DEPARTMENT OF MECHANICAL ENGINEERING

Institute Vision:

To develop highly skilled professionals with strong ethical and human values.

Institute Mission:

M1: To impart quality education through effective teaching–learning practices, industrial exposure, and professional training.

M2: To produce competent and highly knowledgeable graduates with a positive attitude and problem-solving ability.

M3: To instill self-confidence, leadership qualities, and social responsibility to face professional and societal challenges.

Department Vision

To be a recognized center for quality education and applied research in Mechanical Engineering, Producing skilled professionals with an innovation mindset and ethical values.

Department Mission

M1: To impart strong foundational and advanced knowledge in Mechanical Engineering through effective and learner-centric teaching–learning practices.

M2: To develop analytical, design, and problem-solving abilities by providing hands-on laboratory experience, project-based learning, and industry exposure.

M3: To foster innovation, research aptitude, and the effective use of modern engineering tools to address real-world engineering challenges.

M4: To inculcate professional ethics, teamwork, leadership qualities, and concern for sustainable development and societal needs.

Program Educational Objectives (PEOs)

PEO1: Graduates will establish successful careers in mechanical engineering and allied industries or pursue higher studies and research.

PEO2: Graduates will apply fundamental and advanced mechanical engineering principles to analyze, design, and solve complex engineering problems.

PEO3: Graduates will demonstrate proficiency in modern engineering tools, effective

communication, teamwork, and project management skills.

PEO4: Graduates will exhibit professional ethics, leadership qualities, social responsibility, and commitment to lifelong learning.

Program Specific Outcomes (PSOs):

PSO1: Ability to design, analyze, and optimize mechanical components and systems using modern CAD/CAM and engineering analysis tools.

PSO2: Ability to apply principles of manufacturing, thermal, and fluid engineering to develop efficient, sustainable, and practical engineering solutions.

Program Outcomes (POs):

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

COURSE STRUCTURE
AND
DETAILED SYLLABUS
(Up to II Year)

B.Tech

in

MECHANICAL ENGINEERING

Academic Regulation – R24

Applicable for the batches admitted from 2024-2025

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
(Autonomous)
(Approved by A.I.C.T.E., NewDelhi,& Permanently Affiliated to J.N.T.U-GV, Vizianagaram)
NAAC"A+" Accredited Institute
Cherukupally (Village), Near Tagarapuvalasa Bridge, Vizianagaram(Dist), A.P- 531162.
www.aietta.ac.in,principal@aietta.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

Course Structure

Program– B. Tech in Mechanical Engineering

Regulation-R24

Induction Programme

S.No	Course Title	Category	L-T-P-C
1	Physical Activities--Sports, Yoga and Meditation, Plantation	MC	0-0-6-0
2	Career Counseling	MC	2-0-2-0
3	Orientation to all branches -- career options, tools, etc	MC	3-0-0-0
4	Orientation on admitted Branch -- corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency Modules & Productivity Tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial Training in Foundation Courses	MC	2-1-2-0
8	Human Values & Professional Ethics	MC	3-0-0-0
9	Communication Skills -- focus on Listening, Speaking, Reading, Writing skills	BS	2-1-2-0
10	Concepts of Programming	ES	2-0-2-0

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech in Mechanical Engineering Regulation: R24

I Year I Semester- Course Structure

S.No.	Category	Course Code	Course Name	Hours per Week			
				L	T	P	Credits
1.	BS	R24BS01	Linear Algebra & Calculus	3	0	0	3
2.	BS	R24BS07	Engineering Chemistry	3	0	0	3
3.	ES	R24ES02	Problem solving and programming with C	3	0	0	3
4.	ES	R24ES06	Engineering Graphics	1	0	4	3
5.	ES	R24ES05	Basic Electrical & Electronics Engineering	3	0	0	3
6.	BS	R24BS08	Engineering Chemistry Lab	0	0	2	1
7.	ES	R24ES03	Problem solving and programming with C Lab	0	0	3	1.5
8.	ES	R24ES07	Basic Electrical & Electronics Engineering Lab	0	0	3	1.5
9.	ES	R24ES08	Engineering Workshop	0	0	3	1.5
10.	MC	R24MC01	Health and Wellness, Yoga and Sports	0	0	1	0.5
			Total	**13**	**0**	**16**	**21**

Category	Courses	Credits
BS- Basic Sciences Course	3	7
ES- Engineering Science Courses	6	13.5
MC- Mandatory Course	1	0.5
Total	10	21

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech in Mechanical Engineering Regulation: R24

I Year II Semester- Course Structure

S.No.	Category	Course Code	Course Name	Hours per Week			
				L	T	P	Credits
1.	BS	R24BS04	Differential Equations and Vector Calculus	3	0	0	3
2.	BS	R24BS02	Engineering Physics	3	0	0	3
3.	HS	R24HS01	Communicative English	2	0	0	2
4.	ES	R24ES01	Basic Civil & Mechanical Engineering	3	0	0	3
5.	PC	R24MEPC01	Engineering Mechanics	3	0	0	3
6.	HS	R24HS02	Communicative English Lab	0	0	2	1
7.	BS	R24BS03	Engineering Physics Lab	0	0	2	1
8.	ES	R24ES04	IT workshop	0	0	2	1
9.	PC	R24MEPC02	Engineering Mechanics Lab	0	0	3	1.5
10.	MC	R24MC02	NSS/NCC/Scouts & Guides/ Community Service	0	0	1	0.5
			Total	**14**	**0**	**10**	**19**

Category	Courses	Credits
BS- Basic Sciences Course	3	7
PC- Professional Core Courses	2	4.5
HS- Humanities and Social Science including Management	2	3
ES- Engineering Sciences	2	4
MC- Mandatory Course	1	0.5
Total	10	19

Chairperson
Board of Studies (ME)

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
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www.aietta.ac.in, principal@aietta.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B.Tech- Mechanical Engineering **Regulation- R24**

II Year I Semester- Course Structure

S.No	Category	Course Code	Course Name	Hours per Week			
				L	T	P	Credits
1	BS	R24BS10	Numerical Methods and Transform Techniques	3	0	0	3
2	PC	R24MEPC03	Thermodynamics	3	0	0	3
3	PC	R24MEPC04	Mechanics of Solids	3	0	0	3
4	PC	R24MEPC05	Engineering Materials & Manufacturing Processes	3	0	0	3
5	PC	R24MEPC06	CAD/CAM	3	0	0	3
6	PC	R24MEPC07	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7	SC	R24MESC01	Computer-Aided Modeling Lab	0	0	3	1.5
8	PC	R24MEPC08	Manufacturing processes Lab	0	0	3	1.5
9	HS	R24HS04	Logical Reasoning and Corporate Communication Skills	0	0	2	1
10	MC	R24MC03	Environmental Science	2	0	0	0
			Total	**17**	**0**	**11**	**20.5**

Category	Courses	Credits
BS- Basic Sciences Course	1	3
PC- Professional Core Courses	6	15
HS- Humanities and Social Science including Management	1	1
SC- Skill Enhancement Courses	1	1.5
MC- Mandatory Course	1	0
Total	10	20.5

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B.Tech- Mechanical Engineering **Regulation- R24**

II Year II Semester- Course Structure

S.No	Category	Course Code	Course Name	Hours per Week			
				L	T	P	Credits
1	BS	R24BS09	Complex Variables and Statistical Methods	3	0	0	3
2	PC	R24MEPC09	Fluid Mechanics & Hydraulic Machines	3	0	0	3
3	PC	R24MEPC10	Theory of Machines	3	0	0	3
4	PC	R24MEPC11	Machine Tools & Metrology	3	0	0	3
5	HS	R24HS03	Universal Human Values–Understanding Harmony & Ethical human conduct	2	0	0	2
6	PC	R24MEPC12	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	PC	R24MEPC13	Theory of Machines Lab	0	0	3	1.5
8	SC	R24MESC02	Drones & Digital Fabrication Lab	0	0	3	1.5
9	HS	R24HS05	Numerical Ability & Professional Communication Skills	0	0	2	1
10	MC	R24MC05	Design Thinking & Innovation	0	1	2	2
			Total	**14**	**1**	**13**	**21.5**
Mandatory Community Service Project Internship of 08 weeks duration during summer Vacation							

Category	Courses	Credits
BS- Basic Sciences Course	1	3
PC- Professional Core Courses	5	12
HS- Humanities and Social Science including Management	2	3
SC- Skill Enhancement Courses	1	1.5
ES- Engineering Sciences	1	2
Total	10	21.5

Chairperson
Board of Studies (ME)

24BS01 **Linear Algebra and Calculus** **3 0 0 3**
(Common to all Branches)

Course Objectives:

1. To equip the students with standard concepts and tools of mathematics to handle various real- world problems and their applications.
2. To enable the students to apply linear algebra to solve engineering problems.
3. To enable the students to apply calculus to solve engineering problems.

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS01.1	Develop matrix algebra techniques that are needed by engineers for practical applications.	3	2	1	L1,L2,L3
R24BS01.2	To find the eigen values and eigen vectors and solve the problems by using linear transformation.	3	2	1	L1,L2,L3
R24BS01.3	Apply the knowledge of mean value theorems, solve inequality.	3	2	1	L1,L2,L3
R24BS01.4	Familiarize with functions of several variables which is useful in optimization.	3	2	1	L3,L4
R24BS01.5	Familiarize with double and triple integrals of functions of several variables in two and three dimensions.	3	2	1	L4,L5

SYLLABUS

UNIT-I: Matrices and Linear System of Equations **10 Hours**

Matrices: Vector Space, Linear independent, dependent (only definitions).
Rank of a matrix by echelon form, normal form. Cauchy-Binet formulae (without proof). Inverse of Non- singular matrices by Gauss- Jordan method.

System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method. **COs-CO1**

Self-Learning Topic: Encoding and Decoding messages by using matrices

UNIT- II: Linear Transformation and Orthogonal Transformation **10 Hours**

Eigen values and Eigen vectors and their properties(without proof), Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley–Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation. **COs-CO2**

Self-Learning Topic: Google's page rank Algorithm.

UNIT–III: Calculus **10 Hours**

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), problems on the above theorems. **COs-CO3**

Self-Learning Topic: Application of mean value theorems

UNIT- IV: Partial differentiation and Applications **10 Hours**

Partial derivatives, total derivatives, chain rule, change of variables, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobian, maxima and minima of functions of two variables, method of Lagrange multipliers. **COs-CO4**

Self-Learning Topic: Jacobian of implicit functions.

