
CAME016.10	CLO 10	Remember and use the methodology presented in tutorial to solve a convective heat transfer problems	PO 2	2
CAME016.11	CLO 11	Understand the various forms of free and forced convection and the application of the same in day to day problems	PO 1	3
CAME016.12	CLO 12	Calculate local and global convective heat fluxes using Nusselt's Theory.	PO4	1
CAME013.13	CLO 13	Understand the method to evolve hydrodynamic and thermal boundary layers applied mathematically to vertical plates and Tubes	PO 4	1
CAME016.14	CLO 14	Understand the physical mechanisms of phase change involving pool, nucleate and film boiling processes	PO 2	2
CAME016.15	CLO 15	Understand Nusselt's theory of condensation for the application in film and dropwise condensation	PO 2	2
CAME016.16	CLO 16	Correlate the empirical relations in terms of vertical and horizontal cylinders during film condensation	PO 4	1
CAME016.17	CLO 17	Understand the concepts of black and gray body radiation heat transfer.	PO 2	2
CAME016.18	CLO 18	Understand the concept of shape factor and evolve a mechanism for conducive radiation shields	PO 2	2
CAME016.19	CLO 19	Understand the various classifications of heat exchangers based on arrangement and correlate the effects of fouling	PO 2	2
CAME016.20	CLO 20	Understand the LMTD and NTU methods and	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		apply the same for solving real time problems in heat exchangers		

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4	3														
CLO 5	3														
CLO 6	3														
CLO 7		2											1		
CLO 8		2													
CLO 9				1											
CLO 10		2											1		
CLO 11	3														
CLO 12				1											
CLO 13				1											
CLO 14		2											1		
CLO 15		2											1		
CLO 16				1											
CLO 17		2													
CLO 18		2											1		
CLO 19		2											1		
CLO 20	3												1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO2, PO4	SEE Exams	PO 1, PO2, PO4	Assignments	PO1	Seminars	PO 1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Videos	PO 4						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**BASIC CONCEPTS**
Modes and mechanisms of heat transfer, basic laws of heat transfer, applications of heat transfer; conduction heat transfer: Fourier rate equation, general three dimensional heat conduction equations in cartesian, cylindrical and spherical coordinates; Simplification and forms of the field equation, steady and unsteady and periodic heat transfer, initial and boundary conditions.	
UNIT-II	**ONE DIMENSIONAL STEADY STATE AND TRANSIENT CONDUCTION HEAT TRANSFER**
One dimensional steady state conduction heat transfer: Homogeneous slabs, hollow cylinders and spheres, overall heat transfer coefficient, electrical analogy, Critical radius of insulation; one dimensional steady state conduction; heat transfer: with variable thermal conductivity and systems with internal heat generation, extended surfaces (Fins) long, short and insulated tips; one dimensional transient heat conduction: Systems with negligible internal resistance, significance of Biot and Fourier numbers, chart solutions of transient conduction systems.	
UNIT-III	**CONVECTIVE HEAT TRANSFER**
Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow, dimensional analysis as a tool for experimental investigation, Buckingham Pi Theorem and method, application for developing semi, empirical non-dimensional correlation for convection heat transfer, significance of non dimension numbers, concepts of continuity, momentum and energy equations; Forced convection: external flows: Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer, flat plates and cylinders; Internal flows, Concepts about Hydrodynamic and thermal entry lengths, division of internal flows based on this, use of empirical correlations for horizontal pipe flow and annulus flow; free convection: Development of hydrodynamic and thermal boundary layer along a vertical plate, use of empirical relations for vertical plates and pipes.	
UNIT-IV	**HEAT TRANSFER WITH PHASE CHANGE**
Boiling: Pool boiling- regimes Calculations on Nucleate boiling, Critical heat flux, Film boiling; Condensation: Film wise and drop wise condensation, Nusselt's theory of condensation on a vertical plate Film condensation on vertical and horizontal cylinders using empirical correlations; Radiation heat transfer: Emission characteristics, laws of black-body radiation, Irradiation, total and Monochromatic quantities, laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, heat exchange between two black bodies, concepts of shape factor, emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks.	
UNIT-V	**HEAT EXCHANGERS**
Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU methods.	

