INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal- 500 043, Hyderabad, Telangana

APPLIED PHYSICS
COURSE TEMPLATE

1	Department	**CSE-CYBER SECURITY**				
2	Course Title	**Applied Physics**				
3	Course Code	AHSD07				
4	Class / Semester	I / I				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	-	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		-	-	-	-	-
8	Course Offered	Odd Semester ✓		Even Semester ×		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 64		Tutorials: Nil		Practical: Nil	
10	Course Coordinator	Dr. Rizwana				
11	Date Approved by BOS	24 August 2023				
12	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD07.pdf				
13	Course Prerequistes	**Level UG/PG**	**Course Code**	**Course Title**	**Semester**	
		Intermediate	-	-	-	

14. Course Overview

The aim of this course is to promote understanding of fundamental knowledge in physics needed for the future technological advances. The concepts covered are in the fields of solid state physics, modern physics, superconductors and nanoscience. This knowledge helps to develop the ability to apply the principles in many advanced technological sectors such as nanotechnology, optical fiber communication, quantum technology etc.

15. Course Objectives:

The students will try to learn:

I	Fundamental concepts needed to explain a crystal structure in terms of atom positions, unit cells, and crystal symmetry.
II	Basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description.
III	The metrics of optoelectronic components, lasers, optical fiber communication and be able to incorporate them into systems for optimal performance.
IV	The appropriate magnetic, superconducting and nanomaterials required for various engineering applications.

16. Course Outcomes:

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

S.No	Course outcome description
CO 1	Use the general rules of indexing of directions and planes in lattices to identify the crystal systems and the Bravais lattices.
CO 2	Extend the principles of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.
CO 3	Analyze the concepts of laser with normal light in terms of mechanism for applications in different fields and scientific practices.
CO 4	Comprehend the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.
CO 5	Gain knowledge on properties of magnetic and superconducting materials suitable for engineering applications.
CO 6	Formulate the principle factors, fabrication, characterization techniques and the applications of nanomaterials.

17. Mapping of topic learning outcomes (TLO) to course outcomes

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
1	Space lattice, Basis, unit cell, lattice parameters	TLO 1	Recollect the basic properties of crystallography and crystal structures.	CO 1	Remember
2	Crystal systems	TLO 2	Classify various crystal systems in terms of unit cell dimensions and crystallographic axes.	CO1	Understand
3	Bravais lattices	TLO 3	Draw the Bravais lattice structures formed in seven crystal systems.	CO1	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
4	Simple cubic, Body centered cubic, Face centered cubic structures	TLO 4	Explain different crystal structures and determine their packing fractions.	CO1	Understand
5	Planes in a crystal	TLO 5	Identify different planes that can be formed in the crystal structure.	CO1	Apply
6	Interplanar distance	TLO 6	Determine the expression for interplanar spacing in orthogonal crystal system.	CO1	Apply
7	Waves and particles	TLO 7	Explainthe concept of dual nature of matter and light radiation.	CO2	Understand
8	de broglie hypothesis, Matter waves	TLO 8	Extend the debroglie hypothesis to the concept of matter waves.	CO2	Understand
9	Davisson and Germers experiment	TLO 9	Describe how Davisson and Germer experiment explained the existence of matter waves.	CO2	Understand
10	Schrodinger time independent wave equation	TLO 10	Discuss the Schrodinger time independent wave equation associated with matter waves.	CO2	Understand
11	Physical significance of wave function	TLO 11	Analyze the physical significance of wave function associated with matter waves.	CO2	Apply
12	Infinite square well potential	TLO 12	Apply Schrödinger's wave equation for energy values of a free particle confined in one dimensional potential square well.	CO2	Apply
13	Characteristics of lasers	TLO 14	Discuss the basic concepts of laser light sources.	CO3	Understand
14	Spontaneousand stimulated emission of radiation	TLO 15	Obtain the relation between Einstein coefficients associated with absorption, spontaneous emission and stimulated emission.	CO3	Apply
15	Lasing action	TLO 16	Explain the concepts involvedin producing lasing action.	CO3	Understand
16	Ruby and He-Ne lasers	TLO 17	Describe in detail the principle and working of Ruby and He-Ne lasers.	CO3	Understand
17	Applications of lasers	TLO 18	Identify the engineering applications of lasers in different fields.	CO3	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
18	Principle and construction of an optical fiber	TLO 19	Illustrate the principle and construction of optical fibersused in communication system.	CO 4	Understand
19	Acceptance angle, Numerical Aperture	TLO 20	Derive the expressions for the acceptance angle and numerical aperture of an optical fiber.	CO 4	Understand
20	Types of optical fibers, Single mode, multimode, step index, graded index	TLO 21	Discuss different types of optical fibers based on refractive index profile and modes of propagation.	CO 4	Understand
21	Optical fiber communication system	TLO 22	Elucidate the block diagram of fiber optic communication system.	CO 4	Apply
22	Applications of optical fibers	TLO 23	Enlist the applications of optical fibers.	CO4	Remember
23	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility,	TLO 24	Acquire knowledge of basic terms related to magnetic materials.	CO 5	Understand
24	Origin of magnetic moment, Bohr magneton	TLO 25	Describe magnetic moment in an atom in termsof Bohr magneton.	CO 5	Understand
25	Classification of dia, para and ferro magnetic materials on the basis of magnetic moment	TLO 26	Classify different magnetic materials based on electron theory.	CO 5	Understand
26	Hysteresis curve	TLO 27	Examine the spontaneous magnetization in ferromagnets based on orientation of domains.	CO 5	Understand
27	Superconductivity, general properties	TLO 28	Recall he definition of superconductivity based on resistance.	CO 5	Remember
28	Meissner effect	TLO 30	Explain the Meissner effect related to superconductors.	CO 5	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
29	Effect of magnetic field	TLO 31	Analyze the effect of magnetic field on superconductors.	CO 5	Apply
31	BCS theory	TLO 33	Elucidate the concept of flux quantization and BCS theory.	CO 5	Apply
32	Applications of superconductors	TLO 34	Discuss the applications of superconductors.	CO 5	Understand
33	Nanoscale	TLO 35	Recall the definition of nano scale and nanotechnology.	CO 6	Remember
34	Quantum confinement	TLO 36	Explain the quantum confinement factor of nanomaterials.	CO 6	Understand
35	Surface to volume ratio	TLO 37	How the surface to volume ratio changes when particle size is reduced to nano scale.	CO 6	Understand
36	Bottom-up fabrication: sol-gel, precipitation, combustion methods, top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition	TLO 38	Discuss different methods of preparation of nanomaterialssuch as sol-gel, precipitation, and combustion, ball milling, physical vapor deposition and chemical vapor deposition.	CO 6	Understand
37	Characterization techniques: x-ray diffraction, transmission electron microscopy	TLO 39	Acquire the knowledge of different characterization techniques such as X-ray diffraction, Scanning Electron Microscopy and Transmission Electron Microscopy.	CO 6	Understand
38	Applications of nanomaterials	TLO 40	Discuss the applications of nanomaterialsin different engineering fields.	CO 6	Understand

18. Employability Skills

Project based skills: Applied physics for engineering students develop experimental skills, mathematical and problem solving abilities, required to carry out research and development in a large number of specialties.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.
Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given from first two modules. Each question carries 12 marks. There could be a maximum of two sub divisions in a question.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

21. Course content - Number of modules: Five

MODULE I	**CRYSTAL STRUCTURES**	**Number of Lectures: 12**
	Introduction, space lattice, basis, unit cell, lattice parameter, Bravais lattices, crystal systems, structure and packing fractions of simple cubic, body centered cubic, face centered cubic crystals, directions and planes in crystals, Miller indices, separation between successive [h k l] planes.	
MODULE II	**QUANTUM PHYSICS**	**Number of Lectures: 12**
	Waves and particles, de Broglie hypothesis, matter Waves, Davisson and Germer's experiment, Heisenberg's uncertainty principle, Schrödinger's time independent wave equation, physical significance of the wave function, infinite square well potential.	

MODULE III	**LASERS AND FIBER OPTICS** |**Number of Lectures: 15**
	Characteristics of lasers, spontaneous and stimulated emission of radiation, population inversion, lasing action, Ruby laser, He-Ne laser and applications of lasers. **P**rinciple and construction of an optical fiber, acceptance angle, numerical aperture, types of optical fibers (Single mode, multimode, step index, graded index), optical fiber communication system with block diagram and applications of optical fibers.
MODULE IV	MAGNETIC AND SUPERCONDUCTING PROPERTIES | Number of Lectures: 12
	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility, origin of magnetic moment, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment. Superconductivity, general properties, Meissner effect, effect of magnetic field, type-I & type-II superconductors, BCS theory, applications of superconductors.
MODULE V	NANOTECHNOLOGY | Number of Lectures: 13
	Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods, top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition, characterization techniques: x-ray diffraction, transmission emission microscopy, applications of nanomaterials.

TEXTBOOKS

1. Arthur Beiser, Shobhit Mahajan and Rai Choudhary, *Concepts of Modern Physics,* , Tata McGraw Hill, 7th Edition, 2017.

REFERENCE BOOKS:

1. H J Callister, *A Textbook of Materials Science and Engineering,* , Wiley Eastern Edition, 8th Edition, 2013.
2. Halliday, Resnick and Walker, *Fundamentals of Physics,* , John Wiley Sons,11th Edition, 2018.
3. Charles Kittel, *Introduction to Solid State Physics,* , Wiley Eastern, 2019.
4. S.L. Gupta and V. Kumar, *Elementary Solid State Physics,* ,Pragathi Prakashan, 2019.
5. K K Chattopadhyay and A N Banerjee, *Introduction to Nanoscience and Nanotechnology,* , Prentice Hall India, 2nd Edition, 2011.

Electronic Resources:

1. NPTEL :: Physics - NOC:Quantum Mechanics I
2. NPTEL :: Physics - NOC:Introduction to Solid State Physics
3. NPTEL :: Physics - NOC:Solid State Physics
4. https://nptel.ac.in/courses/104104085
5. NPTEL :: Metallurgy and Material Science - NOC:Nanotechnology, Science and Applications

Material Online:

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I
7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations

22. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	Discussion on OBE		
1	Discussion on Outcome Based Education, CO, POs and PSOs		
	Content Delivery (Theory)		
1	Introduction, space lattice	CO 1	T1; R1
2	Basis, unit cell, lattice parameter	CO 1	T1; R1
3	Crystal systems	CO 1	T1; R1
4	Bravais lattices	CO 1	T1; R1
5	Simple cubic structure	CO 1	T1; R1
6	Body centered cubic structure	CO 1	T1; R1
7	Face centered cubic structure	CO 1	T1; R1
8	Directions and planes in crystals	CO 1	T1; R1
9	Miller indices	CO 1	T1; R1
10	Separation between successive [h k l] planes	CO 1	T1; R1
11	Introduction to Quantum Physics	CO 2	T1; R1, R2
12	Wave-particle duality of radiation	CO 2	T1; R1, R2
13	de broglie hypothesis and de broglie wavelength	CO 2	T1; R1, R2
14	Properties of Matter waves	CO 2	T1; R1, R2
15	Davisson and Germer's experiment	CO 2	T1; R1, R2
16	Schr¨odinger time independent wave equation	CO 2	T1; R1, R2
17	Physical significance of wavefunction	CO 2	T1; R1, R2
18	Particle in a one-dimensional potential box	CO 2	T1; R1, R2
19	Characteristics of laser, Spontaneous and Stimulated emis sion	CO 3	T1; R3, R4
20	Metastable state, Population inversion, Lasing action	CO 3	T1; R3, R4
21	Ruby laser	CO 3	T1; R3, R4

S.No	Topics to be covered	CO's	Reference
22	He-Ne laser, Applications of LASER	CO 3	T1; R3, R4
23	Principle and construction of optical fibers	CO 4	T1; R3, R4
24	Acceptance angle, Acceptance cone, Numerical Aperture	CO 4	T1; R3, R4
25	Types of optical fibers	CO 4	T1; R3, R4
26	Optical fiber communication system, Applications of optical fibers	CO 4	T1; R1, R2
27	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility	CO 5	T1; R1
28	origin of magnetic moment, Bohr magneton	CO 5	T1; R1
29	Diamagnetic and Paramagnetic materials	CO 5	T1; R1
30	Ferromagnetic materials	CO 5	T1; R1
31	Hysteresis curve	CO 5	T1; R1
32	Superconductivity, general properties	CO 5	T1; R1
33	Meissner effect, effect of magnetic field	CO 5	T1; R1
34	type-I & type-II superconductors	CO 5	T1; R1
35	BCS theory	CO 5	T1; R1
36	applications of superconductors	CO 5	T1; R1
37	Nanoscale, quantum confinement, surface to volume ratio	CO 6	T1; R4
38	bottom-up fabrication: sol-gel, precipitation, combustion methods	CO 6	T1; R4
39	top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition	CO 6	T1; R4
40	characterization techniques: x-ray diffraction, transmission electron microscopy, applications of nanomaterials	CO 6	T1; R4
Problem Solving/Case Studies			
1	Packing fraction	CO 1	T1; R1
2	Miller indices	CO 2	T1; R1
3	Interplanar spacing	CO 2	T1; R1
4	de broglie wavelength	CO 2	T1; R1, R2
5	Energies associated with one dimensional potential box	CO 2	T1; R1, R2
6	Wavelength and Energy bandgap, Divergence	CO 3	T1; R3, R4
7	Relative population of two states, Number of photons emitted	CO 3	T1; R3, R4
8	Acceptance angle and Numerical Aperture	CO 4	T1; R1
9	Magnetic moment, Magnetic induction, Permeability	CO 5	T1; R1
10	Intensity of magnetization, Magnetic susceptibility	CO 5	T1; R1
11	Critical temperature	CO 5	T1; R4
12	Critical field	CO 5	T1; R4
13	Surface to volume ration	CO 6	T1; R4
14	Particle size	CO 6	T1; R4
15	Debye Scherrer method	CO 6	T1; R4

S.No	Topics to be covered	CO's	Reference
Definition and Terminology			
1	Crystal structures	CO 1	T1; R1
2	Quantum physics	CO 2	T1; R1, R2
3	Lasers and fiber Optics	CO 3	T1; R3, R4
4	Magnetic and superconducting properties	CO 4	T1; R1
5	Nanotechnology	CO 5	T1; R4
Tutorial Question Bank			
1	Crystal structures	CO 1	T1; R1
2	Quantum physics	CO 2	T1; R1, R2
3	Lasers and fiber Optics	CO 3	T1; R3, R4
4	Magnetic and superconducting Properties	CO 4	T1; R1
5	Nanotechnology	CO 5	T1; R4

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Program Outcomes	
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

24. HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

25. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	-	-
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	-	-
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

27. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Illustrate** the different crystal structures based on arrangement of atoms in a unit cell, calculate their packing fraction and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given **problem statement** and formulate lattice parameters and miller indices of a crystal from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of packing fraction.**	4
CO 2	PO 1	**Outline** drawbacks of classical mechanics, basic principles **dual nature** of matter wave, **derive** mathematical wave equation of matter waves and come to **conclusion** of quantization of energy used in quantum dots.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	PO 2	**Explain** the given **problem statement** and formulate quantum confinement problems related to particle enclosed in small dimension from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of result**s.	4
	PO 4	**Identify** the use of these semiconductors under study and their conduction mechanism for the **research based knowledge** and **technological development**.	2
CO 3	PO 1	**Compare** the concepts of laser and normal light in terms of mechanism and **working principle** for applications in different fields and scientific practices.	3
	PO 2	**Explain** different components involved in **laser system** by using the **basics** of absorption, emission and amplification of light radiation.	4
CO 4	PO 1	**Gather** the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	3
	PO 2	**Explain** functionality of components in optical fiber communication **system** by using the **basics** of signal propagation, attenuation and dispersion.	4
	PO 4	**Identify the given problem** and **formulate** expressions for acceptance angle and numerical aperture with the given **information** and **data** by applying principles of information of propagation through optical waveguides.	2
CO 5	PO 1	**Utilize** spin and orbital motion of electrons in determining **magnetic moment** of materials in terms of Bohr magneton materials having specific **engineering applications**.	3
CO 6	PO 1	**Illustrate** the different principal factors affecting particle size, calculate their surface to volume ratio and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given **problem statement** and formulate fabrication, characterization of nanomaterials provided **information** and **data** in reaching substantial conclusions by the **interpretation of application in different fields.**	4

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

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

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

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

30. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

-	Assessment of mini Projects by Experts	✓	End Semester OBE Feedback

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		Graduates who have specialized in physics provide a unique component of the technical workforce. They are able to attack a wide variety of problems with their problem-solving skills and grasp of the principles of physics,. A well-trained physicist is capable of moving quickly among different technical areas, particularly into areas so new that they have not yet evolved into an engineering discipline.
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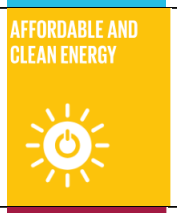
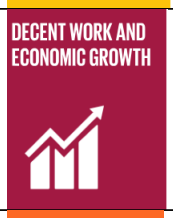
7		
8		
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Approved by: Board of Studies in the meeting conducted on 24 August 2023 .