UNIT-V: Multiple Integrals **10 Hours**

Double integrals - change of variables (Cartesian and Polar coordinates), change of order of integration, Cylindrical and Spherical coordinates, triple integrals. Finding areas (by double integrals) and volumes (by double integrals and triple integrals). **COs-CO5**

Self-Learning topic: Calculating Centers of Mass and Moment of inertia

Board of Studies : Mathematics-Basic Science and Humanities
Approved in BOS No:01, August, 2024
Approved in ACM No: 01, August, 2024

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:

1. Dennis G. Zill and Warren S. Wright , Advanced Engineering Mathematics, Jones and Bartlett, 2018.
2. Michael Green berg, Advanced Engineering Mathematics, 9th edition, Pearson edn.
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science
5. International Ltd., 2021 (9th reprint).
6. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017.

Web References:

1. http://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses/111105121
3. https://onlinecourses.nptel.ac.in/noc24_ma91/course
4. https://onlinecourses.nptel.ac.in/noc24_ma53/course
5. https://onlinecourses.nptel.ac.in/noc24_ma11/course

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	--	25
L5	--	25
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-I

1. State Cauchy-Binet formulae (L1)
2. Define Echelon form of a matrix(L1)
3. Test for consistency and solve $2x+3y+7z=5;3x+y-3z=12;2x+19y-47z=32(L2)$
4. Discuss for what value of λ,μ the simultaneous equations

$x+y+z=6, x+2y+3z=10, x+2y+\lambda z=10$ have (i)no solution(ii) a unique solution (iii) an infinite number of solutions.(L2)

5. Reduce the matrix $\begin{bmatrix} 8 & 1 & 3 & 6 \\ 0 & 3 & 2 & 2 \\ -8 & -1 & -3 & 4 \end{bmatrix}$ into its normal form and hence find its rank.(L2)
6. Find the value of k such that the rank of $\begin{bmatrix} 1 & 2 & 3 \\ 2 & k & 7 \\ 3 & 6 & 10 \end{bmatrix}$ is 2. (L2)

UNIT-II

1. State Cayley-Hamilton theorem (L1)
2. Find the sum and product of the eigen values of $\begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ (L1)
3. Find the latent roots and latent vectors of $A=\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ (L2)
4. Use Cayley-Hamilton theorem to express $A^5-4A^4-7A^3+11A^2-A-10I$ as a linear polynomial in A. where $A=\begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$ (L3)

UNIT-III

1. State Lagrange's mean value theorem(L1)
2. Verify Rolle's theorem for the function $f(x)=(x-a)^m(y-b)^n$ where m.n are positive integers in $[a,b]$ (L2)
3. Calculate approximately $\sqrt[5]{245}$ by using Lagrange's mean value theorem (L3)

UNIT-IV

1. Find the maximum and minimum values of $3x^4-2x^3-6x^2+6x+1$ in $(0,2)$ (L4)
2. If $x+y+z, uv=y+z, uvw=z$, show that $\frac{\partial(x,y,z}{\partial(u,v,w)}=u^2v$ (L4)
3. In plane triangle, finds the maximum value of $\cos A\cos B\cos C$ (L4)

UNIT-V

1. $\int_0^\infty\int_0^\infty e^{-(x^2+y^2)}dxdy$ (L5)
2. Evaluate $\iint(x^2+y^2)dxdy$ over the area bounded by the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (L5)

Chairperson
Board of Studies (Mathematics)

R24BS07 **ENGINEERING CHEMISTRY** **3 0 0 3**

(Mechanical Engineering)

Course objectives:

1. To familiarize engineering chemistry and its applications.
2. To impart the concept of soft and hard waters, softening methods of hard water.
3. To train the students on the principles and applications of electrochemistry, polymers, surface chemistry and cement.
4. To impart basic concepts of fuels.
5. To introduce Refractories.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs		Dok
		PO1	PO12	
R24BS07.1	Assessment of the quality of water, Specifications for drinking water	3	1	L1,L2, L5
R24BS07.2	Demonstrate the corrosion prevention methods and factors affecting corrosion.	3	1	L1, L2
R24BS07.3	Explain the Preparation, Properties and applications of thermo plastics & thermo setting plastics, Explain calorific values, octane number, refining of petroleum and cracking of oils.	3	1	L1, L2
R24BS07.4	Explain the setting and hardening of cement.	3	1	L2,L3, L4
R24BS07.5	Summarize the concepts of colloids, micelle and nano materials.	3	1	L1, L2,L5

SYLLABUS

UNIT-I: Water Technology **10 Hours**

Soft and hard water, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen – Boiler troubles **–**Priming, foaming**,** scale and sludge, Caustic embrittlement, Industrial Water treatment–Specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, Ion-exchange processes – desalination of brackish water, reverse osmosis (RO) and electro dialysis. **COs-CO1**

Self-Learning Topics: Parameters of drinking water.

UNIT-II: Electro chemistry and Applications: **10 Hours**

Electrodes–electrochemical cell, Nernst equation, cell potential calculations. Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (Ni-Cd), and lithium ion batteries-working principle of the batteries including cell reactions;

Fuel cells-Basic Concepts, the principle and working of hydrogen -oxygen Fuel cell.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electro less plating (Nickel), Paints (Constituents and Functions) **. COs-CO2**

Self-Learning Topics: Pb-Acid battery, Methods of Coatings for Controlling Corrosion.

UNIT- III: Polymers and Fuel Chemistry **10 Hours**

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth polymerization (Free radical).

Plastic: Thermoplastics and Thermo-setting plastics, Preparation, properties and applications of polystyrene, PVC, Nylon 6,6 and Bakelite.

Elastomers– Preparation, properties and applications of Buna S Buna N and Thiokol rubbers.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number, Gaseous Fuels **,** liquefied petroleum gas, Flue gas analysis by orsat apparatus.

COs-CO3

Self-Learning Topics: Differences between Thermoplastics and Thermo-setting plastics, Gaseous Fuels.

UNIT-IV Modern Engineering Materials **10 Hours**

Composites- Definition, Constituents, Classification- Particle, Fiber and Structural reinforced composites, properties and Engineering applications.

Refractories- Classification, Properties, Factors affecting the refractory materials and Applications. Lubricants- Definition, mechanism, properties and importance of lubricants, Viscosity, Viscosity Index. Building materials-Portland Cement, constituents, Setting and Hardening of cement.

COs-CO4

Self-Learning Topics: Characterization of Nano Materials.

UNIT- V: Surface Chemistry and Nano materials **10 Hours**

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (Braggs Method), chemical and electrochemical methods, preparation of nano metals and metal oxides, Stabilization of colloids and nano materials by Stabilizing agents, characterization of surface by physic chemical methods (TEM,SEM) applications of colloids and nano materials – catalysis, medicine, Sensors, etc. **COs-CO5**

Self-Learning Topics: Characterization of Nano Materials.

Board of Studies : Basic Science and Humanities (Chemistry)
Approved in BOS No: 01, August, 2024
Approved in ACM No: 01

Textbooks:

1. Jain and Jain, Engineering Chemistry,16/e, Dhanpat Rai, 2013.
2. Peter Atkins, Julio dePaula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.

Reference Books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J.Shaw, Introduction to Colloids and Surface Chemistry, Butterworth – Heineman, 1992.
3. Text book of Polymer Science, FredW.Billmayer Jr, 3rd Edition

Web References:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cy50

Internal Assessment Pattern

Cognitive Level	Internal Assessment#1(%)	Internal Assessment#2(%)

L1	20	20
L2	30	30
L3	30	30
L4	10	10
L5	10	10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT -I

1. Determine the Hardness of Water by EDTA Method.(L5)
2. Discuss Ion-Exchange Process (L2)
3. Describe Reverse Osmosis Method. (L1)

UNIT-II

1. Write the Construction and working of Zinc-Air battery.(L1)
2. Discuss Electro Chemical Theory of Corrosion.(L2)
3. Describe the Factors Influencing rate of Corrosion.(L1)
4. Write a short note on Cathodic and Anodic Protection (L1)

UNIT-III

1. Write the Differences between Thermo Plastics and Thermo Setting Plastics.(L1)
2. Explain the Functionality of Monomers.(L2)
3. Write the mechanism of Chain growth Polymerization.(L1)
4. Write Preparation, properties & applications of Bakelite.(L1)
5. Explain Proximate Analysis of Coal.(L2)

UNIT-IV

1. Discuss Fiber Reinforced Composites (L2)
2. Classify Refractories. (L3)
3. Explain the Mechanism of Lubrication. (L2)
4. Describe the preparation of Portland cement by Rotary Kiln Method (L1)

UNIT-V

1. Explain Sol-Gel method. (L2)
2. Write the Synthesis of Colloids by Braggs Method.(L1)
3. Importance of Nanomaterials in various fields (L5)
4. Write the applications of Colloids. (L1)

Chairperson
Board of Studies (Chemistry)

R24ES02 **Problem Solving & Programming with C** **3 0 0 3**
(Common to all Branches)

Course Objectives:

1. To impart adequate knowledge on the need of programming languages and problem-solving techniques and develop programming skills.
2. To express algorithms and draw flowcharts in a language independent manner.
3. To enable effective usage of Operators &Control Structures.
4. To learn about the design concept of Arrays, Strings and Functions.
5. To understand Structures and Unions and their usage.
6. To assimilate about Pointers, Dynamic Memory Allocation and know the significance of Pre-processors, perform operations on files.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PS01	PS02	
R24ES02.1	Illustrate the fundamental concepts of computers and basic computer programming and problem-solving approach.	3	3	2	3	2	L1, L2
R24ES02.2	Understand the Control structures, Branching and Looping.	3	3	3	3	2	L1, L2 L3
R24ES02.3	Make use of Arrays and Develop Programs on modular programming using functions and strings.	3	3	3	2	3	L1, L2, L3
R24ES02.4	Demonstrate the ability to write programs using Structures and Unions.	3	3	3	3	2	L4
R24ES02.5	Apply File handling operations.	3	3	3	3	3	L4, L5

SYLLABUS

UNIT-I: Introduction to Programming and Algorithm for Problem Solving: 10 Hours

Introduction to Programming: The Basic Model of Computation, Algorithms, Flow-charts, Programming Languages, Compilation, Linking and Loading, Testing and Debugging, Documentation,

Algorithm for Problem Solving: Exchanging values of two variables, summation of a set of numbers, Decimal Base to Binary Base conversion, Reversing digits of an integer, GCD (Greatest Common Division) of two numbers, Test whether a number is prime, Organize numbers in ascending order, Find square root of a number, factorial computation, Fibonacci sequence, Evaluate 'sin x' as sum of a series, Reverse order of elements of an array, Find largest number in an array, Print elements of upper triangular matrix, multiplication of two matrices, Evaluate a Polynomial

COs–CO1

Self-Learning Topics: Compilation and Interpretation

UNIT- II: Introduction to the 'C' Programming **15 Hours**

Introduction: Character set, Variables and Identifiers, Built-in Data Types, Input/output statements, Variable Definition, Arithmetic operators and Expressions, Constants and Literals, Simple assignment statement, Basic input/output statement, Type Casting and Type def Simple 'C' programs

Conditional Statements and Loops: Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, Break statement, Go to statement. **COs-CO2**

Self-Learning Topics: Escape Sequences

UNIT – III: Arrays, Strings and Functions **15 Hours**

Arrays: One dimensional array: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; two dimensional arrays with examples.