Text Books:
1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012. 2. R. C. Sachdeva, "Fundamentals of Engineering, Heat and Mass Transfer", New Age, New Delhi, India, 3rd Edition, 2012.
Reference Books:
1. Holman, ―Heat Transfer‖, Tata McGraw-Hill education, 10th Edition, 2011. 2. P. S. Ghoshdastidar, ―Heat Transfer‖, Oxford University Press, 2nd Edition, 2012. 3. D. S. Kumar, ―Heat and Mass Transfer‖, S.K. Kataria & sons, 9th Edition 2015.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Modes and mechanisms of heat transfer, Basic laws of heat transfer	CLO 1	T1 1-1
3	Applications of heat transfer	CLO 2	R5
4-6	Fourier Equation, General heat conduction equations in Cartesian, Cylindrical and Spherical coordinates.	CLO 1	T1 2-2
7-8	Simplification and forms of the field equation, steady and unsteady and periodic heat transfer.	CLO 2	R5
9-10	Transient heat transfer, Initial and boundary conditions	CLO3	T1 -5
11	One dimensional steady state heat conduction heat transfer Homogeneous slabs, hollow cylinders and spheres.	CLO 4	T1-5
12-13	Overall heat transfer coefficient, Electrical analogy,	CLO 5	T1-3.2
14	One dimensional steady state heat conduction heat transfer: systems with variable thermal conductivity and Systems with internal heat generation.	CLO 6	T1 3.5
15-17	Extended surfaces (Fins), Long, Short and insulated tips.	CLO 7	T1 5.3
18-20	Problems on Long, Short and insulated tips Fins	CLO 7	R5,T3
21-22	Systems with negligible internal resistance, of different geometries.	CLO 6	T2
23	Significance of Biot and Fourier umbers,	CLO6	T1 4.1
24	Chart solutions of transient conduction systems.	CLO 6	T1 4.2
25-26	Classification of systems based on causation flow ,condition of flow, configuration of flow and medium flow	CLO 10	T1 4.3
27 -28	Dimensional analysis as a tool for experimental investigation-Buckingham pi theorem Dimensional analysis-Application for developing non-dimensional correlation for convective heat transfer.	CLO 8	R6 T1 6.1
29-30	Concepts of Continuity, Momentum and Energy Equations.	CLO 9	T1 8.2
31-32	External Flows Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates.	CLO 11	T1 8.2
33	Problems on Forced Convection	CLO 10	T1 7.1,7.2
34	Development of Hydrodynamic and thermal boundary layer along a vertical	CLO 11	R6, T1 7.1,7.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
35	Use of empirical relations for Vertical plates and pipes.	CLO 12	T 1 9.1,9.2,9.3
36	Regimes of Pool boiling and Flow boiling, Critical heat flux, Calculations on Nucleate Boiling	CLO 13	T1 9.4
37	Critical heat flux and film boiling	CLO 14	T1 10.1,10.2
38	Condensation, Film wise and drop wise condensation, Nusselt‟s theory of condensation on a vertical plate.	CLO 15	T1 10.3 R1
39-40	Film condensation on vertical and horizontal cylinders using empirical correlations	CLO 16	R4 T1 10.4
41	Emission characteristics	CLO 17	R4 T1 10.5,10.6
42	Black-body radiation, Irradiation, Total and monochromatic quantities, Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann.	CLO 17	T1 11.2,11.3
43	Heat exchange between grey bodies.	CLO 16	T1 11.4
44	concepts of shape factor,	CLO 16	T1 12.2
45	Comparison of thermal and non -thermal processes	CLO 17	T1 12.3
46	Radiation shields, electrical analogy for radiation networks.	CLO 17	T1 12.5
47-48	Classification of heat exchangers	CLO 18	T1 13.1,13.2
49-50	overall heat transfer Coefficient and fouling factor	CLO 19	T1 13.3
51-53	Concepts of LMTD and NTU methods	CLO 20	T1-13.4,13.5
54-56	Problems using LMTD and NTU methods	CLO 20	T13.6,R5 R6