Signature of Course Coordinator
Dr. Rizwana, Associate Professor

HOD, CSE (CS)

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

OBJECT ORIENTED PROGRAMMING
COURSE TEMPLATE

1	Department	**Computer Science and Engineering (Cyber Security)**				
2	Course code	**ACSD01**				
3	Course Title	**OBJECT ORIENTED PROGRAMMING**				
4	Class / Semester	I / I				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
8	Course Offered	Odd Semester ✓		Even Semester ×		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: 0 hours		Practical: – hours	
10	Course Coordinator	Dr. Bodavula Aslesha				
11	Date Approved by BOS	28/08/2023				
12	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse				
13	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		-	-	-	-	

14. Course Overview

The course provides a solid foundation in object-oriented programming concepts in using them. It includes concepts object-oriented concepts such as information hiding, encapsulation, and polymorphism. It contrasts the use of inheritance and composition as techniques for software reuse. It provides an understanding of object-oriented design using graphical design notations such as Unified Modelling Language (UML) as well as object design patterns.

15. Course Objectives:

The students will try to learn:

I	The fundamental concepts and principles of object-oriented programming in high-level programming languages.
II	Advanced concepts for developing well-structured and efficient programs that involve complex data structures, numerical computations, or domain-specific operations.
III	The design and implementation of features such as inheritance, polymorphism, and encapsulation for tackling complex problems and creating well-organized, modular, and maintainable code.
IV	The usage of input/output interfaces to transmit and receive data to solve real-time computing problems.

16. Course Outcomes:

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

CO 1	**Interpret** the features of object-oriented programming languages, comparison, and evolution of programming languages.
CO 2	**Model** the real-world scenario using class diagrams and exhibit communication between objects.
CO 3	**Estimate** the need for special functions for data initialization.
CO 4	**Outline** the features of object-oriented programming for binding the attributes and behavior of a real-world entity.
CO 5	**Use** the concepts of streams and files that enable data management to enhance programming skills.
CO 6	**Develop** contemporary solutions to software design problems using object-oriented principles.

17. Topic Learning Outcome (TLOs):

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
1	Objects and legacy systems	1	**Summarize** fundamental concepts of programming through a procedural approach.	CO 1	Understand
		2	**Differentiate** between OOP and other programming paradigms such as procedural programming.	CO 1	Understand
2	Object-oriented programming	3	**Gain knowledge** to design and implement software solutions using OOP principles.	CO 1	Remember

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
		4	**Discuss** applications of OOP in software development, graphical user interface development, and mobile application development.	CO 1	Understand
3	Abstraction: Levels of abstraction	5	**Identify** the data components and behaviors of multiple abstract data types.	CO 1	Remember
		6	**Apply** techniques of decomposition to break a program into smaller pieces.	CO 1	Apply
		7	**Implement** a coherent abstract data type with loose coupling between components and behaviors.	CO 6	Apply
4	Classes and objects: Fields, methods, messages	8	**Interpret** knowledge by defining classes and creating instances to represent and interact with real-world entities or concepts.	CO 2	Understand
		9	**Instantiate** objects from classes to understand the relationship between classes and objects.	CO 2	Remember
5	Access specifiers: public, private, protected	10	**Enumerate** access specifiers' visibility and accessibility of class members (variables and methods) within different parts of a program.	CO 2	Remember
6	Class diagrams	11	**Create and interpret** class diagrams to visually represent classes, relationships, and interactions.	CO 2	Apply
7	Encapsulation	12	**Review** the encapsulation principle by specifying who can access and modify class members.	CO 3	Remember
		13	**Implement** encapsulation by using access modifiers (public, private, protected) to control access to class members.	CO 2	Apply
		14	**Use** static fields to keep a count of the number of objects that have been instantiated or to store a value that must be shared among all instances.	CO 6	Apply

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
8	Special member functions: Constructors, destructors	15	**Select** the constructor methods in initializing object attributes when instances are created.	CO 3	Remember
		16	**Illustrate** destructors to manage resources and perform cleanup operations in the classes such as closing files, releasing locks, or cleaning up cached data.	CO 6	Apply
9	Overloading: Functions, operators, constructors	17	**Express** the behavior of operators of a class that enriches programming skills in various ways that are both intuitive and flexible.	CO 3	Understand
		18	**Infer** that data is in a compatible format for specific operations or assignments to avoid unexpected behavior or data loss.	CO 3	Understand
		19	**List** the types of inheritance to facilitate code reuse, organization, and hierarchy for modeling complex systems.	CO 4	Remember
10	Inheritance: Subclasses, and method overriding	20	**Use** subclassing to design class hierarchies that allow code to be reused for distinct subclasses.	CO 4	Apply
		21	**Identify** the type of inheritance to create specialized classes that inherit the properties and behaviors of more general classes.	CO 4	Remember
11	Virtual functions	22	**Demonstrate** code flexibility using virtual functions to work with different types of objects through a common interface.	CO 4	Understand
12	Polymorphism	23	**Review** polymorphism on different derived classes to be treated as objects of their common base class.	CO 4	Remember
		24	**Understand and demonstrate** polymorphic behavior through function overriding and function overloading.	CO 4	Understand

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
13	Streams and files	25	**Illustrate** console input and output to create applications that interact with users, and process data.	CO 5	Understand
		26	**Label** objects to store them in files and deserialize them to recreate objects from files.	CO 5	Remember
		27	**Demonstrate** file-handling operations to enrich programming capabilities to create more sophisticated applications that interact with and manipulate external data sources effectively.	CO 5	Understand
		28	**Use** output with manipulators and predefined manipulatorsfor formatting input and output data.	CO 6	Apply
14	Command line arguments	29	**Interpret** software systems and applications to configure and control via command-line arguments.	CO 5	Understand

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
1. Programming skills - The tech industry evolves rapidly, and staying up-to-date with the latest programming languages, frameworks, and development practices is crucial. Combining OOP skills with a commitment to continuous learning demonstrates a student's dedication to staying relevant in a dynamic field.
2. Project-based skills - Creating projects that utilize OOP principles allows a student to apply theoretical knowledge to real-world scenarios. This hands-on experience helps solidify their understanding of how OOP concepts work in practice.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for each Definitions and Terminology / Quiz, and the remaining 10 marks for Tech Talk / Assignments.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE:

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given in the first two modules. Each question carries 12 marks. There could be a maximum of two sub-divisions in a question.

21. Course content - Number of modules: Five

MODULE I	**Object-oriented concepts.**	**Number of Lectures: 09**
	Objects and legacy systems, procedural versus Object-oriented programming, top-down and bottom-up approaches and their differences, benefits of OOP, applications of OOP, and features of OOP. **Abstraction:** Layers of abstraction, forms of abstraction, abstraction mechanisms.	
MODULE II	**Classes and objects**	**Number of Lectures: 09**
	Classes and objects: Object data, object behaviors, creating objects, attributes, methods, messages, creating class diagrams. **Access specifiers and initialization of class members:** Accessing members and methods, access specifiers - public, private, protected, memory allocation. Static members, static methods.	
MODULE III	**Special member functions and overloading**	**Number of Lectures: 09**
	Constructors and destructors: Need for constructors and destructors, copy constructors, dynamic constructors, parameterized constructors, destructors, constructors and destructors with static members. **Overloading:** Function overloading, constructor overloading, operator overloading - rules for overloading operators, overloading unary and binary operators, friend functions.	

MODULE IV	**Inheritance and polymorphism**	**Number of Lectures: 09**
	Inheritance: types of inheritance, base class, derived class, usage of final, ambiguity in multiple and multipath inheritances, virtual base class, overriding member functions, order of execution of constructors and destructors. **Polymorphism and virtual functions:** Virtual functions, pure virtual functions, abstract classes, introduction to polymorphism, static polymorphism, dynamic polymorphism.	
MODULE V	**Console I/O and working with files**	**Number of Lectures: 09**
	Console I/O: Concept of streams, hierarchy of console stream classes, unformatted I/O operations, managing output with manipulators. **Working with files:** Opening, reading, writing, appending, processing, and closing different types of files, and command line arguments.	

TEXTBOOKS

1. Matt Weisfeld, *The Object-Oriented Thought Process*, Addison Wesley Object Technology Series, 4th Edition, 2013.

REFERENCE BOOKS:

1. Timothy Budd, *Introduction to object-oriented programming*, Addison Wesley Object Technology Series, 3rd Edition, 2002.
2. Gaston C. Hillar, *Learning Object-Oriented Programming*, Packt Publishing, 2015.
3. Kingsley Sage *Concise Guide to Object-Oriented Programming*, Springer International Publishing, 1st Edition, 2019.
4. Rudolf Pecinovsky, *OOP - Learn Object Oriented Thinking and Programming*, Tomas Bruckner, 2013.
5. Grady Booch, *Object-oriented analysis and design with applications*, Addison Wesley Object Technology Series, 3rd Edition, 2007.

MATERIALS ONLINE:

1. https://docs.oracle.com/javase/tutorial/java/concepts/
2. https://www.w3schools.com/cpp/
3. https://www.edx.org/learn/object-oriented-programming
4. https://www.geeksforgeeks.org/introduction-of-object-oriented-programming/

22. Course plan:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
Discussion on Outcome Based Education, CO, POs, and PSOs			
CONTENT DELIVERY (THEORY)			
1	Objects and legacy systems	CO 1	T1, Pg: 05
2	Object-oriented programming	CO 1	T1, Pg: 06
3	Procedural versus object-oriented programming	CO 1	T1, Pg: 07, R4: Pg: 13
4	Top-down and bottom-up approaches and their differences	CO 1	R5: 1.5
5	Benefits and applications of OOP	CO 1	R5: 1.6
6	Features of OOP	CO 1	T1, Pg: 12
7	Abstraction and layers of abstraction	CO 1	R1: 2.1
8	Forms of abstraction	CO 1	R1: 2.2
9	Abstraction mechanisms	CO 1	R1: 2.3
10	Object data, object behaviors, creating objects	CO 2	T1, Pg:12, 13
11	Attributes, methods, messages	CO 2	T1, Pg:19, 20
12	Classes	CO 2	T1, Pg: 17
13	Creating class diagrams with examples	CO 2	T1, Pg: 20
14	Accessing members	CO 2	R5: 3.1
15	Accessing methods	CO 2	R5: 3.2
16	Access specifiers - public, private, protected with examples	CO 2	T1, Pg: 188
17	Memory allocation	CO 2	T1, Pg: 90
18	Static members, static methods	CO 2	T1, Pg: 90
19	Constructors need constructors and destructors	CO 3	T1, Pg: 71
20	Copy constructors with examples	CO 3	R1: 15.1
21	Dynamic constructors with examples	CO 3	R1: 15.3
22	Parameterized constructors and destructors	CO 3	R1: 15.3.1
23	Constructors and destructors with static members	CO 3	R1: 15.3.2
24	Function overloading, constructor overloading	CO 3	R1: 15.3.2
25	Operator overloading - rules for overloading operators	CO 3	R1: 15.3.2
26	Overloading unary and binary operators	CO 3	R1: 15.3.2
27	Friend functions	CO 3	R1: 15.3.2
28	Inheritance and types of inheritance	CO 4	T1, Pg: 153
29	Base class, derived class, usage of final	CO 4	T1, Pg: 45
30	Ambiguity in multiple and multipath inheritance	CO 45	T1, Pg: 136

S.No	Topics to be covered	CO's	Reference
31	Virtual base class, overriding member functions	CO 4	T1, Pg: 137
32	Order of execution of constructors and destructors	CO 4	T1, Pg: 28 R1: 14.1
33	Virtual functions, pure virtual functions	CO 4	T1, Pg: 28
34	Abstract classes	CO 4	T1, Pg: 21
35	Introduction to polymorphism	CO 4	T1, Pg: 21
36	Static polymorphism, dynamic polymorphism.	CO 4	T1, Pg: 21
37	Concept of streams, hierarchy of console stream classes.	CO 5	T1, Pg: 225
38	Unformatted I/O operations	CO 5	T1, Pg: 221
39	Managing output with manipulators and predefined manipulators.	CO 5	T1, Pg: 225
40	Data streams, the opening of a file	CO 5	R1: 2.5
41	Reading/writing a character from/into a file	CO 5	T1, Pg: 225
42	Appending into a file	CO 5	T1, Pg: 232
43	Processing and closing files	CO 6	T1, Pg: 227
44	Different types of files and file systems.	CO 5	T1, Pg: 226
45	Command line arguments	CO 5	T1, Pg: 228
46	Question bank discussion	CO 6	T1
47	Question bank discussion	CO 6	T1
48	Question bank discussion	CO 6	T1
PROBLEM SOLVING/ CASE STUDIES			
1	Design a class to represent books with attributes like title, author, and ISBN. Create a class for library patrons with borrowing history and due dates. Implement methods to borrow and return books, tracking availability, and due dates.	CO 1	
2	Design a class for products with properties like name, price, and description. Develop a shopping cart class that allows users to add and remove products. Use objects to create an interactive shopping experience with calculated totals.	CO 1	
3	Create a class for students with attributes like name, age, and enrolment status. Design a class for courses with properties like title, instructor, and schedule. Implement methods to enroll students in courses and track their progress.	CO 1	
4	Design a class representing a geometric shape (e.g., circle, rectangle). Use the const keyword to declare methods that provide information about the shape without modifying its properties.	CO 2	