Strings: Concepts, String Types, String Input / Output functions, String manipulation functions, Null terminated strings as array of characters, Standard library string functions.

Functions: Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, passing arguments to a Function: call by reference; call by value, Recursive Functions, arrays as function arguments. **COs–CO3**

Self-Learning Topics: String Pattern Matching

UNIT- IV: Structures and Unions **10 Hours**

Structures and Unions: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions, Enumeration.

Storage Classes**:** Scope and extent, Storage Classes in a single source file: auto, extern and static, register, Storage Classes in multiple source files: extern and static **COs–CO4**

Self-Learning Topics: How do you pass a structure to a function?

UNIT-V: Pointers & File Processing **10 Hours**

Pointers: Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation.

File Processing: Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input/output functions (standard library input/output functions for files), file status functions (error handling), Positioning functions

COs-CO5

Self-Learning Topics: Binary Files and operations on Binary files

Board of Studies : Computer Science and Engineering

Approved in BOS No: 01, 30th July, 2024

Approved in ACM No: 01, 30th July, 2024

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Logic Develop using C Programming	CO1–CO5,	PO1,PO2,PO3,PO12,PSO1,PSO2
2. Real Time Applications of C Programming	CO1–CO5,	PO1, PO2,PO3,PO12,PSO1,PSO2

TEXT BOOKS:

1. Byron S Gottfried "Programming with C" Second edition, Tata McGrawhill, 2007 (Paperback)
2. R.G. Dromey, "How to solve it by Computer", Pearson Education, 2008.
3. Kanetkar Y, "Let us C", BPB Publications, 2007.
4. 4. Hanly J R & Koffman E.B, "Problem Solving and Program design in C", Pearson Education, 2009.

REFERENCE BOOKS:

1. E. Balaguruswamy, "Programming with ANSI-C", Fourth Edition, 2008, Tata McGraw Hill.
2. Venugopal K. R and Prasad S. R, "Mastering 'C'", Third Edition, 2008, Tata McGraw Hill.
3. B.W. Kernighan & D. M. Ritchie, "The C Programming Language", Second Edition, 2001, Pearson Education
4. ISRD Group, "Programming and Problem-solving Using C", Tata McGraw Hill, 2008.
5. Pradip Dey, Manas Ghosh, "Programming in C", Oxford University Press, 2007.

Web References:

1. http://www.c4learn.com/
2. http://www.geeksforgeeks.org/c/
3. http://nptel.ac.in/courses/122104019/
4. http://www.learn-c.org/
5. https://www.tutorialspoint.com/c programming/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	35	--
L2	40	--
L3	25	40
L4	--	35
L5	--	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What are the five key features of the C programming language?
2. What are the top 5 applications of C programming language?
3. What do you mean by reserved words in C programming language?
4. What do you mean by library functions?
5. List the name of the tokens

6. What is static() function in C programming?
7. What is the difference between operators = and ==?
8. What are 3 main drawbacks of C language?
9. What is the difference between R-value and L-value?
10. How does const char*p differ from the char const* p

L2: Understand

1. What is the importance of function?
2. Explain the function prototype with an example.
3. What do you mean by error? Discuss types of errors() in C language.
4. What do you mean by function pointer?
5. What is a header file in the C programming language?
6. How can you implement decision-making processes in C language?
7. What are the 4 primary sections to define a function in C language?
8. What are modifiers? List the C programming modifiers?
9. What is an array, and why does it play a major role in C programming?
10. Is sizeof( ) a function or operator?

L3: Apply

1. Program to find Factorial of number?
2. Fibonacci Series Program?
3. Palindrome Program?
4. Program to reverse a String?
5. Find a given number is Armstrong Number?
6. Print first n Prime Numbers?
7. Find Largest among n Numbers?
8. LCM of Two Numbers?
9. GCD of Two Numbers?
10. Reverse a String?

L4: Analysing

1. Swapping Two Numbers using Bitwise operators?
2. Copy File to another File?
3. C program to get and set system current system date and time?
4. C program to run DOS command?

L5: Evaluating

1. C program to find two smallest elements in a one-dimensional array?
2. C program to find odd or even numbers using Bit masking?
3. Swapping two bits of byte using C program?

Chairperson
Board of Studies (CSE)

R24ES06 **ENGINEERING GRAPHICS** **1 0 4 3**

(Common To All Branches)

Course Objectives:

1. Understand the fundamentals of engineering drawing, including lines, lettering, and dimensioning.
2. Develop skills in geometrical constructions, including regular polygons and curves.
3. Learn orthographic projection techniques, including projections of points, lines, and planes.
4. Understand how to project solids in simple positions and create sectional views.
5. Develop skills in converting isometric views to orthographic views and vice versa.
6. Apply computer-aided design (CAD) techniques using AutoCAD to create 2D and 3D drawings.
7. Understand the importance of reference planes and reference lines in orthographic projection.
8. Develop problem-solving skills in engineering drawing, including creating and interpreting drawings.

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PO5	PO10	
R24ES06.1	Understand the basics of Engineering Graphics to construct the polygon, curves, and scales.	3	2	2	1	1	L1, L2, L3
R24ES06.2	Draw the orthographic projections of points and straight lines inclined to both the planes.	3	2	2	1	1	L2, L3
R24ES06.3	Draw the projections of planes in various conditions.	3	2	2	1	1	L2, L3
R24ES06.4	Draw the projections of regular solids, with its axis inclined to one plane and sections of solids.	3	2	2	1	1	L3,
R24ES06.5	Visualize the 3D isometric views from 2D orthographic views and vice versa along with basic introduction to CAD.	3	2	3	1	1	L2, L4

SYLLABUS

UNIT-1 **12 Hours**

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general method.

Curves: construction of ellipse, parabola, and hyperbola by general method, Normal and tangent to Curves.

Scales: Plain scales, diagonal scales and vernier scales. **COs: CO1**

UNIT-2 **16 Hours**

Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes. **COs: CO2**

UNIT-3 **10 Hours**

Projections of Planes: Regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes. **COs: CO3**

UNIT-4 **16 Hours**

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of sections for simple position only. **COs: CO4**

UNIT-5 **12 Hours**

Conversion of Views: Conversion of isometric views to orthographic views and Conversion of orthographic views to isometric views for simple objects only.

Computer graphics: Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (Not for end examination). **COs: CO5**

Textbook:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc.
3. Engineering Drawing with an Introduction to AutoCAD, DhananjayJolhe, Tata McGraw Hill.

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Draw an octagon given the length of side 25mm.
2. Construct a regular hexagon of 40mm side. Using general method?
3. Construct a regular pentagon inscribed in a circle of diameter 80 mm?
4. Construct a pentagon of side 50mm with one side vertical. Attach a non-overlapping hexagon of same side length with common vertical side.

L2: Understand

1. A fixed-point F is 7.5cm from a fixed straight line. Draw the locus of a point P moving in such a way that its distance from the fixed straight line is 2/3 times its distance from F. Plot at least 9 points. Name the curves. Also draw a normal and a tangent to the curve at a point on it 6cm from F.
2. Construct a parabola whose focus is at a distance of 40mm from the directrix. Draw a tangent and a normal to the parabola at point 50mm away from the principal axis. Determine the double ordinate through a point 90mm from the directrix.
3. Construct an ellipse when the distance between the locus and the directrix is 30mm and the eccentricity is 3/4. Draw the tangent and normal at any point P on the curve using directrix.
4. Construct a hyperbola when the distance between the focus and the directrix is 40mm and the eccentricity is 4/3. Draw a tangent and normal at any point on the hyperbola.
5. Draw the involute of hexagon of side 25mm A disc is in the form of a square of side 30mm surmounted by a semi-circle on one of the sides of the square and a half hexagon on the opposite side. Draw the path of the end of a string which is unwound from the circumference of the disc.
6. Draw a vernier scale of R.F = 1/25 to read centimetres up to 4 metres and on it, show lengths representing 3.14m, 2.39 m and 0.91 m.
7. Construct a vernier scale to read distance correct to decimetre on a map in which the actual distances are reduced in the ratio of 1:40000. The scale should be long enough to measure up to 6km. Mark on the scale a length of 3034km and 0.59km.
8. The front view of a line, inclined at 30^0 to the VP is 65mm long. Draw the projections of the line, when it is parallel to and 40 mm above the HP, its one end being 30mm in front of the VP.
9. Mark the projections of the following points on a common reference line, keeping the projectors 35mm apart.
   (i) A, 25mm above H.P and 35mm in front of V.P
   (ii) B, 25mm above H.P and 40 mm behind V.P
   (iii) C, 30mm below H.P and 45 mm behind V.P
   (iv) D, 30 mm below H.P and 40 mm in front V.P
10. Draw the FV, TV of the following points:
    (i) Point P lies in the HP and 20mm behind the VP
    (ii)Point Q lies in the VP and 30mm below the HP
    (iii)Point R lies 35mm below the HP and 25mm behind the VP
11. Draw the involute of hexagon of side 25mm.
12. A 100 mm long line is parallel to and 40mm above the HP. Its two ends are 25 mm and 50 mm in front of the VP respectively. Draw the projections and find its inclination with the VP.
13. Draw the projections of a straight-line AB of 60mm long, in the following positions
    (i)Perpendicular to the HP and in the VP and one end on the HP
    (ii)Parallel to and 30 mm in front of the VP and on the HP

(iii)Inclined at 30^0 to the VP, in the HP and one end on the VP

14. Draw an involute of the circle of 40mm diameter. Also draw a normal and tangent at a point 100mm from the centre of the circle.
15. A rectangular plot of 100sq.km. is represented on a certain map by a similar rectangular area of 4sq.cm. Draw a scale to show km and mark a distance of 43km on it.