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To understand the industrial and practical applications	GUEST LECTURE/ SEMIAR	PO1, PO2, PO4	PSO2
2	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:

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MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	SOLAR ENERGY SYSTEMS				
Course Code	AME525				
Programme	B.Tech				
Semester	VI	ME			
Course Type	Professional Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. M. Sunil Kumar, Assistant Professor				
Course Faculty	Mr. M. Sunil Kumar, Assistant Professor				

I. COURSE OVERVIEW:

This course will helps the students to develop an understanding of the physical and technological principles of photovoltaic energy systems. It will address the solar energy resource, and assessment and measurement techniques for the available insolation. The components in a PV system, with a particular focus on the module will be central topic.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME013	V	Thermal Engineering	3
UG	AAE018	III	Basic Electrical and Electronic Engineering	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Solar Energy Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✔	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering Knowledge**:Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Assignments
PO 2	**Problem Analysis:**An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminars
PO 4	**Design/ Development of solutions:**Competence to design a system, component or process to meet societal needs within realistic constraints.	1	Guest Lectures
PO 6	**Modern tool usage:**An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	2	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Lecture, Assignments.
PSO 2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the concept related various laws in solarengineering
II	Outline the basic idea of solar energy collecting as well as energy storagedevices.
III	Development of solar cells and photo voltaiccells.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS010.01	CLO 1	Understand types and applications of various form of energy sources and its environmental impacts.	PO 1	3
AHS010.02	CLO 2	Construct a practical knowledge on various devices of solar PV systems and trying with an assortment of parameters.	PO 1	3
AHS010.03	CLO 3	Generate perception on practice usages of solar PV gadgets/ industrial utilities	PO 1	3
AHS010.04	CLO 4	Explain the various characteristics of the solar cell under local climatic working conditions	PO 2	2
AHS010.05	CLO 5	Visualize the performance of the Solar PV cell under various specified operating temperature ranges and will be able to relate it with nominal values.	PO 2	2
AHS010.06	CLO 6	Explain to clarify impression of various solar thermal energy collectors.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS010.07	CLO 7	Summarize the basic economics of solar energy collection system.	PO 4	1
AHS010.08	CLO 8	Delineate the other applications and the devices used to collect solar energy.	PO 4	1
AHS010.09	CLO 9	Explain the performance of the solar PV cell under various specified operating temperature ranges and will be able to relate it with nominal values.	PO 2	2
AHS010.10	CLO 10	Understand the concept and the diverse materials used for solar devices	PO 2	2
AHS010.11	CLO 11	Explicate in depth knowledge of about solar cells, thermal energy storage and electrical energy storages	PO 1	3
AHS010.12	CLO 12	Learn the fundamental concepts about solar energy systems and devices	PO 1	3
AHS010.13	CLO 13	Study about approaches for the storage of solar energy along with solar energy collectors	PO 1	3
AHS010.14	CLO 14	Explain the fundamental concepts of solar energy power generating systems and devices	PO 1, PO 2	3
AHS010.15	CLO 15	Analyze various types of energy storage devices and perform the selection based on techno-economic view point.	PO 2	2
AHS010.16	CLO 16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4		2													
CLO 5		2													
CLO 6		2													
CLO 7				1											
CLO 8				1											
CLO 9		2											1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 13	3														
CLO 14	3	2											1		
CLO 15		2													
CLO 16		2													
CLO 17	3	2											1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2 PO 4, PO 6	SEE Exams	PO 1, PO 2 PO 4, PO 6	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	INTRODUCTION TO SOLAR ENERGY
Basics of solar energy, brief history of solar energy utilization, various approaches of utilizing solar energy, blackbody radiation, relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, maximum spectral density; Planck's formula in wavelength unit, Wiendisplacement law, Stefan-Boltzmann law; Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black body formula.	
UNIT-II	**ORIGIN OF SOLAR ENERGY,TRACKING SUNLIGHT AND ATMOSPHERIC INTERACTION**
Basic parameters of the sun, measurement of the solar constant, the structure of the Sun, the origin of solar energy, rotation and orbital motion of the earth around the sun; solar time, sidereal time, universal standardtime,localstandardtime,equationoftime,intensityofsunlightonanarbitrarysurfaceatanytime, interaction with the atmosphere, absorption of the molecules, air mass, rayleigh scattering, direct and scatteredsunlight.	
UNIT-III	**SOLAR CELLS, PHOTOVOLTAIC BASICS**
Formation of a p-n junction, space charge and internal field, quasi Fermi levels, the Shockley diode equation, structure of a solar cell , the solar cell equation, fill factor and maximum power, various electron hole pair recombination mechanisms, crystalline silicon solar cells; Thin film solar cells: CIGS, cite and a silicon Tandem solar cells, dye sensitized solar cells, organic solarcells. Structure and working of Solar Cells, types, electrical properties and behavior of Solar cells, cell properties and design, PV cell interconnection and module fabrication, PV modules and arrays, basics of load estimation.	