S.No	Topics to be covered	CO's	Reference
5	Design a university class with nested classes for departments and courses. Utilize nested classes to represent the hierarchical structure of the university's organization.	CO 2	
6	Design a class representing employees with attributes like name, employee ID, and position. Use a constructor to initialize employee information when an object is created. Implement a destructor to handle any cleanup tasks or logging when an employee object is destroyed.	CO 2	
7	Implement a class for complex numbers with overloaded operators for addition, subtraction, multiplication, and division. Allow users to perform arithmetic operations on complex numbers using intuitive syntax.	CO 3	
8	Design a class for representing dates and overload comparison operators. Allow users to compare dates and determine their chronological order.	CO 3	
9	Create a utility to convert measurements between different units (e.g., inches to centimeters, pounds to kilograms). Utilize type conversion to handle unit conversions based on user input.	CO 3	
10	Design a base class Character with virtual functions for movement, attack, and interaction. Implement derived classes PlayerCharacter and EnemyCharacter that override the virtual functions. Use polymorphism to handle interactions between various characters in the game.	CO 4	
11	Create a base class Employee with virtual functions for calculating salary and displaying information. Implement derived classes RegularEmployee and ContractEmployee that override the virtual functions.	CO 4	
12	Design classes representing accounts (e.g., savings, checking) and customers. Use encapsulation to hide sensitive data and provide methods to deposit, withdraw, and check balances. Apply inheritance to create specialized account types, such as VIP accounts with additional features.	CO 4	
13	Develop an application to manage tasks and to-do lists. Use console stream classes to display tasks, prompt users for new tasks, and mark tasks as completed. Enable users to save and load their to-do lists to/from text files using file stream classes.	CO 5	
14	Create a calculator application that performs basic arithmetic operations. Utilize console stream classes to prompt users for operands and operators, and display the calculation results.	CO 5	

S.No	Topics to be covered	CO's	Reference
15	Create a utility that parses and analyzes log files. Read log files, extract relevant information, and present summaries. Use file streams to process large log files efficiently.	CO 5	
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to programming and object legacy.	CO 1	
2	Constructor and destructor.	CO 2	
3	Operator overloading.	CO 3	
4	Data hiding.	CO 4	
5	Command line arguments.	CO 5	
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Classes and objects.	CO 1	
2	Constructors and destructors.	CO 2	
3	Overloading a unary and binary operator using friend function and member function.	CO 3	
4	Ambiguity in derived classes for multipath inheritance.	CO 4	
5	Console stream classes.	CO 5	

23. Program outcomes and Program specific outcomes:

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

Program Outcomes	
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

24. How program outcomes are assessed:

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

PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and Environmental considerations.	3	CIE/SEE
PO 5	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	3	CIE/SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Tech talk/Definitions and terminology
PO 12	**Life-Long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	CIE/SEE

25. How program-specific outcomes are assessed:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	3	Tech talk /Definitions and terminology/ Assignments
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	3	Tech talk /Definitions and terminology/ Assignments

3 = High; 2 = Medium; 1 = Low

26. Mapping of each CO with PO(s), PSO(s):

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

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

27. Justifications for CO – PO / PSO mapping - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand (knowledge) the basic concept of object-oriented programming while evaluating mathematical expressions in program statements. These concepts provide insight into expression evaluation by applying the principles of mathematics and science.	3
	PO 5	With the help of modern engineering tools, we can easily understand the basic concept of objects and classes while evaluating mathematical expressions in program statements.	1
	PO 10	Extend the knowledge of object-oriented programming to communicate effectively with the engineering community.	1
	PSO 1	Understand features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to security requirements,and for protection of digital applications.	4
CO 2	PO 1	By applying the knowledge of mathematics, science, and engineering fundamentals we can effectively use the properties of OOP.	3
	PO 2	Apply nested classes in problem identification, statement, and validation.	5
	PO 3	Apply constructors and destructors to investigate and understand different complex engineering problems efficiently.	8
	PO 5	Apply static members to model complex engineering activities.	1
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 1	Apply features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to security requirements,and for protection of digital applications.	5
	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time to build a successful career and do higher studies.	2
CO 3	PO 1	Summarize indexing and slicing mechanisms for extracting a portion of data in a sequence using principles of mathematics, and engineering fundamentals.	8
	PO 3	Demonstrate the importance of indexing mechanisms in sequences while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	6
	PO 5	Demonstrate overloading operators with the usage of modern tools.	1
	PSO 1	Summarize indexing mechanisms to design and develop efficient real-time computational problems.	6
	PSO 3	Infer sufficient knowledge of container data types and apply it in real-time for building a successful career and doing higher studies.	2
CO 4	PO 1	Demonstrate different modules/packages in object-oriented programming while developing solutions using the fundamentals of mathematics, science, and engineering.	3
	PO 3	Understand the usage of modules/packages while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	8
	PO 5	Interpret different string functions by using modern tools.	1
	PO 10	Extend the focus to understanding the usage of modules/packages and communicating effectively with the engineering community.	2
	PO 12	Summarize string handling functions that involve manipulating and managing text or character data for tasks like data validation, formatting, and communication.	7
	PSO 1	Demonstrate different modules to understand, design, and analyze computer programs in reducing the time and space complexities of various applications.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 3	Illustrate modern computer tools in implementing string handling mechanisms for various applications to become a successful professional in the domains.	2
CO 5	PO 1	Make use of parameter passing and different types of arguments in user-defined functions to design efficient modular programs by applying the knowledge of mathematics, science, and Engineering fundamentals.	3
	PO 2	Apply modular programming concepts for problem identification, formulation, and data collection.	8
	PO 3	Select a strong foundation for writing efficient modular programs using parameter-passing mechanisms for career building by understanding the requirements and communicating effectively with the engineering community.	7
	PO 5	Develop different functions by using modern tools.	1
	PSO 1	Develop design and analyze object-oriented programming in the areas of the concept of passing of parameters and arguments in functions to do modular programming.	6
CO 6	PO 1	Apply scientific principles and methodologies, mathematical principles, and other engineering disciplines for procedural and object-oriented programming.	3
	PO 2	Apply object-oriented concepts in problem identification, statement, and validation.	7
	PO 3	Identify the need for object-oriented concepts while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	7
	PO 5	Develop object-oriented principles using modern tools.	1
	PO 10	Apply the knowledge of object-oriented programming to communicate effectively with the engineering community.	2
	PO 12	Identify the need for object-oriented principles for the preparation and the ability to engage in independent and lifelong learning	6
	PSO 1	Focus on writing programs using procedural and object-oriented concepts for applications such as secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	6
	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time to build a successful career and pursue higher studies.	2

28. Total count of key competencies for CO – PO / PSO mapping:

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

29. Percentage of key competencies CO – PO / PSO:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	20	0.0	0.0	66.6	0.0	0.0
CO 2	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	83.3	0.0	100
CO 3	100	0.0	60	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100
CO 4	100	0.0	80	0.0	100	0.0	0.0	0.0	0.0	40	0.0	88	83.3	0.0	100
CO 5	100	80	70	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 6	100	80	70	0.0	100	0.0	0.0	0.0	0.0	40	0.0	75	100	0.0	100

30. Course articulation matrix PO / PSO mapping:

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

0 - 0≤ C≤ 5% – No correlation

1-5 <C≤ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% ≤ C < 100% – Substantial /High

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
TOTAL	18	7	15	-	18	-	-	-	-	8	-	6	18	-	12
AVERAGE	3	2.3	3	-	3.0		-	-	-	2.0	-	3.0	3.0	-	3.0

31. Assessment methodology - Direct:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Definitions and Terminology	✓	Tech talk / 5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓	Quiz	✓	Tech Talk	✓

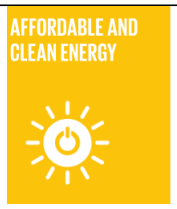
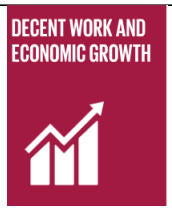
32. Assessment methodology - Indirect:

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

33. Relevance to Sustainability goals

Write a brief description of the course and its relevance to SDGs.

1		
2		
3		

4		**Quality education:** Guarantee an education system that is both inclusive and fair, offering high-quality learning experiences and lifelong opportunities accessible to all.
5		
6		
7		
8		
9		**Industry, innovation, and infrastructure:** Strong OOP skills enable to design and development of services like microservice architecture, cloud computing, machine learning, and AI integration in a modular and maintainable way, contributing to a more flexible and scalable infrastructure.
10		

11		**Sustainable cities and communities:** OOP skills can develop software solutions that contribute to urban sustainability, improve quality of life, and address challenges like smart city solutions, energy efficiency and monitoring, waste management systems, public transportation optimization, environmental sensor networks, education, and awareness faced by modern cities.
12		
13		
14		
15		
16		

17		

Approved by: Board of Studies in the meeting conducted on 28-08-2023.

Signature of Course Coordinator **HOD CS**
Dr. Bodavula Aslesha, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MATRICES AND CALCULUS

COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**				
2	Course Title	**MATRICES AND CALCULUS**				
3	Course Code	AHSD02				
4	Program	B.Tech				
5	Semester	I Semester				
6	Regulation	BT23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	1	4	-	-
8	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
9	Course Offered	Odd Semester ✓		Even Semester ×		
10	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: 16 hours		Practical: 0 hours	
11	Course Coordinator	Mr. P. Shantan Kumar				
	Course Instructor	Mr. Satyanarayana.G				
12	Date Approved by BOS	23 August 2023				
13	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD02.pdf				
14	Course Prerequistes -	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		10+2	-	-	Basic Principles of Algebra and Calculus	

15. Course Overview

This course is a foundation for all engineering branches. It includes concepts of Matrices, Eigen Values, Eigen Vectors, Functions of Single, Several Variables, Fourier Series and Multiple Integrals. This course is applicable for simulation, colour imaging processing and optimal solutions in all engineering problems.

16. Course Objectives:

The students will try to learn:

I	The Concept of the rank of a matrix, eigen values, eigen vectors and solution of the system of linear equations.
II	The Geometrical approach to the mean value theorems and applications.
III	The Fourier series expansion in periodic and non-periodic intervals.
IV	The Evaluation of multiple integrals and applications.

17. Course Outcomes:

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

CO 1	**Determine** the rank and solutions of linear equations with elementary operations.
CO 2	**Utilize** the Eigen values, Eigen vectors for developing spectral matrices.
CO 3	**Make use of** Cayley-Hamilton theorem for finding powers of the matrix.
CO 4	**Interpret** the maxima and minima of given functions.
CO 5	**Apply** the Fourier series expansion of periodic functions for harmonic series.
CO 6	**Determine** the volume of solid bounded regions by using the integral calculus.

18. Topic Learning Outcome (TLOs):

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
1	Rank of a matrix	1	**Calculate** the rank of a matrix by using determinants	CO 1	Apply
		2	**Calculate** the rank of a matrix by using elementary operations	CO 1	Apply
2	Inverse of a matrix by Gauss-Jordan method	3	**Compute** the inverse of the given matrix by elementary operations	CO 1	Apply
3	System of non-homogeneous equations	4	**Identify** the use of matrix theory to solve the system of linear equations in various engineering problems	CO 1	Apply
		5	**Examine** the system of homogeneous equations by its augmented form	CO 1	Apply
		6	**Examine** the system of non homogeneous equations for its augmented form	CO 1	Apply
4	Characteristic equation	7	**Recall** the concepts of characteristic equations of matrices	CO 2	Remember
5	Eigenvalues and Eigenvectors	8	**Recall** the concepts of eigenvalues for future engineering applications	CO 2	Remember
		9	**Recall** the concepts of eigenvectors for future engineering applications	CO 2	Remember

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		10	**Utilize** the characteristic polynomials to compute the eigenvalues and eigenvectors	CO 3	Apply
6	Cayley-Hamilton theorem, Diagonalization of a matrix	11	**Make use of** the Cayley-Hamilton to find inverse of a matrix	CO 3	Apply
		12	**Make use of** the Cayley-Hamilton to find powers of a matrix	CO 3	Apply
		13	**Make use of** the Cayley-Hamilton to find diagonalization of a matrix	CO 3	Apply
7	Continuous functions	14	**Explain** the geometrical interpretation of continuous functions on closed and bounded intervals	CO 4	Understand
8	Mean value theorems	15	**Interpret** the mean value theorems on bounded functions	CO 4	Understand
9	Partial differentiation	16	**Recall** the partial differentiation for the functions of several variables	CO 4	Remember
10	Jacobian transformations	17	**Make use of** Jacobian transformations for the functions are to be dependent or independent	CO 4	Apply
11	Maxima and minima of a function	18	**Identify** the maxima and minima of a function with several variables by using partial derivatives	CO 4	Apply
12	Euler coefficients	19	**State** the Euler coefficients for Fourier expansion of periodic functions in a given interval	CO 5	Remember
13	Fourier series in periodic interval	20	**Extend** the Fourier series of given functions in a given periodic interval $(-\pi, \pi)$	CO 5	Understand
		21	**Extend** the Fourier series of given functions in a given periodic interval $(0,2\pi)$	CO 5	Understand
14	Fourier series in non -periodic intervall	22	**Compute** the Fourier series of given functions in non-periodic interval (0,2l)	CO 5	Apply
15	Half- range Fourier series	23	**Extend** the half- range Fourier series expansions of a function in a given periodic interval $(0,\pi)$	CO 5	Apply
		24	**Extend** the half- range Fourier series expansions of a function in a given arbitrary interval (0, l)	CO 5	Apply

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
16	Double integrals	25	**Solve** the double integrals of functions in given constant limits	CO 6	Apply
		26	**Solve** the double integrals of functions in cartesian coordinates with given limits	CO 6	Apply
		27	**Solve** the double integrals of functions in polar coordinates with given limits	CO 6	Apply
17	Change order of integration	28	**Identify** the change order of integration of double integrals in cartesian form	CO 6	Remember
18	Triple integrals	29	**Calculate** the triple integrals of function in given constant limits	CO 6	Apply
		30	**Calculate** the triple integrals of function in cartesian coordinates with given limits	CO 6	Apply

19. Employability Skills

1. **Linear Algebra:** Employability/ Skill development: Apply the concepts of Linear Algebra in programming languages
2. **Matrices and Differential Calculus:** Employability/ Skill development: Uses the basic of matrices and Calculus calculation concept in the field of Engineering
3. **Integral Calculus:** Employability/ Skill development: Uses the concept of definite integral in engineering problems
4. **Multivariable calculus:** Employability/ Skill development: Can solve the different Multivariable calculus

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given from first two modules. Each question carries 12 marks. There could be a maximum of two sub divisions in a question.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE :

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

22. Course content - Number of modules: Five

MODULE I	**MATRICES**	**Number of Lectures: 09**
	Rank of a matrix by echelon form and normal form; inverse of non-singular matrices by Gauss-Jordan method; system of linear equations: solving system of homogeneous and non-homogeneous equations.	
MODULE II	**EIGEN VALUES AND EIGEN VECTORS**	**Number of Lectures: 10**
	Eigen values; Eigen vectors and their properties (without proof); Cayley-Hamilton theorem (without proof), verification; finding inverse and power of a matrix by Cayley-Hamilton theorem; diagonalization of a matrix.	
MODULE III	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES** .	**Number of Lectures: 10**
	Mean value theorems: Rolle's theorem; Lagrange's theorem; Cauchy's theorem-without proof. Functions of several variables: Partial differentiation; Jacobian; functional dependence; maxima and minima of functions of two variables and three variables; method of Lagrange multipliers.	
MODULE IV	**FOURIER SERIES**	**Number of Lectures: 09**
	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.	
MODULE V	**MULTIPLE INTEGRALS**	**Number of Lectures: 10**
	Evaluation of double integrals (cartesian and polar coordinates); change of order of integration (only cartesian coordinates); evaluation of triple integrals (cartesian coordinates).	