L3: Apply

1. A truck is moving at the rate of 1.2 km per min. Construct a diagonal scale with RF value of 1/25000, showing minutes and seconds. Mark the distance moved by the truck in 4 minutes and 27 seconds?
2. A tunnel on the Konkan railway route has a size of 640m × 10m × 10m. It is represented on a model by the volume of 27 cm^3 Find RF. Devise a diagonal scale of this RF to read up to 300 meters. Show the distances of 299 meters, 171 meters and 9 meters on it.
3. A car is running at a speed of 50 km/hour. Construct a diagonal scale to show 1 km by 3 cm and to measure up to 6 km. Mark also on the scale the distance covered by the car in 5 min 28 seconds.

L4: Analyze

1. Analyze the importance of orthographic projection in CAD and explain how it aids in the visualization of 3D objects from 2D views. Provide examples and diagrams to support your answer.
2. Compare and contrast 2D orthographic views and 3D isometric views. How do they differ in terms of representation and application? Explain with examples and illustrations.
3. Explain the process of creating a 3D isometric view from 2D orthographic views. Use a simple object (e.g., a cube or a cylinder) as an example and provide step-by-step diagrams to illustrate the process.
4. Discuss the advantages and limitations of using CAD software for creating 2D orthographic views and 3D isometric views. How does CAD improve the design process, and what are its limitations?
5. Analyze a given 2D orthographic view (front, top, and side views) and create a 3D isometric view from it. Explain the process and provide diagrams. Then, reverse-engineer the process by creating 2D orthographic views from the 3D isometric view.
6. Explain the concept of dimensioning and annotation in CAD. How are dimensions and annotations added to 2D orthographic views and 3D isometric views? Provide examples and illustrations.

Chairperson
Board of Studies (ME)

R24ES05 Basic Electrical and Electronics Engineering 3 0 0 3

Course Objectives:

1. To expose to the field of electrical & electronics engineering, laws and principles of electrical/ electronic engineering
2. To acquire fundamental knowledge in the relevant field.
3. To teach the fundamentals of semiconductor devices and its applications.
4. To teach the working process and analysis of different rectifying and Amplifying Circuits.
5. To teach the fundamental principles and rules of digital electronic circuits like gates, Sequential and Combinational Circuits.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO6	PO7	PO8	PO12	Dok
R24ES05.1	Understand the problem-solving concepts associated to AC and DC circuits	2	2	1	-	-	-	1	L1, L2,L3
R24ES05.2	Remember the fundamental laws, construction and operation of AC and DC machines, instruments.	2	2	1	-	-	-	1	L2,L3
R24ES05.3	Understand different power generation mechanisms, Electricity billing concept and important safety measures related to electrical operations.	3	1	2	3	2	1	1	L1,L2
R24ES05.4	Understand the fundamental principles of electronic devices, analyzing the different rectifying and Amplifying Circuits.	1	2	3	-	-	-	1	L1, L2,L3
R24ES05.5	analyze and design different digital electronic circuits like gates, Sequential and Combinational Circuits	1	2	3	-	-	-	2	L1, L3,L4

SYLLABUS

Part A-Electrical Engineering

UNIT- I: DC & AC Circuits 10 Hours

DC Circuits: Electrical circuit elements (R, Land C), Ohm's Law and its limitations, KCL& KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems). **COs–CO1**

Self-Learning Topics: Circuit elements

UNIT-II: Machines and Measuring Instruments **10 Hours**

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge. **COs–CO2**

Self-Learning Topics: Magnetic materials

UNIT- III: Energy Resources, Electricity Bill & Safety Measures **10 Hours**

Energy Resources: Conventional and non-conventional energy resources; Layout and operation o various Power Generation systems: Hydal, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of ―unit‖ used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock. **COs– CO3**

Part B: Electronics Engineering

UNIT-IV: Semiconductor Devices and Basic Electronic Circuits **15 Hours**

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier. Rectifiers and power supplies: Block diagram description of a dc power supply, Half-Wave Rectifiers, Full-Wave Rectifiers, capacitor filter (no analysis). Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. **COs –CO4**

Self-Learning Topics: Electronic components and characteristics, Design Amplifier circuit at different R, C Values

UNIT -V: DIGITAL ELECTRONICS and INSTRUMENTTAION **15 Hours**

Overview of Number Systems, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits– Half and Full Adders. Introduction to sequential circuits, Flip flops, Registers and counters (Elementary Treatment only), Electronic Instrumentation: Block diagram of an electronic instrumentation system **COs–CO5**

Self-Learning Topics: Develop digital circuits using minimum no. of gates, design principles of electronic instruments.

Board of Studies : Electrical and Electronics Engineering
Approved in BoS No: 01, 3rd August, 2024
Approved in ACM No: 01

Text Books: Electrical Engineering

1. Basic Electrical Engineering, D. C. Kulshreshtha, TataMcGrawHill,2019, First Edition
2. Power System Engineering, P.V. Gupta,M.L.Soni,U.S.BhatnagarandA.Chakrabarti,Dhanpat Rai & Co, 2013

3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, ThirdEdition

Text Books: Electronics Engineering

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books: Electrical Engineering

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019,FourthEdition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S.Sukhija, Oxford University Press,2017
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, Pearson Publications, 2018,Second Edition.

Reference Books: Electronics Engineering

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall,India, 2002.
3. R.T.Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version,Pearson Education,2009

Web References: (Electrical Engineering)

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

Web References: (Electronics Engineering)

1. https://archive.nptel.ac.in/courses/117/102/117102059
2. https://www.tutorialspoint.com/principles_of_communication
3. https://www.geeksforgeeks.org/electronics-and-communication-engineering

Internal Assessment Pattern (Electrical Engineering)

Cognitive Level	Internal Assessment #1(%)
L1	30
L2	30
L3	40
Total (%)	**100**

Internal Assessment Pattern (Electronics Engineering)

Cognitive Level	Internal Assessment #2(%)
L1	30
L2	30
L3	40
Total (%)	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

Part-A: Electrical Engineering

L1: Remember

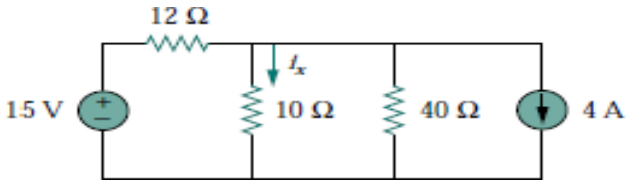
1. State Ohm's law?
2. Define Superposition theorem?
3. Define Active power?
4. Define Reactive power?
5. Define the term tariff?
6. Define form factor?
7. Define RMS value?

L2: Understand

1. Explain the principle and operation of DC Motor?
2. Explain the construction of Alternator?
3. Explain the principle and operation of Moving Iron instruments?
4. What is meant by Earthing and explain about process of earthing?
5. Draw the layout of wind power generating plant?

L3: Apply

1. For the circuit shown below in calculate Ix and the power dissipated by the 10-Ω resistor using superposition.



2. An alternating voltage is given by V=230sin314t.Calculate i)frequency, i)maximum value, iii)average value ,iv)RMS value
3. A Consumer has Maximum demand of 200 KW at 40% load factor. If the tariff is Rs.200per KW of maximum demand plus 10paise per KWH, find the annual charges?

Part-B: Electronics Engineering

L1: Remember

1. Draw the symbol of pn junction of diode
2. What is meant by BJT?
3. Define Avalanche and Zener break down voltages?
4. Draw the symbol of Zener diode.
5. Define Amplifier?
6. Define Rectifier?
7. What is the Zener voltage regulator?
8. Define latch and flip flop?
9. Symbol of JK flip flop?
10. Draw the logic symbols of OR, AND, NOT gate?

L2: Understand

1. Write the Differences between Avalanche and Zener break down voltages?
2. Draw the diagram and explain single input and dual input op-amps?
3. Compare BJT, CB, CE, CC transistor configuration characteristics?
4. Write the notes of PN junction diode?
5. Draw the block diagram of public address system and explain?
6. Discuss the working principal of zener voltage regulator?
7. Draw the block diagram of electronic instrumentation system and explain?

L3: Apply

1. What is doping? Describe P and N type semiconductors with Qualitative theory?
2. Draw the diagram and explain single input and dual input op-amps and design?
3. Design operational amplifier?
4. Explain the block diagram of DC power supply?
5. Explain the circuit diagram and working of RC coupled amplifier?
6. Operation of center tap full-wave rectifier?
7. Explain the operation of full –wave rectifier with capacitor?
8. Explain the JK, SR, D,T flip flops ?
9. Simplify the Boolean expressions to minimum number of literals i) A+B+A'B'C ii) AB + A (B +C) + B'(B+D).