UNIT-IV	SOLAR ENERGY
Solar radiation at the earth's surface, solar radiation measurements, estimation of average solar radiation, solar thermal flat plate collectors , concentrating collectors, solar thermal application, heating, cooling, desalination, drying, cooking etc, solar thermal electric power plant , principle of photovoltaic conversion of solar energy, types of solar cells; photovoltaic applications: battery charger, domestic lighting, streetlighting, water pumping etc, solar PV power plant, net metering concept.	
UNIT-V	**CONCENTRATION OF SOLAR ENERGY, ENERGY STORAGE**
Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on axis tracking, solar thermal electricity using stirling engine or ranking engine, solar photovoltaic's with concentration; necessity of storage for solar energy, chemical energy storage, thermal energy storage, thermal flywheels, compressed air, rechargeable batteries**.**	
Text Books:	
1. V Duffie, J.A., Beckman, W.A., "Solar Energy Thermal Process", John Wiley and Sons,2007. 2. Jui Sheng Hsieh, "Solar Energy Engineering", Prentice-Hall, 1st Edition,2007. 3. M. Stix, "The Sun, An Introduction", Springer, 2nd Edition,2002. 4. G. D. Rai, "Solar Energy Utilization", Khanna Publishers, 1st Edition,2010. 5. B. G. Streetman, S.Banerjee, " Solid state Electronic Devices", Prentice Hall, 6th Edition,2006. 6. S. P. Sukhatme, "Solar Energy", Tata McGraw-Hill, 1st Edition,1984.	
Reference Books:	
1. C S Solanki, "Solar Photovoltaics–Fundamentals, Technologies and Applications", PHI LearningPvt. Ltd., 2011. 2. Solar Energy International, "Photovoltaics: Design and Installation Manual", Solar Energy International, 1st Edition,2010.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Understand the Basics of solar energy, brief history of solar energy utilization, various approaches of utilizing solar energy.	CLO 1	T1:1.5 R1:2.3
2	Illustrate Black body radiation, relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit,	CLO 2	T1:1.6 R1:2.4
3	Demonstrate Maximum spectral density; Planck's formula in wavelength unit, Wien displacement law, Stefan-Boltzmann law.	CLO 2	T1:1.6 R1:2.6
4-5	Explain photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black body formula.	CLO 4	T1:1.7 R1:4.4
6-7	Summarize origin of solar energy, tracking of sunlight and atmospheric interaction.	CLO 4	T1:1.7.5 R1:4.10
8-9	Explain basic parameters of the sun, measurement of the solar constant.	CLO 7	T1:1.8 R1:4.15
10	Illustrate structure of the sun, the origin of solar energy, rotation and orbital motion of the earth around the sun.	CLO 9	T1:1.9 R1:5.4
11	Define solar time, side real time, universal standardtime,localstandardtime,equationoftime,	CLO 9	T1:2.0 R1:5.8
12-13	Explain intensityofsunlightonanarbitrarysurfaceatany time, interaction with the atmosphere,	CLO 11	T1:2.1 R1:5.8
14	Demonstrate absorption of the molecules, air mass, Rayleigh	CLO 11	T1:2.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	scattering, direct and scattered sunlight.		R1:6.13
15-16	Define solar cells, photovoltaic basics formation of a p-n junction, space charge and internal field, quasi Fermi levels, the Shockley diode equation, structure of a solar cell.	CLO 13	T1:2.4 R1:7
17	Explain fill factor and maximum power, various electron hole pair recombination mechanisms.	CLO 11	T1:4.10 R1:7.5
18	Demonstrate crystalline silicon solar cells; Thin film solar cells: CIGS, cite and a silicon Tandem solar cells.	CLO 9	T1:4.11 R1:8.1
19	Explain dye sensitized solar cells, organic solarcells.	CLO 10	T1:8.1
20	Illustrate structure and working of Solar Cells, types,	CLO 10	T1:8.1
21	Explain electrical properties and behavior of Solar cells, cell properties and design, PV cell interconnection and module fabrication.	CLO 10	T1:7.1 R1:7.9
22-23	Explain photo voltaic modules and arrays, basics of load estimation.	CLO 11	T1:8.1 R1:9.10
24-25	Summarize solar radiation at the earth's surface, solar radiation measurements, estimation of average solar radiation	CLO 12	T2:7.5 R1:10.2
26	Explain solar thermal flat plate collectors, concentrating collectors, solar thermal application.	CLO 11	T2:6.7 R1:11.3
27	Demonstrate the process of heating, cooling, desalination, drying, cooking etc.	CLO 12	T2:2.8 R1:11.6
28-30	Explain solar thermal electric power plant, principle of photovoltaic conversion of solar energy, types of solar cells.	CLO 11	T2:6.12 R1:11.7
31-32	Demonstrate types of solar cells; photovoltaic applications.	CLO 12	T2:6.12 R1:11.8
33-34	Explain battery charger, domestic lighting, streetlighting, water pumping etc, solar PV power plant, net metering concepts.	CLO 15	T2:6.12 R1:11.9
35-36	Illustrate concentration of solar energy, energy storage	CLO 14	T2:6.12 R1:11.10
37-38	Explain three types of imaging optics: trough or linear collectors.	CLO 15	T2:6.14 R1:12.3
39	Explain solar thermal electricity using stirling engine	CLO 14	T2:6.1 R1:12.7
40-41	Explain Rankine engine, solar photovoltaic's with concentration.	CLO 15	T2:6.17 R1:12.15
42	Explain Rankine engine, solar photovoltaic's with concentration.	CLO 14	T2:6.18 R1:12.19
43-44	Understand necessity of storage for solar energy	CLO 15	T2:7.19 R2:7.4
45	Understand necessity of storage for solar energy	CLO 14	T2:7.19 R2:7.5
46	Understand necessity of storage for solar energy	CLO 15	T2:7.19 R2:7.5
47	Explain chemical energy storage	CLO 14	T2:7.19 R2:7.5
48	Explain thermal energy storage.	CLO 15	T2:6.18 R1:12.19
49	Explain thermal flywheels, compressed air.	CLO 14	T2:7.19 R2:7.4
50	Summarize of rechargeable batteries**.**	CLO 15	T2:7.19 R2:7.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with PO's	Relevance with PSO's
1	Design and development of solar Photovoltaic panels	Seminars	PO 1, PO 4	PSO 1
2	Summarize the estimation of solar radiation	Seminars/ NPTEL	PO 4	PSO 1
3	Development of storage batteries.	NPTEL	PO 2, PO 6	PSO 1