Text Books

1. B. S. Grewal, "*Higher Engineering Mathematics*", Khanna Publishers, 44/e, 2017.
2. Erwin Kreyszig, "*Advanced Engineering Mathematics*", John Wiley & Sons, 10/e, 2011.

ReferenceE Books:

1. R. K. Jain and S. R. K. Iyengar, "*Advanced Engineering Mathematics*", 3/ed Narosa Publications, 5th Edition , 2016.
2. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas,, "*Calculus*", Uma Publications, 13/e Edition,Pearson Publishers, 2013.
3. N.P. Bali and Manish Goyall "*A text book of Engineering Mathematics*", Laxmi Publication, Reprint, 2008.
4. Dean G. Duffy, "*Advanced Engineering Mathematics with MATLAB*", PCRC Press
5. Peter O'Neil, "*Advanced Engineering Mathematics*", Cengage Learning.
6. B.V. Ramana, "*Higher Engineering Mathematics*", McGraw Hill Education

Electronic Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ma88/preview
2. https://onlinecourses.nptel.ac.in/noc23_ma86/preview
3. https://www.efunda.com/math/math_home/math.cfm
4. https://www.ocw.mit.edu/resourcs/#Mathematics
5. https://www.sosmath.com
6. https://www.mathworld.wolfram.com

Materials Online:

1. Course template
2. Tech-talk topics
3. Assignments
4. Definition and terminology
5. Tutorial question bank
6. Model question paper – I
7. Model question paper – II
8. Lecture notes
9. Early lecture readiness videos (ELRV)
10. Power point presentations

23. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Theory of Matrices: Types of Real Matrices	CO 1	T1:2.4 R3:3.11
2	Elementary Operations: Elementary Row and Column Transformations	CO 1	T1:2.7.2 R3:3.34
3	Rank of a Matrix by Echelon Form	CO 1	T1:2.7.4 R3:3.38
4	Rank of a Matrix by Normal Form	CO 1	T1:2.7.7 R3:3.38
5	Inverse of a Matrix by Gauss-Jordan Method	CO 1	T1:2.7.6 R3:3.37
6	Solving system of Non-Homogeneous equations	CO 1	T1:2.10.1 R3:3.39
7	Solving system of Homogeneous equations	CO 1	T1:2.10.3 R3:3.39
8	Solving system of Non Homogeneous equations(Unknown Values)	CO 1	T1:2.10.3 R3:3.39
9	Eigen Values of a Matrix	CO 2	T1:2.13.1 R3:3.46
10	Eigen Vectors of a Matrix	CO 2	T1:2.13.2 R3:3.47
11	Properties of Eigen values and Eigen Vectors of a Matrix Problems	CO 2	T1:2.14 R3:3.47
12	Cayley-Hamilton Theorem- Statement, Verification	CO 3	T1:2.15 R3:3.48
13	Applications of Cayley – Hamilton: Finding Inverse and Powers of a Matrix	CO 3	T1:2.15 R3:3.48
14	Diagonalization of Matrix by Linear Transformation	CO 3	T1:2.16.1 R3:3.49
15	Linear Dependence and Independence of Vectors	CO 3	T1:2.3 R3:3.2
16	Mean Value Theorems:1: Rolle's Theorem	CO 4	T1:4.3.1 R6:2.1
17	Mean Value Theorems:2: Lagrange's Theorem	CO 4	T1:4.3.2 R6:2.2
18	Mean Value Theorems:3: Cauchy's Theorem	CO 4	T1:4.3.3 R6:2.3

S.No	Topics to be covered	CO's	Reference
19	Functions of Several Variables: Partial Differentiation	CO 4	T1:5.2 R3:5.1
20	Jacobian Transformations	CO 4	T1:5.7.1 R3:5.10
21	Functional Dependence	CO 4	T1-5.7.4 R3:5.11
22	Maxima and Minima of Functions with Two Variables	CO 4	T1:5.11.1 R3:5.13
23	Maxima and Minima of Functions with Three Variables	CO 4	T1-5.11.1 R3:5.14
24	Method of Lagrange Multipliers	CO 4	T1-5.12 R3:5.15
25	Euler Coefficeients for Fourier Expansion of Periodic Function in a Given Interval of Length (-π, π),(0,2π)	CO 5	T1-10.2 R3:10.3
26	Fourier Series of Even Functions in a Given Interval of Length ($-\pi, \pi$)	CO 5	T1-10.6.1 R3:10.3
27	Fourier Series of Odd Functions in a Given Interval of Length ($-\pi, \pi$)	CO 5	T1-10.6.2 R3:10.3
28	Fourier Series of Neither Functions in a Given Interval of Length ($-\pi, \pi$)	CO 5	T1-10.6.2 R3:10.3
29	Fourier Series in an Arbitrary Interval (0,2l)	CO 5	T1-10.6.1 R3:10.6
30	Fourier Series in an Arbitrary Interval (-l,l)	CO 5	T1-10.6.2 R3:10.6
31	Half- Range Fourier Sine Expansions in a Given Interval of Length (0,π)	CO 5	T1-10.7 R3:10.7
32	Half- Range Fourier Cosine Expansions in a Given Interval of Length (0,π)	CO 5	T1-10.7 R3:10.7
33	Double Integrals in Constant Limits	CO 6	T1-7.1 R3:6.1
34	Double Integrals in Variable Limits	CO 6	T1-7.1 R3:6.2
35	Double Integrals in cartesian coordinates (Area enclosed by plane curves)	CO 6	T1-7.4 R3:6.2
36	Double Integrals in polar coordinates	CO 6	T1-7.3 R3:6.3
37	Change of order of integration (only Cartesian form)	CO 6	T1-7.2 R3:6.4
38	Triple Integrals in Constant Limits	CO 6	T1-7.5 R3:6.5
39	Triple Integrals in Variable Limits	CO 6	T1-7.5 R3:6.5

S.No	Topics to be covered	CO's	Reference
40	Double and Triple Integrals	CO 6	T1-7.1 R3:6.5
PROBLEM SOLVING/ CASE STUDIES			
1	Rank of the Matrix by Echelon and Normal Form	CO 1	T1-2.7 R3:3.38
2	Homogeneous and Non Homogeneous Equations	CO 1	T1-2.10 R3:3.39
3	Eigen Values and Eigen Vectors of the Matrix	CO 2	T1-2.13 R3:3.46
4	Eigen Values and Eigen Vectors of the Matrix	CO 2	T1-2.16 R3:3.49
5	Cayley Hamilton Theorem Problems	CO 3	T1-2.15 R3:3.48
6	Powers of the Matrix by Cayley Hamilton Theorem	CO 3	T1-2.15 R3:3.48
7	Powers of the Matrix by Cayley Hamilton Theorem	CO 4	T1-4.3 R6:2.1
8	Jacobians, Functional Relationship	CO 4	T1-5.7 R3:5.10
9	Maxima and minima problems	CO 4	T1-5.11 R3:5.13
10	Fourier Series expansion of Periodic Function in a Given Interval of Length 2π	CO 5	T1-10.2 R3:10.3
11	Fourier Expansion of Periodic Function in a Given Interval of Length $(-\pi, \pi)$	CO 5	T1-10.6 R3:10.3
12	Fourier Series in an Arbitrary Interval (-l,l), Fourier Sine, Cosine Series in Interval (0,l)	CO 5	T1-10.6 R3:10.6
13	Finding Double Integrals in Cartesian and Polar Coordinates	CO 6	T1:7.1 R3:6.1
14	Change of order of integration	CO 6	T1-7.2 R3:6.4
15	Triple Integrals	CO 6	T1-7.5 R3:6.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Rank of a Matrix, Homogeneous and Non-Homogeneous equations	CO 1	T1-2.7 R3:3.39
2	Eigen Values and Eigen Vectors, Diagonalization	CO 2, CO3	T1-2.13 R3:3.46
3	Mean Value Theorems, Jacobian Transformations, Functionally Dependent and Independent	CO 4	T1-4.3 R6:2.1
4	Fourier Series (Even, Odd, Neither Functions)	CO 5	T1-10.2 R3:10.3

S.No	Topics to be covered	CO's	Reference
5	Multiple Integrals (Double and Triple)	CO 6	T1-7.1 R3:3.6.1
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Matrices	CO 1	T1-2.4 R3:3.11
2	Eigen Values and Eigen Vectors	CO 2, CO 3	T1-2.13 R3:3.46
3	Functions of Several Variables	CO 4	T1-5.2 R3:5.1
4	Fourier Series	CO 5	T1-10.2 R3:10.3
5	Multiple Integrals	CO 6	T1-7.1 R3:6.1

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Program Outcomes	
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

25. HOW PROGRAM OUTCOMES ARE ASSESSED:

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

26. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	-	-
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	-	-

PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

28. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Explain the role of rank and inverse of real and complex matrices in solving complex engineering problems by using elementary transformation methods (principles of mathematics).	2
CO 2	PO 1	Determine the Eigen values, Eigen vectors, Spectral matrix complex engineering problems modelled by matrices with help of Characteristic Equation (principles of mathematics).	2
	PO 2	Model the problem into matrices, prepare precise statement of the problem and apply the concepts of Eigen values and Eigen vectors to develop the solution and interpret, validate the results through proper documentation.	6
CO 3	PO 1	Make use of Cayley Hamilton theorem for finding positive and negative powers of the matrix and apply them in the complex engineering problems modelled by matrices (principles of mathematics).	2
CO 4	PO 1	Explain the mean–value theorems for the single variable functions and the extreme values for functions of several variables apply them in the complex engineering problems Partial derivatives of (principles of mathematics).	2
CO 5	PO 1	Build the Fourier series expansion for the complex engineering problems modelled by given periodic, even and odd functions in various intervals with the help of Fourier coefficients formulae (principles of mathematics).	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Model the problem with the help of suitable periodic functions, prepare precise statement of the problem and apply Fourier series expansions to develop the solution and interpret, validate the results through proper documentation..	6
CO 6	PO 1	Determine the solution of complex engineering problems modelled by Double and Triple Integrals by using substitution method and principles of mathematics.	2
	PO 2	Model the problem with the help of ordinary integrations, prepare precise statement of the problem and apply on double and triple integrations by method of ordinary integration and other analytical methods to develop the solution and interpret, validate the results through proper documentation.	6

29. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO):

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-

31. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

32. ASSESSMENT METHODOLOGY DIRECT:

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

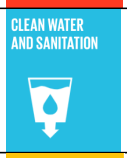
33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

34. Relevance to Sustainability goals:

Brief description about the course and how its relevance to SDGs.

Mathematics plays an important role in the achievement of the Sustainable Development Goals (SDG) and at the same time these allow working with real situations in the subject of mathematics, providing the student with active learning. Sustainability is used to make the student see the usefulness of mathematics while instilling values and attitudes towards it.

×		-
×		-
×		-
✓		**Quality Education:** Minimizing school dropout: The teaching of mathematics plays an important role in the implementation of sustainable education to achieve future goals: to make learning mathematics more relevant and applicable, as well as to support the development of 21st century skills.
×		-
×		-
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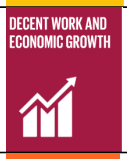
×		-
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Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD**
Mr.P.Shantan kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ENGINEERING CHEMISTRY
COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**				
2	Course Title	**ENGINEERING CHEMISTRY**				
3	Course Code	AHSD03				
4	Program	B.Tech				
5	Semester	I Semester				
6	Regulation	BT-23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
8	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
9	Course Offered	Odd Semester ✓		Even Semester ×		
10	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 64 hours		Tutorials: ..... hours		Practical: ..... hours	
11	Course Coordinator	Dr.V Anitha Rani				
12	Date Approved by BOS	24/08/2023				
13	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD03.pdf				
14	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		.Intermediate		I	Basic principle of chemistry	
		B.Tech		I	XXXX	

15. Course Overview

The course focuses on the fundamental concepts of chemistry to impart knowledge on applications of chemical sciences in engineering and technology. It deals with topics such as electrochemical principles in batteries, techniques to control corrosion, alternative sources of energy and water purification process. The significance of advanced materials and their usage in industrial, commercial and social sectors for sustainable development.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The concepts of electrochemical principles and causes of corrosion in the new developments and breakthroughs efficiently in engineering and technology.
II	The different parameters to remove causes of hardness of water and their reactions towards complexometric method.
III	The properties, separation techniques of natural gas and crude oil along with potential applications in major chemical reactions..
IV	The different types of materials with respect to mechanisms and its significance in industrial applications.

17. COURSE OUTCOMES:

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

CO 1	**Implement** the principles of electrochemical systems to control the corrosion in metals.
CO 2	**Analyze** the basic properties of water for its usage in domestic and industrial purposes.
CO 3	**Use** complexometry for calculation of hardness of water to avoid industrial problems.
CO 4	**Extend** the applications of polymers based on their degradability and properties..
CO 5	**Choose** the appropriate fuel based on their calorific value for energy efficient processes.
CO 6	**Predict** the knowledge on viability of advanced materials for technological improvements in various sectors.