Chairperson
Board of Studies (EEE& ECE)

R24BS08 **ENGINEERING CHEMISTRY LAB** **0 0 2 1**
(Mechanical Engineering)

Course Objectives:

1. Verify the fundamental concepts with experiments.
2. Learn and carry out some of the important experiments related to batteries and their properties.
3. Learn the preparation of engineering polymer materials like Bakelite
4. Know the fundamental principles of chemistry lab experiments which include volumetric analysis, dichrometry, PH metry

At the end of the course, the students will be able to

Course Code	Course Outcomes	Mapping with POs		
		PO1	PO2	Dok
R24BS08.1	Conductometric titration of strong acid vs. strong base, P^H metric titration, Dissolved Oxygen, ferrous iron, Calcium in port land Cement, Moisture content in a coal sample the cell constant and conductance of solutions.	1	3	L1,L2
R24BS08.2	Prepare advanced polymer Bakelite materials, nano materials by precipitation method, Adsorption of acetic acid by charcoal.	1	3	L1,L3
R24BS08.3	Determine the physical properties like surface tension, adsorption and viscosity, Strength of an acid in Pb-Acid battery, Calculation of hardness of water.	1	3	L1,L4

Board of Studies : Basic Science and Humanities (Chemistry)
Approved in BOS No: 01, 5th August, 2024
Approved in ACM No: 01

List of Experiments

Week-1
1. Determination of Hardness of a groundwater sample **COs:CO3**

Week-2
2. Estimation of Dissolved Oxygen by Winkler's method **COs:CO1**

Week-3
3. Determination of Strength of an acid in Pb-Acid battery **COs:CO3**

Week-4
4. Estimation of ferrous iron by Dichrometry **COs:CO1**

Week-5
5. Estimation of Calcium in port land Cement **COs:CO1**

Week-6
6. Preparation of nano materials by precipitation method **COs:CO2**

Week-7
7. Adsorption of acetic acid by charcoal **COs:CO2**

Week-8
8. Determination of percentage Moisture content in a coal sample **COs:CO1**

Week-9

9. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
10. Conductometric titration of strong acid vs. strong base
11. PH metric. titration of strong acid vs. strong base **COs:CO1**

Week-10

9. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
10. Conductometric titration of strong acid vs. strong base
11. PH metric. titration of strong acid vs. strong base **COs:CO1**

Week-11

12. Determination of Surface tension of liquids **COs:CO3**

Week-12

13. Preparation of a polymer (Bakelite) (Demo) **COs:CO2**

Additional Experiments

1. Determination of Sodium carbonate by using Hydrochloric acid **COs:CO4**
2. Determination of alkalinity of a sample containing Na2CO3 and NaOH **COs:CO4**

Reference:

1. "Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C.Denney, J.D.Barnes and B. Sivasankar
2. Practical Engineering Chemistry by K. Mukkanti, etal, B.S. Publications, Hyderabad.
3. Instrumental methods of chemical analysis, Chatwal, Anand, Himalaya Publications.

Chairperson
Board of Studies (Chemistry)

R24ES03 **Problem Solving &Programming with C Lab** **0 0 3 1.5**
(Common to all Branches)

Course Objectives:

The course aims to give students hands – on experience and train them on the concepts of the C-programming language.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs			
		PO1	PO2	PO3	Dok
R24ES03.1	Read, understand, and trace the execution of programs written in C language.	2	2	2	L1, L2
R24ES03.2	Select the right control structure for solving the problems .and demonstrate the application of arrays functions and strings	3	3	3	L2,L3
R24ES03.3	Develop Debug and Execute programs to demonstrate the applications of Pointers, Structures& Unions, and Files.	3	3	3	L2, L3

Board of Studies : Computer Science and Engineering
Approved in BOS No: 01, 30th July, 2024
Approved in ACM No: 01, 30th July, 2024

Developing the following programs:

Week 1:

1. Write a C program using printf() and Scanf(). COs:CO1
2. Write a C program on swapping of two nos. COs:CO1
3. Write a C program using arithmetic Expressions. COs:CO1

Week 2:

4. Simple interest calculation COs:CO2
5. Finding compound interest COs:CO2
6. Area of a triangle using heron's formulae COs:CO2
7. Distance travelled by an object COs:CO2

Week 3:

8. Find the maximum of three numbers using conditional operator COs:CO2
9. Take marks of 5 subjects in integers, and find the total, average in float COs:CO2
10. Write a C program to shift/rotate using bit fields. COs:CO2
11. Finding the square root of a given number COs:CO2
12. Write a C program using if-else statement. COs:CO2

Week 4:

13. Write a C program to find the max and min of four numbers using if-else. COs:CO2
14. Write a C program to generate electricity bill. COs:CO2
15. Find the roots of the quadratic equation. ` COs:CO2

16. Write a C program to find the given year is a leap year or not. COs:CO2
17. Write a C program to simulate a calculator using switch case. COs:CO2

Week 5:

18. Find the factorial of given number using any loop. COs:CO2
19. Find the given number is a prime or not. COs:CO2
20. Compute sine and cos series. COs:CO2
21. Checking a number palindrome. COs:CO2
22. Construct a pyramid of numbers. COs:CO2

Week 6:

23. Write a C program on Linear Search. COs:CO3
24. Find the min and max of a 1-D integer array. COs:CO3
25. Perform linear search on1D array. COs:CO3
26. The reverse of a 1D integer array. COs:CO3

Week 7:

27. Find 2's complement of the given binary number. COs:CO3
28. Eliminate duplicate elements in an array. COs:CO3
29. Sort array elements using bubble sort. COs:CO3
30. Addition of two matrices. COs:CO3

Week 8:

31. Multiplication two matrices. COs:CO3
32. Write a C program using call by reference. COs:CO3
33. Write a C program to find factorial of n using recursion. COs:CO3
34. Write a C function to calculate NCR value COs:CO3
35. Concatenate two strings without built-in functions. COs:CO3

Week 9:

36. Write a C function to transpose of a matrix. COs:CO3
37. Write a C function to find the length of a string. COs:CO3
38. Reverse a string using built-in and without built-in string functions. COs:CO3
39. Write a C program to find the sum of a 1D array using malloc ( ). COs:CO3

Week 10:

40. Write a recursive function to find the lcm of two numbers. COs:CO3
41. Write a recursive function to find the sum of series. COs:CO3
42. Write a C program to swap two numbers using call by reference. COs:CO3
43. Write a C program using Pointers, Structures and Unions. COs:CO4
44. Write a C program to find the total, average of n students using structures. COs:CO4

Week 11:

45. Enter n students data using calloc() and display failed students list. COs:CO4
46. Read student name and marks from the command line and display the student details along with the total. COs:CO4
47. Write a C program to implement realloc(). COs:CO4
48. Write a C program to copy one structure variable to another structure of the same type. COs: CO4

Week 12:

49. Demonstrate Dangling pointer problem using a C program. COs: CO4
50. Write a C program to copy one string into another using pointer. COs: CO4

51. Write a C program to find no of lowercase, uppercase, digits and other characters using pointers. COs: CO4

Week 13:

52. Write a C program using Files operations. COs:CO5
    a. Sum and average of 3 numbers
    b. Conversion of Fahrenheit to Celsius and vice versa.
53. Write a C program to write and read text into a file. COs:CO5

Week 14:

54. Write a C program to write and read text into a binary file using fread() and fwrite() COs:CO5
55. Copy the contents of one file to another file. COs:CO5
56. Write a C program to merge two files into the third file using command-line arguments. COs: CO5

Week 15:

57. Find no. of lines, words and characters in a file. COs:CO5
58. Write a C program to print last n characters of a given file. COs:CO5

Textbooks:

1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum' s Outline of Programming with C, McGraw Hill

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, PrenticeHall of India
2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE

Chairperson
Board of Studies (CSE)

R24ES07 Basic Electrical and Electronics Engineering Lab 0 0 3 1.5
(Common to all branches of Engineering)

Course Objectives:

To impart knowledge on the fundamental laws & theorems of electrical circuits, functions of electrical machines and energy calculations.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO4	PO5	PO11	PS01	Dok
R24ES07.1	Apply the theoretical concepts and operating principles to derive mathematical models for circuits, Electrical machines and measuring instruments; calculations for the measurement of resistance, power and power factor.	1	1		3	1			L1, L2, L3
R24ES07.2	Apply the theoretical concepts to obtain calculations for the measurement of resistance, power and power factor and design suitable circuits for measurement of electrical parameters	1	1		3	1	2	2	L2, L3
R24ES07.3	Plot and discuss the characteristics of various electron devices/instruments.	1	1		3	1	2		L1, L2, L3

Board of Studies : Electrical and Electronics Engineering
Approved in BOS No: 01, 3rd August, 2024
Approved in ACM No: 01

Developing the following programs:

List of Experiments

1. Verification of KCL and KVL **COs: CO2**
2. Verification of Superposition theorem **COs: CO2**
3. Measurement of Resistance using Wheatstone bridge **COs: CO2**
4. Magnetization Characteristics of DC shunt Generator **COs: CO2**
5. Measurement of Power and Power factor using Single-phase wattmeter **COs: CO2**
6. Measurement of Earth Resistance using Megger **COs: CO2**
7. Calculation of Electrical Energy for Domestic Premises **COs: CO2**

Reference Books:

1. Basic Electrical Engineering, D.C.Kulshreshtha,TataMcGrawHill,2019, First Edition
2. Power System Engineering, P.V.Gupta, M.L.Soni, U.S.Bhatnagar and A. Chakrabarti,

DhanpatRai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition.

Web References:

1. https://www.jntumaterials.co.in/2015/06/jntuk-btech-lab-manuals
2. www.jntumaterials.in

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Sample Lab Experiments of Various Cognitive Levels:

Experiments

1. Verification of KCL and KVL **COs: CO2**
2. Verification of Superposition theorem **COs: CO2**
3. Measurement of Resistance using Wheatstone bridge **COs: CO2**
4. Magnetization Characteristics of DC shunt Generator **COs: CO2**
5. Measurement of Power and Power factor using Single-phase wattmeter **COs: CO2**
6. Measurement of Earth Resistance using Megger **COs: CO2**
7. Calculation of Electrical Energy for Domestic Premises **COs: CO2**

S. No.	Title	Cognitive Level
1	Verification of KCL and KVL	L1, L2,L3
2	Verification of Superposition theorem	L1, L2,L3
3	Measurement of Resistance using Wheatstone bridge	L2,L3,
4	Magnetization Characteristics of DC shunt Generator	L1, L2,L3
5	Measurement of Power and Power factor using Single-phase wattmeter	L1, L2,L3
6	Measurement of Earth Resistance using Megger	L1,L3
7	Calculation of Electrical Energy for Domestic Premises	L1, L2

Note: Minimum Six Experiments to be performed.

PART B: Electronics Engineering Workshop

Course Objectives:

To impart knowledge on the principles of digital electronics and fundamentals of electron devices & its applications.

List of Experiments:

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias. **COs: CO3**
2. Plot V – I characteristics of Zener Diode and its application as voltage Regulator. **COs: CO3**
3. Implementation of half wave and full wave rectifiers **COs: CO3**
4. Plot Input & Output characteristics of BJT in CE and CB configurations **COs: CO3**
5. Frequency response of CE amplifier. **COs: CO3**
6. Simulation of RC coupled amplifier with the design supplied **COs: CO3**

7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs. **COs: CO2**
8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs. **COs: CO2**

Tools / Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

Reference Books:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using bothHardware and Software.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Web References:

1. https://www.jntumaterials.co.in/2015/06/jntuk-btech-lab-manuals
2. www.jntumaterials.in

Experiments of Various Cognitive Levels:

S. No.	Title	Cognitive Level
1	Plot V-I characteristics of PN Junction diode A)Forward bias B) Reverse bias.	L1, L2, L3
2	Plot V – I characteristics of Zener Diode and its application as voltage Regulator.	L1, L2, L3
3	Implementation of half wave and full waverectifiers	L2,L3,L4
4	Plot Input & Output characteristics of BJT in CEand CB configurations	L1, L2,L3
5	Frequency response of CE amplifier.	L1, L2,L3
6	Simulation of RC coupled amplifier with the designsupplied	L1,L3,L4
7	Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates	L1, L4
8	Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs.	L1,L3,L4

Note: Minimum Six Experiments to be performed.