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**NON DESTRUCTIVE TESTING**				
Course Code	AME526				
Programme	B.Tech				
Semester	VI	ME			
Course Type	Professional Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. A. Venuprasad, Assistant Professor				
Course Faculty	Mr. A. Venuprasad, Assistant Professor Mr. A. Anudeep Kumar, Assistant Professor				

I. COURSE OVERVIEW:

Understand the basic principles of various NDT methods, fundamentals, discontinuities in different product forms, importance of NDT, applications, limitations of NDT methods and techniques and codes, standards and specifications related to non-destructive testing technology. To impart knowledge of advanced NDE Techniques-I and advanced NDE Techniques-II. Overview the concepts, principles, and methods employed for NDT of structures and materials.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied Physics	3
UG	AME005	III	Metallurgy and Material Science	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Non Destructive Testing	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✔	Videos
✘	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). 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 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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

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. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Presentation on real-world problems
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
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
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 limitation.	2	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Seminar
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Apply the techniques of surface non destructive techniques testing methods.
II	Apply of ultrasonic, radiographic techniques.
III	Understand advanced NDT technique.
IV	Understand the relevant non-destructive testing methods for various engineering practice.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME526.01	CLO 1	Understand the visual examination techniques in direct and indirect methods for NDT.	PO 1	3
AME526.02	CLO 2	Remember the various equipment available for the visual inspection and the codes and standards for non-destructive testing.	PO 1, PO 3	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME526.03	CLO 3	Apply the liquid penetrant test that can be used for effective identification of surface cracks in metals. .	PO 1, PO 4	2
AME526.04	CLO 4	Apply the codes and standards applicable for the liquid penetrant testing in the classification of NDT	PO 1, PO 4, PO 5	3
AME526.05	CLO 5	Understand the principle of magnetic particle testing and the advantages and limitations of the magnetic particle testing equipment and process.	PO 1, PO 3	2
AME526.06	CLO 6	Understand the principle of ultrasonic testing and identify the suitable methods for conducting non-destructive testing using the ultrasonic testing equipment.	PO 1, PO 3, PO 4	3
AME526.07	CLO 7	Evaluate the interpretation procedures for NDT by ultrasonic testing along with its applications.	PO 1	2
AME526.08	CLO 8	Understand transmission and pulse-echo methods of ultrasonic testing.	PO 1	2
AME526.09	CLO 9	Evaluate and apply ultrasonic testing and acoustic emission testing and for various particle applications.	PO 1, PO 3	3
AME526.10	CLO 10	Understand the working principle, advantages, limitations and applications of X-ray film in radiography testing.	PO 1	2
AME526.11	CLO 11	Remember X-ray films used in industrial radiography and describe the stage of development of X-ray films in radiography testing.	PO 3	3
AME526.12	CLO 12	Apply the knowledge of radiographic testing method for the NDT of metals for knowing the defects internally present in the metals.	PO 1	3
AME526.13	CLO 13	Remember the variables and the radiographic image quality improving techniques along with the safety norms to be considered for radiation effects	PO 1, PO 5	3