18. Topic Learning Outcome (TLOs):

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
1	Galvanic cell	TLO 1	Recall the oxidation and reduction reactions by observing the chemical changes in a cell.	CO 1	Remember
		TLO 2	Explain the operation of electrochemical cell to produce electrical energy from spontaneous redox reactions..	CO 1	Understand
		TLO 3	Use electrochemical principles in batteries.	CO 1	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
2	Electrolytic cell	TLO 4	Illustrate the process of electrolysis by using electrical energy for non-spontaneous chemical reactions..	CO 1	Understand
		TLO 5	Use electrolysis process in separating or obtaining pure elements from ores.	CO 1	Apply
3	Electrochemical series	TLO 6	Interpret the degree of reactivity of electrodes based on activity series table with standard hydrogen electrode.	CO 1	Understand
		TLO 7	Use standard reduction potential data to determine the relative strength of oxidizing and reducing agents.	CO 1	Apply
4	Zinc-air battery	TLO 8	Discuss the chemical reactions in Zinc and oxygen to produce electrical energy.	CO 1	Understand
5	Lead-Acid battery and Li-ion battery	TLO 9	Relate the relationship between charge produced and the amount of product formed for both electrochemical cell and electrolytic cells.	CO1	Understand
6	Causes of corrosion	TLO 10	Recall the corrosion process in metals in presence of environment.	CO 1	Understand
7	Chemical Corrosion	TLO 11	Interpret the oxidation and reduction reactions on the surface of metal in presence of oxygen to form metal oxide in presence of oxygen.	CO 1	Understand
8	Electrochemical corrosion	TLO 12	Illustrate the electrochemical corrosion of metals in acidic and alkaline environment.	CO1	Understand
9	Cathodic protection	TLO 13	Use sacrificial anodes to control corrosion inmetal structures.	CO1	Apply
10	Galvanizing, Tinning	TLO 14	Make use of metallic coatings and coating deposition technologies to prevent corrosion in metals	CO1	Apply
11	Electroplating	TLO 15	Use the process of electrolysis in industries to prevent corrosion in metals.	CO1	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
12	Treatment methods of potable water, Ion-exchange process and Reverse osmosis	TLO 16	Estimate the different water treatment methods to use in industries and domestic purpose.	CO2	Understand
13	Expression of hardness	TLO 17	Select the CaCO3 equivalents to express the total, temporary and permanent hardness of water.	CO3	Apply
14	Complexometry method	TLO 18	Make use of complexometry method to calculate the hardness of water	CO3	Apply
15	Types of polymerization	TLO 19	Relate the addition and condensation polymerization process to synthesize the polymers	CO4	Understand
16	Synthetic polymers	TLO 20	Explain the properties of polymers from organiccompounds.	CO4	Understand
17	Applications of polymers	TLO 21	Use polymers in various sectors based on their properties.	CO4	Apply
18	Classification of fuels	TLO 22	Classify the different types of fuels based their physical state of aggregation.	CO5	Understand
19	Analysis of coal	TLO 23	Demonstrate the qualitative and quantitative analysis of coal to prevent problems inindustries.	CO 5	Understand
20	Refining of petroleuml	TLO 24	Illustrate the fractions of crude oil by fractional distillation process.	CO 5	Understand
21	Demonstrate the qualitative and quantitative analysis of coal to prevent problems inindustries.	TLO 25	Develop the work energy relations and apply to connected systems.	CO5	Understand
22	Gaseous fuels	TLO 26	Use Liquefied petroleum gas and Compressed natural gas in various sectors.	CO 5	Apply
23	Calorific value of fuels	TLO 26	Use the Dulong's formula to find the highercalorific value and lower calorific value of fuels	CO 5	Apply
24	Combustion of fuels	TLO 27	Use theoretical calculation of amount of air required for combustion of fuels.	CO 5	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
25	Synthesis of Nanomaterials	TLO 28	Enhance the understanding of nano-structural materials	CO 6	Apply
26	Nanomaterials	TLO 29	Enhance the use of nanomaterials as a complex materials and structures in buildings.	CO 6	Apply
27	Smart materials	TLO 30	Recognize the importance and applications of smart materials.	CO 6	understand
28	Thermoresponse materials	TLO 31	Identify the importance and benefits of thermoresponse materials	CO 6	understand
29	Setting and hardening of cement	TLO 32	Relate the chemical reactions in setting and hardening of cement	CO 6	understand
30	Mechanism of lubrication	TLO 33	Discuss the mechanism of lubrication processapplied under different load, pressure andtemperatureconditions	CO6	understand

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Project based skills Engineering chemistry for students based on qualitative and quantitative analysis of experimental skills.

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

22. COURSE CONTENT-Number of Modules:Five

MODULE I	**BATTERIES CHEMISTRY AND CORROSION** | Number of Lectures: 13
	Introduction to electrochemical cells: electrolytic cell, Galvanic cell; electrochemical series and its applications; Batteries: classification of batteries, construction, working and applications of Zinc-air battery, Lead-acid battery, Li-ion battery, applications of Li-ion battery to electric vehicles; Corrosion: causes and effects of corrosion, theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Corrosion control methods: cathodic protection, sacrificial anode and impressed current methods; Metallic coatings: Galvanization and tinning; electroplating of Copper.
MODULE II	**WATER AND ITS TREATMENT** | **Number of Lectures: 13**
	Hardness Introduction: Hardness of water, causes of hardness; types of hardness, temporary and permanent hardness, expression and units of hardness; estimation of hardness of water by complexometric method; potable water and its specifications, steps involved in the treatment of water, disinfection of water by chlorination and ozonization;external treatment of water; ion-exchange process; desalination of water: reverse osmosis, numerical problems.
MODULE III	**POLYMER TECHNOLOGY** . |**Number of Lectures: 13**
	Polymers: classification of polymers; types of polymerization-addition, condensation polymerization withexamples. Plastics: thermoplastic and thermosetting plastics; preparation, properties and engineering applications of PVC, Nylon6,6 and Bakelite; Biodegradable polymers: polylactic acid and polyvinyl alcohol and theirapplications. Elastomers: Introduction to natural rubber, vulcanization of natural rubber, preparation, properties and engineering applications of Buna-S and Thiokol rubber.
MODULE IV	**ENERGY SOURCES** | **Number of Lectures: 13**
	Introduction to fuels; classification of fuels; Solid fuels: coal; analysis of coal, proximate and ultimate analysis and their significance; Liquid fuels: petroleum and its refining; Gaseous fuels: composition, characteristics and applications of natural gas, LPG and CNG; Alternative and non-conventional sources of energy: solar, wind and hydropower advantages and disadvantages. Calorific value of fuel: HCV and LCV, Dulongs formula, calculation of air quantity required for complete combustion of fuel, numerical problems

MODULE V	**ENGINEERING MATERIALS** | **Number of Lectures: 12**
	Nanomaterials: introduction, preparation of nanoparticles by sol-gel method, chemical reduction method, applications of nanomaterials. Smart materials and their engineering applications: shape memory materials, poly L-lactic acid. Thermoresponse materials: Polyacryl amides, Poly vinyl amides. Cement: composition of Portland cement, setting and hardening of cement. Lubricants: characteristics of a good lubricant, mechanism of lubrication, thick film, thin film and extreme pressure lubrication; properties of lubricants: viscosity, Redwood viscometer, flash and fire point, cloud and pour point.

TEXTBOOKS

1. Jain and jain, Monika jain , "*Engineering Chemistry* ", Dhanpat Rai Publishers, 17th Edition, 2022.

REFERENCE BOOKS:

1. Shashi chawla& *Engineering Chemistry*", 1th Edition, 2017.
2. jaya sree Reddy, "*Engineering Chemistry*", wiley Publications, 2023.
3. S.S Dara "*Engineering Chemistrys. chand*"12th Edition, 2018.
4. Nitin K Puri "*Nanomaterials Synthesis Properties And Applications*", I K international publishing house pvt Ltd, 1st edition 2021.
5. S. Bhavikatti, "*Engineering Chemistry*", New Age International, 5th Edition, 2020.
6. R. C. Hibbler, "*Engineering Chemistry*", Pearson Press, 2021.

MATERIALS ONLINE:

1. Lecture notes, ELRV videos and power point presentations
2. Answers / solutions to all questions / problems in the textbook
3. Online exercises
4. Problems and solutions in files

23. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Electrochemical cells (Galvanic cell), electrolytic cell	CO 1	T1:6.1, R1:7.4,8
2	Electrochemical series and its applications	CO 1	T1: 6.7, R1:10
3	Batteries, classification of batteries	CO 1	T2:5.10 R1:1.15
4	Construction, working and applications of Zinc-air battery	CO 1	T1:3.13, R1:23.1
5	Construction, working and applications of Lead-acid storage battery	CO 1	T1:3.13,R1:23.2
6	Construction, working and applications of Li-ion battery, applications of Li-ion battery to electric vehicles	CO 1	T1:3.14 , R1:24
7	Corrosion, causes and effects of corrosion, chemical corrosion	CO 1	T1:3.20, R1:1.2
8	Electrochemical corrosion, mechanism of electrochemical corrosion	CO 1	T1:3.21, R1:2.1
9	Cathodic protection, sacrificial anode and impressed current methods	CO 1	T1:3.22, R1:6.4
10	Metallic coatings, Galvanization and tinning, electroplating of Copper.	CO 1	T1:3.23, R1:6.3,6.6
11	Hardness of water, causes of hardness, disadvantages of hard water	CO 2	T1:2.1, R1:4
12	Types of hardness, temporary and permanent, expression and units of hardness	CO 2	T1:2.1, R1:5.3
13	Estimation of hardness of water by complexometric method	CO 3	T1:2.6, R1:6.1
14	potable water and its specifications, steps involved in the treatment of water, disinfection of water by chlorination and ozonization	CO 2	T1:2.6.5, R1:14
15	External treatment of water, ion-exchange process	CO 3	T1:2.8, R1:12.3
16	Desalination of water, reverse osmosis	CO 3	T1:2.10.2, R1:17.4
17	Classification of polymers; types of polymerization-addition, condensation polymerization with examples.	CO 4	T1: 3.5, R1: 3

S.No	Topics to be covered	CO's	Reference
18	Plastics, thermoplastic and thermosetting plastics	CO 4	T1:1.4, R1: 2.10
19	Preparation, properties and engineering applications of PVC	CO 3	T1:3.5, R1: 7.2
20	Preparation, properties and engineering applications of Nylon 6,6 s	CO 4	T1: 3.12, R1:7.7 5.1.2
21	Preparation, properties and engineering applications of Bakelite	CO 4	T1:3.14, R1: 3.2.3
22	Biodegradable polymers, polylactic acid and polyvinyl alcohol and their applications.	CO 4	T1:3.14, R1: 3.2.3
23	Elastomers, vulcanization of natural rubber	CO 4	T1: 3.15, R1:6.1
24	Preparation, properties and applications of Buna-s and Thiokol rubber.	CO 4	T1: 3.22, R1: 6.7
25	Classification of fuels, analysis of coal, proximate analysis of coal and their significance	CO 5	T1:4.2, R1: 2.1, 7.1,7.2
26	Ultimate analysis of coal and their significance	CO 4	T1:4.4.1, R1:7.1,7.2
27	Liquid fuels, petroleum and its refining	CO 5	T1:4.5.2, R1:15.2
28	Composition, characteristics and applications of natural gas, LPG and CNG	CO 5	T1:4.6, R1:9.1,9.2
29	Alternative and non-conventional sources of energy: solar, wind and hydropower advantages and disadvantages.	CO 4	T1:4.6, R1:9.8
30	Calorific value of fuel: HCV and LCV, Dulongs formula,	CO 5	T1:4.8, R1: 4.1
31	Calculation of air quantity required for complete combustion of fuel, numerical problems.	CO 5	T2:16.9 R1:8.11.2
32	Nanomaterials, preparation of nanoparticles by sol-gel method	CO 6	T1: 6.0, R1: 1
33	Preparation of nanoparticles by chemical reduction method and applications of nanomaterials.	CO 6	T1: 6.1, R1:11
34	Smart materials and their engineering applications, shape memory materials, Poly L-Lactic acid.	CO 6	T1: 6.1 R2:12.24
35	Thermoresponse materials, Polyacryl amides, Poly vinyl amides.	CO 6	T1: 6.1
36	Cement, composition of Portland cement	CO 6	T1: 5.1.2, R1: 3.2
37	Setting and hardening of cement.	CO 6	T1: 5.1.3, R1: 3.3
38	Lubricants, characteristics of a good lubricant	CO 6	T1: 3.24, R1: 3,5

S.No	Topics to be covered	CO's	Reference
39	Mechanism of lubrication, thick film, thin film and extreme pressure lubrication	CO 6	T1: 3.24, R1: 3,5
40	properties of lubricants, viscosity, flash and fire point, cloud and pour point	CO 6	T1: 3.25, R1: 7 R1: 7
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on temporary and permanent hardness in Degree French and ppm	CO 3	T1:2.1, R1:5.4
2	Problems on temporary, permanent and total hardness in ppm and Degree Clark	CO 3	T1:2.1, R1:5.4
3	Problems on the temporary, permanent and total hardness of water in Degree French and Degree Clark.	CO 3	T1:2.1, R1:5.5
4	Problems on the temporary, permanent and total hardness of water in Degree Clark and Mg/L.	CO 3	T1:2.1, R1:5.5
5	Problems on the total hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
6	Problems on the temporary hardness and permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
7	Problems on the temporary hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
8	Problems on the permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
9	Problems on the higher and lower calorific values of the fuel.	CO5	T1:4.8, R1:4.3
10	Problems on the gross and net calorific values of the fuel.	CO 5	T1:4.8, R1:4.3
11	Problems on HCV and LCV (polar coordinates).	CO 5	T1:4.8, R1:4.3
12	Problems on GCV and NCV	CO 5	T1:4.8, R1:4.3
13	Problems on calculation of air quantity required for complete combustion of coal	CO 5	T1:4.9, R1:10.2
14	Problems on complete combustion of fuel in air	CO 5	T1:4.9, R1:10.2
15	Problems on calculation of air quantity required for complete combustion of fuel	CO 5	T1:4.9, R1:10.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions & terminology discussion onbatteries chemistry and corrosion	CO 1	T1:6.1, R1: 7.4,1.2
2	Definitions & terminology discussion on water and its treatment	CO 2, CO3	T1:2.1, R1:5.3
3	Definitions &terminology discussion on polymer technology	CO 3, CO 4	T1: 3.5, R1: 7.2

S.No	Topics to be covered	CO's	Reference
4	Definitions &terminology discussion on energy sources	CO 5	T1:4.2, R1:2.1
5	Definitions & terminology discussion on engineering materials	CO 6	T1: 6.0, R1: 11,3,3.2
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Question bank discussion on batteries chemistry and corrosion	CO 1	T1:6.1, R1: 7.4,1.2
2	Question bank discussion on water and its treatment	CO 2, CO 3	T1:2.1, R1:5.3
3	Question bank discussion on polymer technology	CO 4	T1: 3.5, R1: 7.2
4	Question bank discussion on energy sources	CO 5	T1:4.2, R1:2.1
5	Question bank discussion on engineering materials	CO 6	T1: 6.0, R1: 11,3,3.2

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

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

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

25. HOW PROGRAM OUTCOMES ARE ASSESSED:

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

26. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications..	-	
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	-	
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making..	-	

3 = High; 2 = Medium; 1 = Low

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

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

28. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	2
	PO 7	Use metallic coatings to control the corrosion in metals and know the impact in socio economic and environmental contexts for sustainable development..	2
CO 2	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 3	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	3
	PO 2	Identify the problem and formulate for finding the hardness of water in terms of CaCO3 equivalents with given information and data by applying principles of science..	2
CO 4	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	2
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development..	2
CO 5	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	3
	PO 2	Identify the problem and formulate for finding the hardness of water in terms of CaCO3 equivalents with given information and data by applying principles of science.. .	2
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development.	2
CO 6	PO 1	Explain the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using principles of science for solving engineering problems.	2
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development.	2

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

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	33.3	-
CO 2	66.6	-	-	-	-	-	-	-	-	-	-	-	-		-
CO 3	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	33.3	-
CO 5	100	20	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-

31. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% < C < 100% – Substantial /High

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

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

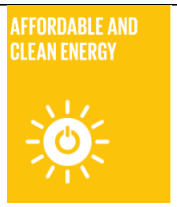
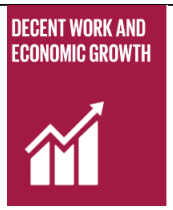
33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

34. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		Water purification can help to decrease dangerous bacteria and other chemicals that can weaken the immune system by removing pollutants and impurities. This may assist stay in good health and lowers chance of illness.
4		The fundamental principles of water treatment and its applications in industry, apply electrochemical principle in batteries
5		

6		Safe and readily available water is important for public health, domestic use, food production or recreational purpose.countries' economic growth and can contribute greatly to poverty reduction.
7		Affordable electricity is provided by clean energy sources such as solar, wind and hydropower.
8		
9		
10		
11		Renewable energy systems for sustainable cities
12		Renewable energy systems for sustainable cities

13		Non-renewable energy resources release harmful greenhouse gases into the atmosphere, creating the greenhouse effect which causes global warming.
14		
15		The biodegradable plastics material focuses on creating a more sustainable and greener world with a smaller environmental imprint.
16		
17		

Approved by: Board of Studies in the meeting conducted on21-August-2023 .