Chairperson
Board of Studies (EEE&ECE)

R24ES08 **ENGINEERING WORKSHOP** **0 0 3 1.5**
(Common to all Branches)

Course Objectives:

- Describe how different tools are used in home wiring, tin smiting, blacksmithing, carpentry, and fitting.

Course Code	Course Outcomes	Mapping with Pos					
		PO1	PO2	PO3	PO4	PO6	PO9
R24ES08.1	Identify workshop tools and their operational capabilities. Practice on manufacturing of components using workshop trades including carpentry, fitting, sheet metal	3	2	1	1	1	1
R24ES08.2	Practice on manufacturing of components using workshop trades including foundry and welding.	3	2	1	1	2	3
R24ES08.3	Apply fitting operations in various applications and engineering knowledge for Plumbing, House Wiring Practice, and Making square rod and L-bend from the round rod in black smithy	3	2	1	1	2	3

List of Experiments

1. **Wood Working:** **COs: CO1**
   a) Half – Lap joint
   b) Mortise and Tenon joint
   c) Corner Dovetail joint or Bridle joint
2. **Sheet Metal Working:** **COs: CO1**
   a) Tapered tray
   b) Conical funnel
   c) Elbow pipe
   d) Brazing
3. **Fitting:** **COs: CO1**
   a) V-fit
   b) Dovetail fit
   c) Semi-circular fit
   d) Bicycle tire puncture and change oftwo-wheeler tyre
4. **Foundry Trade:** Preparation of Green Sand Moulds **COs: CO2**
   a) Single piece pattern
   b) Double piece pattern
5. **Welding Shop: Arc welding Practice** **COs: CO2**
   a) Lap joint
   b) Butt joint

6. Electrical Wiring: **COs: CO3**

a) Parallel and series connection
b) Two-way switch connection
c) Tube light connection
d) Soldering of wires

7. Plumbing: **COs: CO3**

a) Prepare Pipe joint with coupling for 1 inch diameter
b) Prepare Pipe joint with coupling for 1.5 inch diameter

8. Black smithy: **COs: CO3**

a) Round rod to Square
b) Round rod to S-Hook

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 &2017

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; AtulPrakashan 2021-22

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Sample Experiments

1. Prepare Half – Lap joint
2. Prepare Mortise and Tenon joint
3. Prepare Corner Dovetail joint or Bridle joint
4. Prepare Tapered tray
5. Prepare Conical funnel
6. Prepare Elbow pipe
7. Do Brazing operation
8. Prepare V-fit
9. Prepare Dovetail fit
10. Prepare Semi-circular fit
11. Do Bicycle tire puncture andchange of two-wheeler tyre
12. Prepare Parallel and series
13. Prepare Two-way switch
14. Prepare Tube light
15. Do Soldering of wires
16. Prepare Green Sand Moulds for single piece Pattern

17. Prepare Green Sand Moulds for double piece Patterns
18. Prepare Lap joint using arc welding
19. Prepare Butt joint using arc welding
20. Prepare Pipe joint with coupling for same diameter(10mm)
21. Prepare Pipe joint with coupling for same diameter(12mm)
22. Prepare Round rod to Square rod
23. Prepare Round rod to S-Hook

Chairperson
Board of Studies (ME)

R24MC01 **Health and Wellness, Yoga and Sports** **0 0 1 0.5**
(Common to all Branches)

Course Objectives:

The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs				
		PO3	PO6	PO7	PO9	PO12
R24MC01.1	Understand the importance of yoga and sports for Physical fitness and sound health.	2	1	1	1	1
R24MC01.2	Demonstrate an understanding of health-related fitness components.	1	2	1	1	1
R24MC01.3	Compare and contrast various activities that help enhance their health	2	1	2	2	1
R24MC01.4	Assess current personal fitness levels.		1	1		1
R24MC01.5	Develop Positive Personality	1	1	2	1	1

SYLLABUS

UNIT-I: **3 Hours**

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

1. Organizing health awareness programmes in community.
2. Preparation of health profile.
3. Preparation of chart for balance diet for all age groups **COs-CO1**

UNIT- II: **3 Hours**

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities: Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar. **COs-CO2**

UNIT–III: **3 Hours**

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

1. Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.
2. Practicing general and specific warm up, aerobics
3. Practicing cardio respiratory fitness, treadmill, run test, 9 min walk, skipping and running.

COs-CO3

Board of Studies : BS&H
Approved in BoS No: 01, August, 2024
Approved in ACM No: 01

Text Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc.2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Assessment Pattern:

1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva
4. voce on the subject.

Chairperson
Board of Studies (Mathematics)

24BS04 Differential Equations and Vector Calculus (Common to all Branches) 3 0 0 3

Course Objectives:

1. To enlighten the learners in the concept of differential equations and multivariable calculus.
2. To furnish the learners with basic concept and techniques at plus two level to lead them in to advanced level by handling various real-world applications.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS04.1	Solve the first order differential equations related to various engineering fields.	3	2	1	L1,L2,L3
R24BS04.2	Model engineering problems as higher order differential equations and solve analytically.	3	2	1	L1,L2,L3
R24BS04.3	Identify solution methods for partial differential equations that model physical processes.	3	2	1	L1,L2,L3
R24BS04.4	Interpret the physical meaning of different operators such as gradient, curl and divergence.	3	2	1	L3,L4
R24BS04.5	Estimate the work done against a field, circulation and flux using vector calculus.	3	2	1	L4,L5

SYLLABUS

UNIT- I: Differential equations of first order and first degree 10 Hours

Formation of differential equations, order, degree, separation of variables (only Review). Linear differential equations-Bernoulli's equations-Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay, Electrical circuits (RL and LC). **COs-CO1**

Self-Learning Topic: Mixed tank problems

UNIT- II: Higher order Linear differential equations with Constant Coefficients 10 Hours

Definitions, homogenous and non-homogenous, complimentary function, particular integral $\left(e^{ax}, \sin ax, \cos ax, \text{Polynomial in } x, e^{ax}V(x), xV(x)\right)$, general solution, Wronskian, method of variation of parameters. **COs-CO2**

Applications: L-C-R Circuit problems

Self-Learning Topic: Simple Harmonic motion

UNIT–III: Partial Differential Equations 10 Hours

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solution of first order linear equations using Lagrange's method. Homogenous Linear Partial differential equations with constant coefficients. **COs-CO3**

Self-Learning Topic: Method of Separation of Variables

UNIT- IV: Vector differentiation **10 Hours**

Vector, Scalar, dot product, cross product, unit vector, equation of a line passing through two points (Review only)

Scalar and vector point functions, vector operator del, del applies to scalar point function-Gradient, del applied to vector point function – Divergence and Curl, Vector Identities **COs-CO4**

Application: Scalar Potential

Self-Learning Topic: Equation of tangent plane and Normal plane.

UNIT-V: Vector integration **10 Hour**

Line integral – circulation – work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof). **COs-CO5**

Self-Learning Topic: Application of above theorems.

Board of Studies: Basic Science and Humanities
Approved in BOS No: 01, 2nd August, 2024
Approved in ACM No: 01

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:

1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2018.
2. Michael Green berg, Advanced Engineering Mathematics, 9th edition, Pearson edn
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science
5. International Ltd., 2021 (9th reprint).
6. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017.

Web References:

1. http://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses/111105121
3. https://onlinecourses.nptel.ac.in/noc24_ma86/course

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	--	25
L5	--	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-I

1. Define Leibnitz's linear differential equation(L1)
2. State Newton's law of cooling(L1)
3. Write differential equation of L-R series circuit (L1)
4. solve the differential equation $\left(1+x^2\right)\frac{dy}{dx}+2xy=4x^2$ (L2)
5. If the temperature of the air is 30^0C and the substance cools from 100^0C to 70^0C in 15 minutes, find when the temperature will be 40^0C (L3)
6. The rate at which bacteria multiply is proportional to the instantaneous number present. If the original number doubles in two hours, then it will triple after ….hours (L3)

UNIT-II

1. Define Wronskian (L1)
2. solve the differential equation $\frac{d^2y}{dx^2}-6\frac{dy}{dx}+13y=8e^{3x}\sin 2x$ (L2)
3. An inductance of 2 henries and a resistance of 20 ohms are connected in series with e.n.f. E volts. If the current is zero when $t=0$. Find the current at the end of 0.01 seconds if E=100 volts. (L3)

UNIT-III

1. State Lagrange's Linear equation (L1)
2. form a partial differential equation by eliminating the arbitrary function φ from $lx+my+nz=\varphi\left(x^2+y^2+z^2\right)$ (L2)
3. solve $\frac{\partial^3 z}{\partial x^3}-2\frac{\partial^3 z}{\partial x^2\partial y}=2e^{3x}+3x^2y$ (L2)
4. Solve $\left(mz-ny\right)\frac{\partial z}{\partial x}+\left(nx-lz\right)\frac{\partial z}{\partial y}=ly-mx$ (L3)

UNIT-IV

1. The temperature of points in space is given by $T\left(x,y,z\right)=x^2+y^2-z.$ A mosquito located at $\left(1,1,2\right)$ desires to fly in such a direction that it will get warm as soon as possible. In what direction should it move? (L3)
2. Show that $\nabla^2\left(r^n\right)=n\left(n+1\right)r^{n-2}$ (L4)

UNIT-V

1. Evaluate $\iiint_v \nabla.\vec{F}dV$, where $\vec{F}=4x\hat{i}-2y^2j+z^2k$ and V is bounded by $x^2+y^2=4, z=0$ and $z=3$ (L4)
2. Evaluate $\int_C\left(3x^2-8y^2\right)dx+\left(4y-6xy\right)dy$ where C is the curve bounded by $y=\sqrt{x}$ and $y=x^2$ (L5)

Chairperson
Board of Studies (Mathematics)