AME526.14	CLO 14	Understand various process during interaction of X-ray with matter. .	PO 1	2
AME526.15	CLO 15	Understand the working principle, advantages, limitations and applications of various advanced radiography techniques viz fluoroscopy testing, xerography, computed tomography.	PO 1, PO 3,	3
AME526.16	CLO 16	Understand the principle of phase array and its technique utilized for the NDT of materials along with the equipment for phase array.	PO 1,PO 5	2
AME526.17	CLO 17	Remember the verification for flow existence and position for reporting and applications of the phase array	PO 1, PO 4, PO 5	2
AME526.18	CLO 18	Understand the techniques and interpretation of radiography in the field of phase array techniques and various applications of the process.	PO 1	2
AME526.19	CLO 19	Remember the special radiographic techniques and the various advantages and limitations of the processes.	PO 1	1
AME526.20	CLO 20	Understand the acoustic emission inspection method principle and understand its various applications.	PO 1, PO 3, PO 4	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1	2	
CLO 2	3		3											2	
CLO 3	2			2									1	2	
CLO 4	3			3	3								1	2	
CLO 5	2		2										1	2	
CLO 6	3		3	3										2	1
CLO 7	2												1	2	
CLO 8	2													2	
CLO 9	3		3											2	1
CLO 10	2												1		
CLO 11			3											2	
CLO 12	3												1	2	
CLO 13	3				2								1	2	
CLO 14	2												1		1
CLO 15	3		3										1	2	
CLO 16	2				2									2	1
CLO 17	2			2	2								1		
CLO 18	2													2	
CLO 19	1													2	
CLO 20	3		3	3									1	2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1 PO 3 PO 4 PO 5	SEE Exams	PO 1 PO 3 PO 4 PO 5	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	-	Student Viva	PO 1	Mini Project	PO 1	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**SURFACE NDE METHODS**
Visual examination, direct and indirect methods, equipment, codes and standards, liquid penetrant testing, variables, interpretation and evaluation of test results, applicable codes and standards, magnetic particle testing, principle, equipment, advantages and limitations.	
UNIT-II	**ULTRASONIC TESTING**
Principle of ultrasonic testing, methods, equipment, evaluation, interpretation, applications.	
UNIT-III	**RADIOGRAPHIC TESTING**
Principles, films, radiography equipment, variables, radiographic image quality, techniques, safety.	
UNIT-IV	**ADVANCED NDE TECHNIQUES-I**
Principle of phase array, technique, equipment, verification of flow existence and position, reporting, application, special radiographic techniques and interpretation of radiography, advantages and limitations.	
UNIT-V	**ADVANCED NDE TECHNIQUES-II**
Acoustic, emission inspection, principles and applications, leak testing, principles and applications, industrial computed tomography principles and applications.	
Text Books:	
1. J. Prasad, C.G.K Nair, ―Non-destructive Test and Evaluation of materials‖, Tata McGraw-Hill, 2nd Edition, 2011. 2. J. Krautkramer, H. Krautkramer, ―Ultrasonic Testing of material‖, Springer, 4th Edition, 1990	
Reference Books:	
1. B. Raj, T. Jayakumar, M. Thavasinumuthu, ―Practical Non-destructive Testing‖, Alpha science International Limited, 3rd Edition, 2002. 2. R. Halshaw, ―Industrial Radigraphy: Theory and Practice‖, Springer, 2nd Edition, 1995. 3. ASM, ―Non–destructive examination and quality control‖, ASM International, volume17, 9th Edition, 1989.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Outline of various units	CLO 1	T1:1.4, R1:1.2
2-5	Explain the Visual examination, direct and indirect methods	CLO 1	T1:1.5, R1:2.4
6-7	Explain equipment, codes and standards	CLO 1	T1:2.5, R1:2.5
8-10	Explain liquid penetrant testing, variables, interpretation.	CLO 1	T1:2.5, R1:2.6
11-12	Discuss evaluation of LT test results, applicable codes and standards	CLO 4	T1:2.7