Signature of Course Coordinator **HOD,CSE(CS)**
Dr.V.Anitha Rani, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

APPLIED PHYSICS LABORATORY
COURSE TEMPLATE

1	Department	**CSE (Cyber Security)**			
2	Course Title	**Applied Physics Laboratory**			
3	Course Code	AHSD09			
4	Program	B.Tech			
5	Semester	I Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Practical Hours: 48		Credits: 1	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Dr. Surya Sharma N V			
10	Date Approved by BOS	24/08/2023			
11	Course Webpage	www.iare.ac.in/B.Tech. Course Syllabus BT23 -CSE/—-			
12	Course Prerequistes	**Level UG/PG**	**Course Code**	**Course Tittle**	**Semester**
		Intermediate	-	-	-

13. Course Overview

The aim of the course is to provide hands on experience for experiments in different areas of physics. This laboratory includes experiments involving electromagnetism and optoelectronics. This also develops student's expertise in applying physical concepts to practical problem and apply it for different applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	Familiarize with the lab facilities, equipment, standard operating procedures..
II	About the different kinds of functional magnetic materials which paves away for them to use in various technical and engineering applications..
III	The analytical techniques and graphical analysis to study the experimental data for optoelectronic devices.
IV	The application characteristics of lasers and its propagation in optical fibre communication.

15. COURSE OUTCOMES:

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

CO 1	**Identify** the type of semiconductor using the principle of Hall effect and also determine the energy gap and resistivity of a semiconductor diode using four probe method.
CO 2	**Illustrate** principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones.
CO 3	**Investigate** the energy losses, curie temperature and properties associated with a given Ferro magnetic material
CO 4	**Examine** launching of light through optical fiber from the concept of light gathering capacity of numerical aperture and determine the divergence of Laser beam
CO 5	**Graph** V-I /L-I characteristics of various optoelectronic devices like Light Emitting diode, Solar cell at different intensities to understand their basic principle of functioning as well as to infer the value of Planck's constant
CO 6	**Analyse** the variation of magnetic field induction produced at various points along the axis of current carrying coil.

16. Employability Skills

1. **Project based:** Project based skills: Would be able to familiarize themselves with basic experiments and calculations that would inculcate the concept of learning by doing.

17. Content Delivery / Instructional Methologies:

✓	 Day to Day lab evaluation	✓	 Demo Video	✓	 Viva Voce questions	✓	 Open Ended Experiments
x	 Competitions	x	 hackathons	x	 Certifications		Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
	5	5	5	5	20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT SYLLABUS:

CO 1	**Identify the type of semiconductor using the principle of Hall effect and also determine the energy gap and resistivity of a semiconductor diode using four probe method.**
	1. Errors and Measurement 2. Hall Effect (Loreentz Force) 3. Energy gap of a Semiconductor diode 4. Resistivity -Four probe Method

CO 2	**Illustrate principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones.**
	1. Melde's Experiment
CO 3	**Investigate the energy losses, curie temperature and properties associated with a given Ferro magnetic material.**
	1. B-H Curve With CRO 2. Magnetic Materials
CO 4	**Examine launching of light through optical fiber from the concept of light gathering capacity of numerical aperture and determine the divergence of Laser beam**
	1. 1 Optical Fiber 2. 2 Laser Divergence
CO 5	**Graph V-I /L-I characteristics of various optoelectronic devices like Light Emitting diode, Solar cell at different intensities to understand their basic principle of functioning as well as to infer the value of Planck's constant.**
	1. Solar Cell 2. Light Emitting Diode 3. Planck's Constant 4. Biassing Diode
CO 6	**Analyse the variation of magnetic field induction produced at various points along the axis of current carrying coil**
	1. Stewart's and Gee's Appratus

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. C. L. Arora, "Practical Physics", S. Chand Co., New Delhi, 3rd Edition, 2012.
2. Vijay Kumar, Dr. T. Radha krishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.
3. Dr. Rizwana, "Engineering Physics Manual", Spectrum Techno Press, 2018

REFERENCE BOOKS:

1. CF Coombs, "Basic Electronic Instrument Handbook", McGraw - HillBookCo.,1972.
2. CH Bernard and CD Epp, John Wiley and Sons, " Laboratory Experiments in College Physics"

20. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	To estimate the error and uncertainty in measurement	CO 1	T1 :10.2
2	Study the phenomenon of Hall effect and determine the charge carrier density and Hall coefficient of a given sample	CO 1	T1:13.5
3	Determination of energy gap of a given semiconductor diode by measuring the variation of current as a function of temperature	CO 1	T1:16.8
4	Determination of the resistivity by forcing current through two outer probes and reading the voltage across the two inner probes of semiconductor by four probe method.	CO 1	T2:5.15 R1:1.16
5	Determination of frequency of a given tuning fork in longitudinal wave propagation and transverse mode of wave propagation	CO 2	T1:15.5 R1:1.13.1
6	Evaluate the energy loss per unit volume of a given magnetic material per cycle by tracing the hysteresis loop (B-H curve)	CO 3	T1:15.7
7	Determine the curie temperature (Tc) and relative permeability of a ferromagnetic materials.	CO 4	T1:15.8
8	Evaluation of numerical aperture and acceptance angle of a given optical fiber.	CO 4	T1:17.9
9	Determination of the beam divergence of the given laser beam	CO 4	T1:17.5
10	Studying the characteristics of solar cell at different intensities and determination of maximum workable power.	CO 5	T1:17.5
11	Studying V-I characteristics of LED in forward bias for different LEDs and measure the threshold voltage and forward resistance	CO 5	T1:19.10
12	Determination of Planck's constant by measuring threshold voltage of given LED.	CO 5	T1:19.10
13	Study the forward bias of LED and reverse bias of Photodiode	CO 5	T1:19.10
14	Study the magnetic field along the axis of current carrying coil – Stewart and Gee's method	CO 6	T1:14.7

21. Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1	To study the bending losses and transmission losses of an optical Fiber
2	To determine the mobility and conductivity of given semiconductor using Hall Effect
3	To Determine the resistivity of given ferromagnetic material using Two Probe method.

22. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

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

Program Outcomes	
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

23. HOW PROGRAM OUTCOMES ARE ASSESSED:

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

24. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	1	Laboratory experiments and surveys

3 = High; 2 = Medium; 1 = Low

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

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

26. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO1	Identify basic principle of Hall effect and make use of mathematical expression for Hall coefficient to deduce the type of semiconductor	3
	PO 2	Understand the given problem statement of variation of resistance with temperature in a semiconductor diode and formulate Resistivity from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 4	Make use of graphical analysis of current versus temperature curve for a given semiconductor, and interpret the data, to provide valid conclusions regarding the energy gap in a given semiconductor	2
CO 2	PO 1	Recall the theory of propagation of longitudinal and transverse waves and make use of number of loops formation in string to determine frequency of an electronically maintained tuning fork.	1
	PO 2	Understand the given problem statement of stationary wave propagation and formulate harmonics and overtones of fundamental frequency from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
CO 3	PO 1	Investigate the energy losses associated with a given ferromagnetic material and make use of graphical representation of hysteresis loop exhibited by magnetic material	2

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PO 2	Understand the given problem statement of effect of temperature on a given ferromagnetic material and formulate Curie temperature and relative permittivity from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PSO 3	Apply the CRO for visualizing and analysing the Hysteresis of Ferromagnetic materials.	1
CO 4	PO 1	Interpret launching of light through optical fibre and make use of mathematical expression for analysing light gathering capacity through numerical aperture	2
	PO 2	Understand the given problem statement on directionality of laser light in comparison with ordinary light and formulate the divergence of a given laser source from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	3
CO 5	PO 1	Understand the phenomenon of recombination of electron-hole pair and determine the value of threshold voltage of a given LED	1
	PO 2	Understand the given problem statement of conversion light energy to electrical energy and formulate V-I characteristics of solar cell from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	2
	PO 4	Analyse and interpret the data obtained by using different LED's and synthesise the information to infer the value of Planck's constant	2
CO 6	PO 1	Explain the variation of magnetic field at various points along the axis of current carrying coil and make use of mathematical expression of Tangent's law using Stewart Gee's apparatus.	2
	PO 2	Understand the given problem statement of current loop and formulate magnetic field induction at various points along the axis of current loop from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66	40	-	18	-	-	-	-	-	-	-	-	-	-	-
CO 2	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66	40	-	-	-	-	-	-	-	-	-	-	-	-	35
CO 4	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	66	40	-	18	-	-	-	-	-	-	-	-	-	-	-
CO 6	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-

29. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	11	6	-	2	-	-	-	-	-	-	-	-	-	-	1
AVERAGE	1.8	1	-	1	-	-	-	-	-	-	-	-	-	-	1

30. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	✓

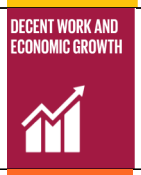
31. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

32. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		-
2		-
3		-
4		**Quality Education:In order to ensure inclusive and equitable quality education and promote life long learning oppurtunities for all, foundation is very much important. Physics laboratory comes under basic science course falicitating students to gain and ascertain basic knowledge which will help them to envisage to their higher education**
5		-

6		-
7		-
8		-
9		-.
10		-
11		-
12		-
13		-
14		-
15		-

16		-
17		-

Approved by: Board of Studies in the meeting conducted on24/08/2023

Signature of Course Coordinator **HOD**
Dr. N V Surya Sharma, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**			
2	Course Title	**OBJECT ORIENTED PROGRAMMING WITH JAVA**			
3	Course Code	ACSD02			
4	Program	B.Tech			
5	Semester	I Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Tutorial Hours: 1		Practical Hours: 2	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Dr. C Labesh Kumar			
10	Date Approved by BOS	25/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-	-	-	-
		-	-	-	-

13. COURSE OVERVIEW

This course provides a solid foundation in object-oriented programming concepts and hands-on experience in using them. It introduces the concepts of abstraction and reusable code design via the object-oriented paradigm. Through a series of examples and exercises students gain coding skills and develop an understanding of professional programming practices. Mastering Java facilitate the learning of other technologies.

14. COURSE OBJECTIVES

The students will try to learn:

I	The strong foundation with the Java Virtual Machine, its concepts and features.
II	The systematic understanding of key aspects of the Java Class Library
III	The usage of a modern IDE with an object oriented programming language to develop programs.

15. COURSE OUTCOMES

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

CO 1	Develop non-trivial programs in an modern programming language.
CO 2	Apply the principles of selection and iteration.
CO 3	Appreciate uses of modular programming concepts for handling complex problems.
CO 4	Recognise and apply principle features of object-oriented design such as abstraction and encapsulation.
CO 5	Design classes with a view of flexibility and reusability.
CO 6	Code, test and evaluate small usecases to conform to a specification.

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, design solutions using Java's object-oriented principles, and translate real-world scenarios into code.
2. **Debugging and Troubleshooting:** Debugging challenges in the lab help students master error identification, interpretation, and use of debugging tools, essential for real-world software development.

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	 Day to Day lab evaluation	✓	 Demo Video	✓	 Expected Viva Voce questions	✓	 Open Ended Experiments
X	 Competitions	**X**	 hackathons	✓	 Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Develop non-trivial programs in an modern programming language.**
	1. Getting Started Exercises 2. Exercises on Number Systems (for Science/Engineering Students)
CO 2	**Apply the principles of selection and iteration.**
	1. Exercises on Decision and Loop 2. Exercises on Input, Decision and Loop 3. Exercises on Nested-Loops (Patterns) 4. Magic(Special) Numbers 5. Exercises on String and char Operations 6. Exercises on Arrays
CO 3	**Appreciate uses of modular programming concepts for handling complex problems.**
	1. Exercises on Methods 2. Exercises on Command-line Arguments and Recursion 3. More (Difficult) Exercises
CO 4	**Recognise and apply principle features of object-oriented design such as abstraction and encapsulation.**
	1. Exercises on Classes and Objects
CO 5	**Design classes with a view of flexibility and reusability.**
	1. Exercises on Inheritance
CO 6	**Code, test and evaluate small usecases to conform to a specification.**
	1. Exercises on Polymorphism, Abstract Classes and Interfaces

Note: One Course Outcome may be mapped to multiple number of experiments.

Text Books

1. Farrell, Joyce."*Java Programming*", Cengage Learning B S Publishers, 8th Edition, 2020
2. Schildt, Herbert. "*Java: The Complete Reference*" 11th Edition, McGraw-Hill Education, 2018.

Reference Books

1. Deitel, Paul and Deitel, Harvey. "*Java: How to Program*", Pearson, 11th Edition,2018.
2. Evans, Benjamin J. and Flanagan, David. "*Java in a Nutshell*", O'Reilly Media, 7th Edition, 2018.
3. Bloch, Joshua. "*Effective Java*", Addison-Wesley Professional, 3rd Edition, 2017.
4. Sierra, Kathy and Bates, Bert. "*Head First Java*", O'Reilly Media, 2nd Edition, 2005.

Materials Online

1. https://docs.oracle.com/en/java/
2. https://www.geeksforgeeks.org/java
3. https://www.tutorialspoint.com/java/index.htm
4. https://www.coursera.org/courses?query=java

20. COURSE PLAN

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

S.No	Topics to be covered	CO's
1	Getting Started Exercises	CO 1
2	Exercises on Number Systems (for Science/Engineering Students)	CO 1
3	Exercises on Decision and Loop	CO 2
4	Exercises on Input, Decision and Loop	CO 2
5	Exercises on Nested-Loops (Patterns)	CO 2
6	Magic(Special) Numbers	CO 2
7	Exercises on String and char Operations	CO 2
8	Exercises on Arrays	CO 2
9	Exercises on Methods	CO 3
10	Exercises on Command-line Arguments, Recursion	CO 3
11	More (Difficult) Exercises	CO 3
12	Exercises on Classes	CO 4
13	Exercises on Inheritance	CO 5
14	Exercises on Polymorphism, Abstract Classes and Interfaces	CO 6

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1.	Given an array of integers nums and an integer target, return indices of the two numbers such that they add up to target.
2.	Given a sorted array of distinct integers and a target value, return the index if the target is found. If not, return the index where it would be if it were inserted in order.
3.	Given a roman numeral, convert it to an integer.