R24BS02 **Engineering Physics** **3 0 0 3**
(Common to all Branches)

Course Objectives:

1. To bridge the gap between the physics in school at 10+2 level and UG level engineering courses.
2. To identify the importance of the optical phenomenon i.e. interference and diffraction related to its engineering applications.
3. To understand the mechanism of emission of light, utilization of lasers as coherent light sources for low and high energy applications.
4. To enlightening the periodic arrangement of atoms in crystalline solids and classify various crystal systems.
5. To explain the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging micro devices.
6. To enlightenment of the concepts of quantum mechanics and to provide fundamentals of de-Broglie matter waves and the importance of free electron theory for metals.
7. To understand the physics of semiconductors and identify the type of semiconductor using Hall Effect.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with Pos			Dok
		PO1	PO2	PO12	
R24BS02.1	Analyze the intensity variation of light due to interference, diffraction and classify various types of lasers.	3	2	1	L1 ,L2, L3
R24BS02.2	Identify various crystal systems and analyze the crystalline structure.	3	2	1	L1, L2, L3
R24BS02.3	Summarize various types of polarization of dielectrics and classify the magnetic materials.	2	2	1	L2, L3
R24BS02.4	Explain fundamentals of quantum mechanics and apply to one dimensional motion of particles.	3	2	2	L1, L4
R24BS02.5	Outline the properties of charge carriers in semiconductors	3	2	1	L2, L5

SYLLABUS

UNIT-I: Wave Optics and Lasers **14 Hours**

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colors in thin films- Newton's Rings- Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit- Fraunhofer diffraction due to N-Slits -Diffraction Grating - Dispersive power and resolving power of Grating (Qualitative).

Lasers: Introduction - Characteristics of laser - Spontaneous and Stimulated emissions of radiation - Population inversion - Lasing action - Pumping mechanisms - Ruby laser - He-Ne laser- Applications of lasers. **COs–CO1**

Self-Learning Topics: Interference in thin films due to Transmission of light

UNIT-II: Crystallography and X-ray diffraction **10 Hours**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters - Bravais Lattices - crystal systems (3D) - coordination number - packing fraction of SC, BCC & FCC - Miller indices - separation between successive (hkl) planes.

X-ray diffraction: Bragg's law - X-ray Diffraction - Crystal structure determination by Laue's and Powder methods. **COs–CO2**

Self-Learning Topics: Effect of crystallite size on diffracted X-Ray intensity

UNIT-III: Magnetic and Dielectric Materials **12 Hours**

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability - Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro& Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials.

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector - Relation between the electric vectors - Types of polarization- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation - dielectric loss. **COs–CO3**

Self-Learning Topics: Frequency dependence of polarization.

UNIT-IV: Quantum Mechanics and Free electron theory **12 Hours**

Quantum Mechanics: Dual nature of matter - Heisenberg's Uncertainty Principle - Significance and properties of wave function - Schrodinger's time independent and dependent wave equations - Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) - Quantum free electron theory - electrical conductivity based on quantum free electron theory - Fermi-Dirac distribution - Fermi energy. **COs– CO4**

Self-Learning Topics: Density of states, Origin of energy bands in solids

UNIT-V: Semiconductors **8 Hours**

Semiconductors: Formation of energy bands - classification of crystalline solids - Intrinsic semiconductors: - Fermi level - Extrinsic semiconductors- P-Type semiconductors- N-Type semiconductors- Principle of operation and Characteristics of P-N Junction diode - Drift and diffusion currents - Einstein's equation - Hall Effect and its applications. **COs-CO5**

Self-Learning Topics: Zener diode, Solar cells

Board of Studies : Department of Physics
Approved in BOS No: 01, 5th August, 2024
Approved in ACM No: 01

Textbooks:

1. A Text book of Engineering Physics - M. N. Avadhanulu, P.G. Kshirsagar& TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Introduction to Quantum Mechanics, David J. Griffiths, Pearson Education India Learning Private Limited (2015).
3. Laser Fundamentals, William T. Silfvast, 2nd edn, Cambridge University press, New York (2004).
4. Introduction to Solid State Physics, 8 th Edition, Charles Kittel, John Wiley & Sons, NJ,

USA (2005).
5. Engineering Physics - D.K. Bhattacharya and Poonam Tandon, Oxford press (2015).
6. Semiconductor Physics and Devices:Basic principle, Donald A. Neamen 4th ed,, McGraw-Hill, New York (2012).

Reference Books:

1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning.
2. The Principles of Quantum Mechanics, P. A. M. Dirac, fourth Edition (Oxford University Press, Oxford, 1958).
3. Physics-Resnick, Halliday, Krane, Fifth edison, Volume-1, Wiley student edition.
4. Engineering Physics - Dr.R. Swapna, Scientific International Publishing House.
5. Concepts of Modern Physics. Arthur Beiser, Tata McGraw-Hill, New Delhi (2010).
6. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.
7. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web References:

1. https://www.ebooksdirectory.com/
2. http://www.sciencedirect.com/Science
3. https://onlinecourses.nptel.ac.in/
4. https://www.link.springer.com/physics/
5. https://www.loc.gov/rr/scitech/selected-internet/physics.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	40	20
L2	30	30
L3	30	--
L4	--	30
L5	--	20
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-1

1. Define interference? What are the necessary conditions for obtaining interference of light? (L1)
2. Explain interference in thin films due to reflected light. What are the conditions to obtain the maximum and minimum intensities in the reflected light? (L2)
3. Describe the principle and formation of Newton's rings and give a method to determine the radius of nth dark ring, radius of curvature (R) of plano convex lens and radius of nth dark ring. (L1,L3)
4. What is meant by diffraction? Distinguish between Fresnel and Fraunhofer diffraction. (L1)
5. Discuss Fraunhofer diffraction due to single slit and derive an expression for width of the central maxima? (L2,L3)
6. What is meant by stimulated emission. Describe Lasing action. (L1,L2)
7. Describe the construction and working of He-Ne Laser. (L1)

UNIT-2

1. Define the terms space lattice, basis, unit Cell, lattice parameters, bravais Lattice, atomic radius and coordination number. (L1)

2. Illustrate the SC, BCC and FCC crystal structures. (L3).
3. Explain body centered cubic (BCC) and determine the packing fraction of BCC. (L2,L3)
4. Explain body centered cubic (FCC) and determine the packing fraction of FCC. (L2,L3)
5. Classify the seven crystal systems and write the relationship between lattice parameters in various crystal systems. (L2)
6. What are the Miller indices? How are they obtained? (L1)
7. What are the important features of Miller indices? Draw the planes (100), (101) (110) (010) and (111), (123). (L1)
8. State and explain Bragg's law. (L2)
9. Describe the LAUE method for determination of crystal structure. (L2)

.UNIT-3

1. Define the terms magnetic dipole moment and magnetic susceptibility, magnetization, permeability, dielectric flux density and magnetic field intensity. (L1)
2. Summarize various types of polarization of dielectrics. (L2)
3. Show that $\mu r = 1 + \chi$. (L3)
4. Describe the origin of magnetic moment of an atom. (L1)
5. Explain the domain concept of ferromagnetism based on Hysteresis loop (B-H Curve). (L2)
6. Describe soft and hard magnetic materials? (L1)
7. What is meant by internal field or local field or Lorentz field? Derive an expression for internal field. (L1, L3)
8. Derive Clausius-Mosotti relation in dielectrics subjected to static fields. (L3)

UNIT-4

1. Discuss the de-Broglie's hypothesis. Show that $\lambda = h / \sqrt{2mE}$ (L1, L4)
2. Show that the wavelength of an electron accelerated by potential differences $\lambda = \frac{1.227}{\sqrt{V}} nm$. (L3)
3. What are the matter waves? Explain the properties of matter waves. (L1)
4. What is the physical significance of wave function ψ.(L4)
5. Derive the time independent and dependent Schrodinger wave equation. (L4)
6. Describe the particle in 1 dimensional infinite potential box. (L1)
7. Explain Heisenberg uncertainty principle? (L4)
8. Find the energy required to jump an electron from ground state to the second excited state in a metal.(L1),
9. Define the terms (i) mean free path (ii) drift velocity (iii) relaxation time. (L1)
10. What are the success and draw backs of classical free electron theory of metals. (L1)
11. Derive an expression for electrical conductivity on the basis of quantum free electron theory of metals. (L3)
12. What is Fermi level? Explain Fermi-Dirac distribution function (FDD) of the electrons. (L1, L4)

UNIT-5

1. Explain the classification of solids (conductors, semiconductors and insulators (L5).
2. What are the differences between intrinsic and extrinsic semiconductors? (L2)
3. Explain N-Type and P-Type semiconductors. Indicate on an energy level diagram the donor and acceptor level for intrinsic and extrinsic semiconductors. (L5)
4. Explain the characteristics of P-N Junction diode. (L5)

5. Describe the diffusion current and drift current in a semiconductor. (L2)
6. Derive an expression for Einstein's equation by using drift and diffusion currents. (L5)

7. What is Hall Effect? Identify the type of semiconductor using Hall effect and derive an expression for Hall coefficient. (L2, L3).
8. Write the applications of Hall Effect. (L1)

Chairperson
Board of studies (Physics)

R24HS01 COMMUNICATIVE ENGLISH 2 0 0 2

(Common to CSE, CSE-AI & ML, CSD Branches in Semester-I)

(Common to EEE, MECH & ECE in Semester-II)

Course Objectives:

1. To identify the English Communication Skills among the first year B.Tech students and to initiate measures to bridge the gap.
2. To enlighten the students on the necessity of cultivating good language habits through practising LSRW skills.
3 To explain them various topics of grammar and the importance of being grammatically correct in speech and writing.
4 To make them practise Phonetics and impart the nuances of fine speech.
5 To instruct them about the various types of format related to writing letters, paragraph, emails, essays and reports.
6 To make them appreciate English text and deepen their comprehension through reading of textual and non-detailed topics.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO9	PO10	PO12	
R24HS01.1	To utilize the text, online resources, and other social, and real time situations with an aim to practice Communicative English	1	3	2	L2, L4
R24HS01.2	To apply grammatical knowledge for speaking, and writing purposes	2	3	1	L3, L6
R24HS01.3	To analyze and practice various devices of speech for effective conversation and presentations	2	3	1	L4, L6
R24HS01.4	Appraising the language competence of the learners and suggesting remedial action	2	3	1	L3,L5
R24HS01.5	To make the learners practice writing tasks which are relevant for job training and academic purposes.	1	2	3	L3,L6

SYLLABUS

UNIT-I **12 Hours**

Lesson: HUMAN VALUES: A Power of a Plate of Rice by Ifeoma Okoye (Short story)

Listening: Identifying the topic, the context and specific pieces of information

By listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words. **COs-C01**

Self learning topics : The Great Indian Scientists-Biography of CV Raman

UNIT-II **10 Hours**

Lesson: NATURE: Night of the Scorpion by Nissim Ezekiel (Indian and contemporary)

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Structure of a paragraph - Paragraph writing (specific topics)

Grammar: Cohesive devices-linkers, use of articles and zero article prepositions.