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
13-14	Explain magnetic particle testing principle.	CLO 6	T1:3.1, R1:5.3
15-17	Discuss magnetic particle equipment, advantages and limitations	CLO 7	T1:3.2, R1:5.3.6
18-21	Explain principle of ultrasonic testing and methods	CLO 7	T1:7.1, R1:6.3
22-24	Discuss Equipment, evaluation, interpretation and applications.	CLO 7	T1:7.3, R1:6.3
25-27	Explain principles, films, radiography equipment.	CLO 7	T1:8.1, R1:6.8
28	Discuss radiographic image quality.	CLO 7	T1:8.2, R1:13.1
29-30	Discuss techniques and safety of radiographic testing.	CLO 9	T1:8.3, R1:13.2
31-32	Explain Principle of phase array.	CLO 10	T1:9.1, R1:13.7
33-36	Discuss technique, equipment, verification of flow existence and position.	CLO 11	T1:9.2, R1:10.2
37-39	Discuss the reporting, application and special radiographic techniques.	CLO 12	T1:9.3, R1:10.3
40-42	Discuss the interpretation of radiography, advantages and limitations.	CLO 12	T1:9.4, R1:11.9
43-45	Discuss the Advanced NDE techniques.	CLO 12	T1:11.1, R1:11.5
46-48	Explain the acoustic emission inspection principles and applications	CLO 12	T1:11.2
49-52	Discuss the leak testing, principles and applications	CLO 18	T1:11.3, R1:17.2
53-56	Explain the Industrial computed tomography principles	CLO 19	T1:11.4, R1:17.4
56-58	Discuss the industrial computed tomography applications.	CLO 20	T1:11.6 R1:18.5
59-60	Compare the advanced NDE techniques I and advanced NDE techniques II.	CLO 21	T1:8.1, T1:8.2

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars/ Guest Lecture	PO 1, PO 4	PSO 1
2	Encourage students to learn advanced NDE techniques.	Seminars / NPTEL	PO 4, PO3	PSO 2
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 5	PSO 3

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