4.	Implement the myAtoi(string s) function, which converts a string to a 32-bit signed integer
5.	Given a string s, find the length of the longest substring without repeating characters.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

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

Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	LAB PROGRAMS/CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	LAB PROGRAMS/CIE/SEE
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	LAB PROGRAMS/CIE/SEE
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	LAB PROGRAMS/CIE/SEE
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	LAB PROGRAMS/CIE/SEE
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	LAB PROGRAMS/CIE/SEE

23. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	2	LAB PROGRAMS/CIE/SEE
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	2	LAB PROGRAMS/CIE/SEE
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	2	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

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

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

25. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
	PO 5	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
	PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
CO 3	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2
	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	4
CO 4	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	6
	PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	3
CO 5	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	PO 6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	3
	PSO 2	Focus on improving software reliability, network security or information retrieval systems.	1
CO 6	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	PO 6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	4
	PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	3
	PSO 2	Focus on improving software reliability, network security or information retrieval systems.	1

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	-	-	-	100	-	-	-	-	-	-	-	-	-	50
CO 2	33.3	70	-	-	-	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 3	33.3	70	-	-	-	-	-	-	-	-	-	-	66.6	-	-
CO 4	-	70	60	-	-	-	-	-	-	-	-	-	50	-	-
CO 5	-	70	-	-	-	20	-	-	-	-	-	-	50	50	-
CO 6	-	70	-	-	-	60	-	66.6	-	-	-	-	50	50	-

28. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

29. ASSESSMENT METHODOLOGY DIRECT:

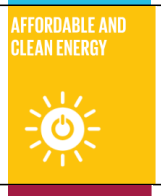
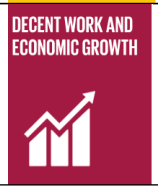
CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31.RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		
✓		**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
X		
X		
X		
X		

✓		**Industry, Innovation, and Infrastructure:** Java programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
X		
✓		**Sustainable Cities and Communities:** Java programming plays a crucial role in developing applications for smart cities, efficient transportation, and waste management systems. Through projects in the lab, students can explore ways to create more sustainable urban environments.
X		
✓		**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java programming. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X		
X		
X		

✓		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD, CSE (CS)**
Dr. C Labesh Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ENGINEERING CHEMISTRY LABORATORY
COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**			
2	Course Code	AHSD05			
3	Course Title	**ENGINEERING CHEMISTRY LABORATORY**			
4	Semester	I			
5	Regulations	BT-23			
6	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		-		36	
7	Course Offered	Odd Semester ✓		Even Semester ×	
8	Course Coordinator	Dr. B Divya			
9	Date Approved by BOS	24/08/2023			
10	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD05.pdf			
11	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-	-	-	-

12. Course Overview

The course promotes the use of analytical tools from an engineering standpoint. It provides the overview of analytical techniques, and outline the importance of volumetric analysis, comprehensive instrumental analysis for properties of polymers, colorimetric analysis, and spectroscopic analysis. This practical approach gives the awareness to chemical methods and perform testing of materials in various industries.

13. Course Objectives:

The students will try to learn:

I	The quantitative analysis to know the strength of unknown solutions by instrumental methods.
II	The troubles of hard water and its estimation by analytical techniques
III	The applications of appropriate lubricant for finely tuned machinery
IV	The basic knowledge on synthesis of nanomaterials and its properties

14. Course Outcomes:

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

CO1	**U**se conductivity meter and potentiometer for measurement of conductance and electromotive force of solutions
CO2	**U**se PH meter for measurement of Strength of Acidic Solutions.
CO3	**M**ake use of the principles of water analysis for domestic and industrial applications.
CO4	**P**redict the Properties of polymeric materials by synthesizing the monomers
CO5	**U**se different types of lubricants to know its properties for the proper lubrication of machinery in industries.
CO6	**I**nterpret the absorption tendency of solids or liquids by using Colorimetry and spectroscopy techniques.

15. Employability Skills

1. **Project based skills:** Awareness on instrumental methods of analysis and real-time applications through properties of materials.

16. Content Delivery / Instructional Methologies:

✓	 Day to Day lab evaluation	✓	 Demo Video	✓	 Viva Voce questions	x	 Open Ended Experiments
x	 Competitions	x	 hackathons	x	 Certifications	✓	Probing Further Questions

17. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks for internal assessment, continuous lab assessment will be done for 20 marks for the day today's performance including viva voce, 10 marks for the final internal lab assessment, and the remaining 10 marks for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) AppDevelopment (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report/Project and Presentation.

Table 1.0: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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

Table 2.0: Experiment based

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

Table 3.0: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

18. Course Content:

CO 1	**Use conductivity meter and potentiometer for measurement of conductance and electromotive force of solutions**
	1. Determine the Neutralization Point between Strong Acid against Strong Base 2. Estimate the Amount of Iron by Potentiometry 3. Determine the pH of the unknown solution by pH metry
CO 2	**Use PH meter for measurement of strength of acidic solutions.**
	1. Determine the pH of the unknown solution by pH metry
CO 3	**Make use of the principles of water analysis to control the hardness of water used in domestic and industrial purposes**
	1. Determination of chloride content of water by argentometry 2. Measurement of Total Dissolved Solids (TDS) in different water samples 3. Estimate the Total Hardness of water using EDTA
CO 4	**Predict the properties of polymeric materials by synthesizing the monomers.**
	1. Synthesize Thiokol rubber using sodium polysulphide with 1, 2-Dichloroethane.
CO 5	**Use the appropriate lubricant oil for the industrial machinery based on their properties.**
	1. Determine the Viscosity of the Lubricants using Red Wood Viscometer / Ostwald's Viscometer 2. Determine the Flash and Fire Points of Lubricants 3. Determine Cloud and Pour Points of Lubricants
CO 6	**Interpret the absorption tendency of solids or liquids using colorimetry and spectroscopic techniques.**
	1. Estimate the Metal Ion Concentration using Colorimeter 2. Characterization of Nanomaterials by UV-Visible Spectrophotometer

Note: One Course Outcome may be mapped to multiple number of experiments.

19. Course Plan:

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

S.No	Topics to be covered	CO's	Reference
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping ; Introduction to chemistry laboratory Safety guidelines to chemistry laboratory	CO 1	T2:10.31
2	Determine the neutralization point by titration of strong acid against strong base by conductometrically.	CO 1	T1:10.12 T2:10.31 R1:1.12.3
3	Studying the electrode potential measurements and estimate the amount of Fe^{2+} by using potentiometer.	CO 1	T2:10.31 R1:1.15
4	Determination of the pH of a given solution by pH metry	CO 1	T1:10.12 R1:1.16
5	Determination of chloride content of water by argentometry.	CO 2	T1:16.8 R1:1.13.1
6	Studying the water hardness and determine the Total Dissolved Solids (TDS) in each test liquid.	CO 3	T5:17.5 R1:1.13.2
7	Studying the specifications of water and estimate the total hardness of water by complexometric method	CO 3	T5:17.5 R1:1.13.3
8	Synthesize Thiokol rubber using sodium polysulphide with 1, 2-Dichloroethane.	CO 4	T3:2.6 R1:1.7.1
9	Studying the viscosity of lubricants and determine the viscosity of lubricants at various temperature using Red wood viscometer	CO 5	T1:19.10 R1:1.17.3
10	Determination of flash and fire points of lubricants by using Pensky Martens apparatus	CO 5	T1:19.10 R1:2.6.1
11	Determination of cloud and pour points of lubricants.	CO 5	T1:19.10 R1:2.6.2
12	Estimation of metals ion concentration by colorimetry	CO 6	T2:16.9 R1:2.10
13	Characterization of nanomaterials by using UV-visible spectrophotometer	CO 6	T2:16.9

20 Experiments for Enhanced Learning (EEL):

S.No	Design Oriented Experiments
1	To study the Beer Lambert's Law and utilize for the determination metal concentration in effluents by colorimetry
2	To study the absorption edges of metal complex using spectrophotometry
3	To study the iron content by potentiometry using different oxidizing agents

21. Program Outcomes & Program Specific Outcomes:

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

Program Outcomes	
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

22. How program outcomes are assessed:

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

23. How program specific outcomes are assessed:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	0	
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	0	

PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	0	

3 = High; 2 = Medium; 1 = Low

24. Mapping of each CO with PO(s),PSO(s):

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

25. Justifications for CO – PO / PSO mapping - direct:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Explain basic principle of conductance and EMF to make use of titrimetry to obtain graphical plots to determine the strength of acid by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Use basic principles of conductance and EMF to find the neutralization point that helps in interpretation of results..	2
CO 2	PO 1	Interpret the basic principles of pH metry to find the pH of unknown solutions and obtain graphical plots to determine the strength of acid by using principles of science and mathematical expressions or solving engineering problems.	3
	PO 2	Make use of pH metry and find the neutralization point that helps in interpretation of results.	2
CO 3	PO 1	Make use of coloured indicators to complex the metal ions, Investigate the concentration of hardness causing salts using Complexometry and argentometry methods by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Identify the problems of hard water and examine the total dissolved salts that provides information and data for its usage in industry.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 7	Recognize the problems in industries by using hard water and its impact in socio economic and environmental contexts for sustainable development.	2
CO 4	PO 1	IExplain the polymerization process to synthesize the polymers from monomers by using principles of science and for solving engineering problems	2
CO 5	PO 1	Describe the physical properties of a lubricant and its determination using instrumental methods by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Extend the properties of lubricants with experimental collection of information and data in reaching conclusions by the interpretation of results.	2
CO 6	PO 1	Explain the principle of molecular transitions and make use of mathematical expression of Beer Lambert's Law colorimetry and UV-VIS spectroscopy by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Utilize graphical analysis of concentration versus absorbance for a given solution, and interpret the data, to provide valid conclusions regarding the quantitative analysis.	2

26. Total count of key competencies for CO – (PO, PSO) MAPPING:

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

27. Percentage of key competencies for CO – (PO, PSO):

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

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

28. Course articulation matrix (PO – PSO mapping):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	17	10	-	-	-		-	-	-	-	-	-	-	-	-
AVERAGE	2.8	2	-	-	-	-	2	-	-	-	-	-	-	-	-

29. Assessment methodology direct:

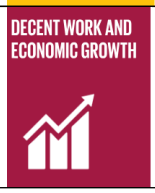
CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. Assessment methodology indirect:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		**Quality Education:** Enhancement in the additional skills for the students with analytical tools.
5		
6		**Clean Water and Sanitation:** Ensures the availability to clean water through hard water analysis and its removal with chemical methodology
7		
8		

9		
10		
11		
12		
13		
14		**Life Below Water:** Knowledge gained on the colorimetry provides awareness to students on the effect of metals from industrial effluents on living organisms in water bodies
15		

16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,CSE(CS)**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ENGINEERING GRAPHICS
COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**			
2	Course Title	**ENGINEERING GRAPHICS**			
3	Course Code	AMED03			
4	Program	B.Tech			
5	Semester	I Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		15		30	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Faculty	Mr. V Phaninder Reddy			
10	Date Approved by BOS	30/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**

13. Course Overview

Introduction to graphical representation using free hand drawing and computer-aided drafting. Engineering graphics covers basic engineering drawing techniques such as lines & lettering, geometrical constructions, principles of tangency, orthographic projections, sectional views, and dimensioning. This course assists to draw 2D drawings for industrial applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	The basic engineering drawing formats.
II	Projections of points, lines, planes and solids at inclinations of horizontal plane and vertical plane.
III	Use of computer-aided design (CAD) to communicate concepts and ideas in the design of three-dimensional engineering products.

15. COURSE OUTCOMES:

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

CO 1	**Demonstrate** an ability to dimension and annotate two-dimensional engineering graphics..	Understand
CO 2	**Demonstrate**the freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.	Understand
CO 3	**Make use of** CAD software for the creation of 3D models and 2D engineering graphics.	Apply
CO 4	**Comprehend** the principles and techniques for creating sectional views of three-dimensional solids in engineering graphics.	Understand
CO 5	**Explain** the application of industry standards and best practices applied in engineering graphics.	Understand
CO 6	**Apply** the general projection theory with emphasis on orthographic projection to represent three-dimensional objects in two-dimensional views.	Apply

16. Employability Skills

1. **Employment advantage:** This can give competitive advantage when seeking employment as Design Engineer.
2. **Problem-Solving and Analytical Thinking:** Engineering Drawing involves CFD analysis and structural analysis of structures before inspection of prototype. This cultivates the ability to think critically and find innovative solutions, which is a fundamental skill sought by employers before finalization of product design in industries.
3. **Safety Awareness:** The analysis, decides the safety factor for the machine member when subjected to static and dynamic forces which enhances safety consciousness. Graduates should consider this awareness in every engineering industry where safety is a priority.

17. Content Delivery / Instructional Methologies:

✓	 Day to Day lab evaluation	✓	 Demo Video	✓	 Viva Voce questions	x	 Open Ended Experiments
x	 Competitions	x	 hackathons	x	 Certifications	✓	Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
	5	5	5	5	20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT SYLLABUS:

CO 1	**Demonstrate an ability to dimension and annotate two-dimensional engineering graphics.**
	1. Introduction to CAD 2. Introduction to Engineering Drawing 3. Exercises on Dimensioning 4. Exercises on Geometrical Constructions
CO 2	**Demonstrate the freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.**
	1. Exercises on Conic Sections
CO 3	**Make use of CAD software for the creation of 3D models and 2D engineering graphics.**
	1. Exercises on Technical Sketching and Shape Description
CO 4	**Comprehend the principles and techniques for creating sectional views of three-dimensional solids in engineering graphics.**
	1. Exercises on Sectional views
CO 5	**Explain the application of industry standards and best practices applied in engineering graphics.**
	1. Exercise on Development of surfaces-1 (Prisms) 2. Exercise on Development of surfaces-2 (Cylinder, Cone and Pyramid)
CO 6	**Apply the general projection theory with emphasis on orthographic projection to represent three-dimensional objects in two-dimensional views.**
	1. Exercise on orthographic views 2. Exercise on Isometric projection of planes 3. Exercise on isometric projections of solids 4. Demonstration of SOLID WORKS Software 5. Demonstration of CREO Software

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. Frederick E Giesecke, Alva Mitchell, Henry C Spencer, Ivan L Hill, John T Dygdon, James E. Novak, R. O. Loving, Shawna Lockhart, Cindy Johnson" *Technical Drawing with Engineering Graphics*", Pearson Education, 16th Edition, 2016.
2. Donald Hearn "*Computer Graphics*", Pearson Education, 12th Edition, 2021.

REFERENCE BOOKS:

1. Basant Agrawal and C M Agrawal "*Engineering Drwing*", 3 rd Edition, Mc GraHill, 2018.
2. James M. Leake, Molly Hathaway Goldstein, Jacob L. Borgerson, "*Engineering Design Graphics, Modelling and Visualization* ", Wiley Publications, 3 rd Edition, 2020.

MATERIALS ONLINE:

1. Lecture notes, ELRV videos and power point presentations
2. Answers / solutions to all questions / problems in the textbook
3. Online exercises
4. Problems and solutions in files

20. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Introduction to AUTOCAD	CO 1	
2	Introduction to Engineering Drawing	CO 1	T1:5.6 R1:1.12.3
3	Exercises on Dimensioning	CO 1	T2:5.10 R1:1.15
4	Exercises on Geometrical Constructions	CO 1	T2:5.15 R1:1.16
5	Exercises on Conic Sections	CO 2	T2:5.17 R1:1.13.1
6	Exercises on Technical Sketching and Shape Description	CO 3	T2:5.18 R1:1.13.2
7	Exercises on Sectional views	CO 4	T2:5.19 R1:1.13.3
8	Exercise on Development of surfaces-1(Prisms)	CO 5	T2:5.20 R1:1.7.1
9	Exercise on Development of surfaces-2 (Cylinder, Cone, Pyramid)	CO 5	T2:5.24 R1:1.17.3
10	Exercise on orthographic views	CO 6	T2:6.3 R1:2.6.1
11	Exercise on Isometric projection of Planes	CO 6	T2:6.5 R1:2.6.2
12	Exercise on Isometric projection of Solids	CO 6	T2:7.7 R1:2.10

S.No	Topics to be covered	CO's	Reference
13	Demonstration of SOLID WORKS Software	CO 6	T2:7.11
14	Demonstration of CREO Software	CO 6	T2:7.11

21. EXPERIMENS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Develop the procedure to draw knuckle joint by using AUTO CAD.
2	Develop the standard procedure to draw 2D drawing of any machine component by using AUTO CAD.

22. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

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

Program Outcomes	
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

23. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/Quiz/AAT
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	CIE/Quiz/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Seminar / Conferences / Research papers
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Seminar / Conferences / Research papers
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Seminar / Conferences / Research papers

24. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications	-	-
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	-	-
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

26. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2
CO 2	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2
CO 3	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2
CO 4	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2
CO 5	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2
CO 6	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of designing.	2

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 2	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 3	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 4	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 5	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 6	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-

29. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

30. ASSESSMENT METHODOLOGY DIRECT:

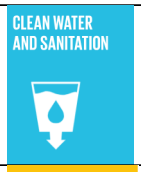
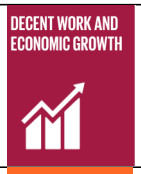
CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

31. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

32. Relevance to Sustainability goals

1		
2		
3		

4		**Quality Education:** An engineering drawing course provides students with a strong foundation in design-analysis skills, enhancing their overall educational experience and empowering them to address real-world challenges.
5		
6		**Clean Water and Sanitation:** Proper infrastructure design, can contribute to the effective delivery of clean water and sanitation services, benefiting communities' health and well-being.
7		**Affordable and Clean Energy:** Engineering drawing plays a role in the design and analysis of equipments, contributing the sustainable energy solutions. Students learn to optimize energy use, design renewable energy systems, and enhance energy efficiency in various applications.
8		**Decent Work and Economic Growth:** Engineering drawing equips students with skills that contribute the job creation and economic growth while also promoting ethical and responsible engineering practices.
9		**Industry, Innovation, and Infrastructure:** Engineering drawing principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.
10		
11		**Sustainable Cities and Communities:**Engineering drawing underpins the construction and maintenance of urban infrastructure, which can withstand environmental challenges and contribute to the safety and sustainability of urban spaces.
12		
13		

14		
15		
16		
17		

Approved by: Board of Studies in the meeting conducted on30/08/2023

Signature of Course Faculty **HOD,CSE (CS)**
Mr V Phaninder Reddy, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**CSE (CYBER SECURITY)**	
2	Course Title	**MOBILE APPLICATIONS DEVELOPMENT**	
3	Course Code	ACSD04	
4	Program	B.Tech	
5	Semester	I Semester	
6	Regulation	BT-23	
7	Structure of the course	Practical	
		Lecture Hours	Practical Hours
		0	3
8	Course Offered	Odd Semester ✓	Even Semester ×
9	Course Coordinator	Ms.K.Praveena	
10	Date Approved by BOS	29/08/2023	
11	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse	
12	Course Pre-requistes	Object Oriented Programming	

13. Course Overview

This course focuses on hands-on experience in designing, developing, and testing mobile applications for various platforms helps to gain practical skills in mobile app development, including user interface design, programming, and deployment. The applications of this course can be pre-installed on phones and mobile app development have been required to create various applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	The mobile application development for different platforms using appropriate tools and frameworks.
II	The user interface design with best practices for usability and user experience.
III	The process of debugging and troubleshooting for common issues in mobile app development.

15. COURSE OUTCOMES:

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

CO 1	**Apply** layout management and multi layout techniques to create adaptable user interface	Apply
CO 2	**Develop** user interface for mobile application using widgets with event handling.	Develop
CO 3	**Design** push notifications for incoming messages.	Design
CO 4	**Create** mobile application models using appropriate range of methods provided.	Create
CO 5	**Evaluate** applications on mobile platforms with different configurations.	Evaluate
CO 6	**Deploy** applications to the android marketplace for distribution to app store.	Apply

16. Employability Skills

1. **Employment advantage:** This can give competitive advantage when seeking employment as Application Development.
2. **Problem-Solving and Analytical Thinking:** Students are expected to design and develop a high-quality mobile application that addresses a real-world problem in an innovative way. Coursework will include project conception, design, implementation, and pilot testing of mobile phone software applications.

17. Content Delivery / Instructional Methologies:

✓	 Day to Day lab evaluation	✓	 Demo Video	✓	 Viva Voce questions	x	 Open Ended Experiments
x	 Competitions	x	 hackathons	x	 Certifications	✓	Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

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

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. SYLLABUS:

CO 1	**Apply layout management and multi layout definition techniques to create adaptable user interface**
	1. Food ordering application 2. Music player application 3. Smart Health Prediction
CO 2	**Develop user interface for mobile Application using widgets with event handling.**
	1. Hostel Management Application 2. Stay safe women security application 3. Controlling Anti Ragging Application
CO 3	**Design push notifications for incoming messages.**
	1. Extracurricular Event Tracking Application 2. Student management system 3. Pharm easy application
CO 4	**Create Mobile application models using appropriate range of methods provided.**
	1. News Application 2. Air Transit Trip Planner App 3. Student-Faculty Document Sharing System
CO 5	**Evaluate applications on mobile platforms with different configurations.**
	1. Online Recruitment System 2. Student Counseling Management System 3. Data Mart Management System
CO 6	**Deploy applications to the android marketplace for distribution to app store.**
	1. Restaurant Reservation And Table Management System 2. Secure Stock Exchange System 3. Country Cargo And Express Couriers System

TEXTBOOKS

1. 1. Reto Meier, Professional Android 4 Application Development, Wile Publication, 1 st Edition, 2012.

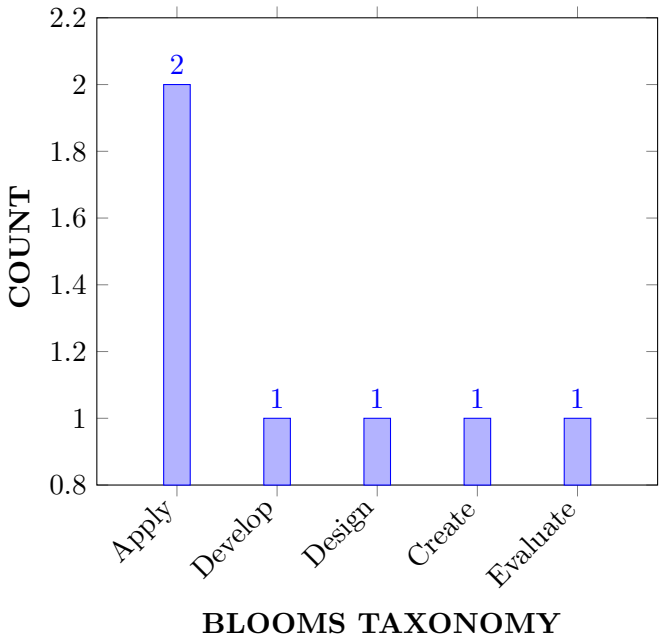
REFERENCE BOOKS:

1. 1. Bill Phillips and Chris Stewart, Kristin Marsicano "*Android Programming*", The Big Nerd Ranch Guide, O'Reilly, 3rd Edition, 2017.
2. 2.Dawn Griffiths, David Griffiths, "*Head First Android Development: A Learner's Guide to Building Android Apps with Kotlin, Third Edition,* ", O'Reilly, 3rd Edition, 2021.
3. 3.Antonio Leiva, "*Kotlin for Android Developers: Learn Kotlin while developing an Android App,*", CreateSpace Independent Publishing, 1st Edition, 2016.

MATERIALS ONLINE:

1. Course Template
2. Lab Manual

20. COURSE KNOWLEDGE COMPETENCY LEVEL



21. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

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

Program Outcomes	
Program Specific Outcomes	
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Experiments /CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Experiments / CIE / SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and Environmental considerations.	3	Lab Experiments / CIE / SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Lab Experiments / CIE / SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Experiments / CIE / SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Lab Experiments / CIE / SEE

PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Lab Experiments / CIE / SEE
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.	1	Lab Experiments / CIE / SEE
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Lab Experiments / CIE / SEE

23. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Develop secure software with vulnerability assessment, and security requirements, designed with the least privileges for the protection of digital applications.	3	Lab Programs/ CIE /SEE
PSO 2	Evaluate the function of cyber security by identifying the tools and systems to minimize the risk to an organization's cyberspace.	3	Lab Programs/ CIE /SEE
PSO 3	Apply machine learning models, methods, and techniques for data analysis, data handling, and data visualization for effective decision-making.	3	Lab Programs/ CIE /SEE

3 = High; 2 = Medium; 1 = Low

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

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

25. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the mathematics, science and Engineering fundamentals to problems for determining reactions, resultants and condition for equilibrium of structure using the knowledge of mathematics and science fundamentals.	2
	PO 2	Formulate the complex engineering problems to determine the reactions, resultants and condition for equilibrium of given force systems by identify the problem statement, formulation, data collection and validation for the analysis.	4
	PSO 2	Focus on improving software reliability, network security or information retrieval system	2
CO 2	PO 1	Apply the mathematics, science and Engineering fundamentals to problems involving frictional force additionally in system of forces using the knowledge of mathematics and science fundamentals.	3
	PO 2	Formulate the complex engineering problems involving frictional force and normal reaction by identify the problem statement, formulation, data collection and validation for the analysis.	3
CO 3	PO 1	Apply the mathematics, science and Engineering fundamentals for locating centroid and centre of gravity using the knowledge of mathematics and science fundamentals.	2
	PO 2	Formulate the complex engineering problems involving centroid and centre of gravity by identifying the problem statement, formulation, data collection and validation .	4
	PSO 2	Focus on improving software reliability, network security or information retrieval system	2
CO 4	PO 1	Apply the mathematics, science and Engineering fundamentals to problems involving area moment of inertia and mass moment of inertia using the knowledge of mathematics and science fundamentals.	2
	PO 2	Formulate the complex engineering problems involving area moment of inertia and mass moment of inertia by identify the problem statement, formulation, data collection and validation .	4
	PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 5	PO 1	Apply the mathematics, science and Engineering fundamentals to of kinematics and kinetics problems using the knowledge of mathematics and science fundamentals.	2
	PO 2	Formulate the complex engineering problems involving kinematics and kinetics by identify the problem statement, formulation, data collection and validation .	2
	PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	2
CO 6	PO 1	Apply the mathematics, science and Engineering fundamentals to dynamic equilibrium the problems for analysis of forces using the knowledge of mathematics and science fundamentals.	2
	PO 2	Formulate the complex dynamic equilibriums by identify the problem statement, formulation, data collection and validation .	4
	PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur anddesire for higher studies.	3

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6
CO 2	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6
CO 3	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 4	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6
CO 5	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6
CO 6	66.6	40	66.6	40	66.6	-	-	-	66.6	40	66.6	40	66.6	33.3	66.6

28. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

0 - 0≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

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

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

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

31. COURSE PLAN:

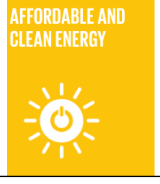
The course plan is meant as a guideline. Probably there may be changes.

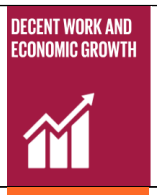
S.No	Topics to be covered	CO's	Reference
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	CO 1	
2	Getting Started An Excercises: **1.1 Helloworld**	CO 1,CO2	T2:5.6 R1:1.12.3
3	Food Ordering Application	CO 1,CO2,CO3	T2:5.10 R1:1.15
4	Music Player Application:	CO 2,CO3,CO4	T2:5.15 R1:1.16
5	Smart Health Prediction:	CO 2,CO3,CO4	T2:5.17 R1:1.13.1
6	Hostel Management Application:	CO 3,CO4,CO5	T2:5.18 R1:1.13.2
7	Stay Safe Women Security Application:	CO 4,CO5,CO6	T2:5.19 R1:1.13.3
8	Controlling Anti Ragging Application:	CO 3,CO4,CO5	T2:5.20 R1:1.7.1
9	Extracurricular Event Tracking Application	CO 3,CO4,CO6	T2:5.24 R1:1.17.3
10	Student Management System	CO 2,CO4,CO5	T2:6.3 R1:2.6.1
11	Pharm Easy Application	CO 2,CO4,CO5	T2:6.5 R1:2.6.2
12	News Application	CO 4,CO5,CO6	T2:7.7 R1:2.10
13	Air Transit Trip Planner App	CO 3,CO4,CO5	T2:7.11
14	Student-Faculty Document Sharing System	CO 2,CO4,CO5	T2:7.11
15	Online Recruitment System	CO 2,CO3,CO4	T2:15.2 R1:8.2
16	Student Counseling Management System	CO 2,CO4,CO5	T2:15.7 R1:8.3.3
17	Data Mart Management System	CO 3,C05,C06	T2:2.1 R1:7.9.2
18	Restaurant Reservation And Table Management System	CO 3,CO5,CO6	T2:2.2 R1:7.9.1

S.No	Topics to be covered	CO's	Reference
19	Secure Stock Exchange System	CO 4,C05,C06	T2:2.4 R1:7.11
20	Country Cargo And Express Couriers System	CO 3,CO5,C06	T2:16.8 R1:8.12.1

32. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		**Quality Education:** An Mobile Applications Decelopment course provides students with a strong foundation in design-analysis skills, enhancing their overall educational experience and empowering them to address real-world challenges.
5		
6		
7		

8		
9		**Industry, Innovation, and Infrastructure:** Mobile applications development principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.
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Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,CSE(CS)**
K.Praveena, Assistant Professor