Vocabulary: Homonyms, Homophones, Homographs. **COs-C02**

Self learning Topics : Seven Ages of Man by William Shakespeare.

UNIT-III **12 Hours**

Lesson: BIOGRAPHY: Steve Jobs

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences-recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs-tenses; Subject-verb agreement; Compound words, Collocations

Vocabulary: Compound words, Collocations **COs-C03**

Self learning topics: Elon Musk

UNIT-IV **8 Hours**

Lesson: INSPIRATION: The Knowledge Society by APJ Abdul Kalam (Ignited minds)

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/ patterns / relationships, communicate processes or display complicated data.

Writing: Letter Writing: Official Letters and Resumes

Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice

Vocabulary: Words often confused, Jargons **COs-C04**

Self learning Topics: The writings of Sudha Murthy- "The day I stopped drinking milk"

UNIT-V **10 Hours**

Lesson: MOTIVATION: The Power of Intra personal Communication (An Essay)

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal Oral Presentation topics from academic contexts

Reading: Reading comprehension.

Writing: Writings structured essays on specific topics.

Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject-verb agreement)

Vocabulary: Technical Jargons **COs-C05**

Self learning Topics: Body Language (Allan Pease)

Board of Studies : ENGLISH
Approved in BOS No: 6th August, 2024
Approved in ACM No: 01

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1stEdition,Orient BlackSwan, 2023 (Units 1,2,3 &5)
2. Empowering English by Cengage Publications, 2023
3. The Great Indian Scientists-Cengage Publications
4. English Essentials- Maruthi Publications.(Unit 4)

Reference Books:

1. P. Elian : A Hand book of English for Engineers and Technologists,
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy Raymond English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. English for Engineers by Shyam Ji Dubey- Vikas Publishing House

Web References:

1. www.bbc.co.uk/learningenglish
2. https://dictionary.cambridge.org/grammar/british-grammar/
3. www.eslpod.com/index.html
4. https://www.learngrammar.net/
5. https://english4today.com/english-grammar-online-with-quizzes/
6. https://www.talkenglish.com/grammar/grammar.aspx
7. https://www.youtube.com/c/DailyVideoVocabulary/videos
8. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	25	25
L2	25	25
L3	15	15
L4	15	15
L5	10	10
L6	10	10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of various cognitive levels

UNIT-I

1. List the major characters in the story.
2. How did the family financial circumstances affect narrator's behaviour and relationship with her family and students?
3. What are the different types of reading?
4. How to avoid errors in spellings and enlist few steps for vocabulary development?
5. What are the different parts of speech?

UNIT-II

1. Write the summary of the poem Night of the Scorpion?
2. How does the ruler setting serve as a perfect background for the programme?
3. Describe the superstitious beliefs and practices mentioned by writer Nissim Ezekiel in his poem.
4. Write a paragraph on Artificial intelligence
5. Write about Definite and In-definite articles with examples?

UNIT-III

1. How did informal jobs and formal education influence his career?
2. Sketch the biography of Elon Musk.
3. List three steps to effective note making.
4. Can technological advancements address the pressing human problems like climate change and disease prevention?
5. Can you come up with creative ideas to match the technological vision of Elon Musk for our humanity?

UNIT-IV

1. What are the various resources of knowledge that Abdul Kalam points out in the knowledge society?
2. What are three main objectives which need to be realized for India to become a Super Power?
3. How ancient Indian knowledge systems have informed the world over centuries?
4. What does it take according to Dr.Kalam for India to become a Knowledge Society?
5. What message can students import from Knowledge Society?

UNIT-V

1. Write the difference between Inter personal communication and Intra personal communication?
2. Mention the different ways through which Intra personal communication helps to improve every day's life.
3. What do you mean by non-verbal communication? Discuss the various types of non-verbal communication.
4. What is the most important type of non-verbal communication, justify your answer?
5. How to make an effective presentation?

Chairperson
Board of Studies (English)

R24ES01 BASIC CIVIL AND MECHANICAL ENGINEERING 3 0 0 3
(COMMON TO ALL BRANCHES)

Course Objectives:

1. **Understand the Role of Civil Engineers**: Familiarize students with the roles and responsibilities of civil engineers in society and the various sub-disciplines within civil engineering.
2. **Construction Materials**: Provide knowledge about different construction materials such as cement, aggregates, bricks, concrete, steel, soil, stones and their applications in building construction.
3. **Transportation Engineering**: Offer insights into the importance of transportation engineering for national economic development and the fundamentals of highway pavements, harbor, tunnel airport and railway engineering.
4. **Water Resources and Environmental Engineering**: Cover the basics of water sources, water quality specifications, hydrology, rainwater harvesting, and water storage structures, emphasizing their importance in environmental sustainability.
5. **Scope and Importance of Mechanical Engineering**: Familiarize students with the scope and significance of mechanical engineering in various sectors, including energy, manufacturing, automotive, aerospace and marine industries.
6. **Engineering Materials and Manufacturing Processes**: Explain different engineering materials and various manufacturing processes and computational manufacturing.
7. **Thermal Engineering**: Provide an overview of thermal engineering principles, including the working of boilers, IC engines, and power plants, and introduce concepts related to electric and hybrid vehicles.
8. **Mechanical Power Transmission Systems**: Describe different mechanical power transmission systems such as belt drives, chain drives, gear drives, and their applications.
9. **Basics of Robotics**: Introduce the basics of robotics, including joints, links, configurations, and applications, along with advancements in robotics technology.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO5	PO9	PO12	
R24ES01.1	Understand the role of civil engineers in various disciplines, the scope of each discipline, and the materials used in building construction and principles of surveying.	3	-	1	-	2	1	L1
R24ES01.2	Describe the fundamentals of transportation engineering, water resources, and environmental engineering, including highway pavements, water quality, hydrology, and water storage structures.	3	1	1	1	1	-	L2, L3
R24ES01.3	Understand and apply different manufacturing processes and engineering materials, including	3	2	1	2	2	2	L1

	their applications, and basic mechanical design principles.							
R24ES01.4	Explain the basics of thermal engineering, including working principles of engines, power plants, and related thermal cycles, along with their applications.	3	1	1	2	2	2	L1,L2
R24ES01.5	Describe the working of different mechanical power transmission systems and the basics of robotics and their applications.	3	1	1	2	1	2	L2, L3

SYLLABUS

UNIT I **10 Hours**

Role of Civil Engineers in Society, Various Disciplines of Civil Engineering, Structural Engineering, Geo-technical Engineering, Transportation Engineering, Hydraulics and Water Resources Engineering, Environmental Engineering, Scope of Each Discipline, Building Construction and Planning, Construction Materials Cement, Aggregate, Bricks, Cement Concrete-Steel, soils and stones. Introduction to Prefabricated construction Techniques.

Surveying: Objectives of Surveying, Horizontal Measurements, Angular Measurements, Introduction to Bearings Simple problems on bearings-Contour mapping.

Self-Learning Topic: Advancements in Prefabricated Construction Techniques **COs: CO1**

UNIT II **15 Hours**

Transportation Engineering: Importance of Transportation in Nation's economic development, Types of Highway Pavements, Flexible Pavements and Rigid Pavements, Simple Differences. Basics of Harbor, Tunnel, Airport, and Railway Engineering

Water Resources and Environmental Engineering: Introduction, Sources of water, Quality of water, Specifications, Introduction to Hydrology, Rainwater Harvesting, Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Self-Learning Topic: Sustainable Transportation Engineering **COs: CO2**

UNIT-III: **12 Hours**

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Basic Mechanical Design Principles: Fundamentals of Mechanical Design- Introduction to the design process, understanding design requirements, and conceptual design, Design of Simple Machine Components - Design considerations for basic machine components like shafts, bearings, gears, and fasteners.

Engineering Materials – Metals - Ferrous and Non-ferrous, Ceramics, Composites, Smart materials**.**

Self-Learning Topics: Sustainable Engineering Practices, Advancements in Smart Materials.

COs: CO3

UNIT- IV: **12 Hours**

Thermal Engineering– Working principle of Boilers

Cycles- Otto cycle, Diesel cycle, Refrigeration and air conditioning cycles,

Engines- IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines,

Power plants – Working principle of Steam, Diesel, Hydro, Nuclear power plants, Introduction to Electric and Hybrid Vehicles.

Self-Learning Topics: Advanced Engine Technologies, Thermodynamics in Renewable Energy Systems. **COs: CO4**

UNIT – V: 12 Hours

Manufacturing Processes: Principles of Casting, Forming, joining processes,

Computational Manufacturing: Introduction to CNC machines, 3D printing, and Smart manufacturing.

Machining – Conventional & Non-Conventional,

Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics - Joints & links, configurations, and applications of robotics.

Self-Learning Topics: Additive Manufacturing Technologies, Innovations in Mechanical Power Transmission **COs: CO5**

Text Books:

1. Basic Civil and Mechanical Engineering, by Ommi Srikanth, M. Sreenivasa Reddy S. Chand Publications
2. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
3. A Tear book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
4. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, cengage learning India pvt. Ltd.

Reference Books:

1. AppuuKuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications
3. Thermal Engineering by Mahesh M Rathore Tata Mcgraw Hill publications (India) Pvt. Ltd.
4. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata Mcgraw Hill publications (India) Pvt. Ltd.

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	30
L2	30	50
L3	20	20
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

Basic Civil Engineering

L1: Remember

1. List out components of building.
2. Steps in preparation of bricks cement.
3. Explain various requirements of building
4. Write various principles in building planning
5. Write qualities of goods bricks
6. Write uses of concrete
7. What are types in soils.
8. Write about pre-fabricated structures.
9. What are the uses of surveying
10. What are types in surveying
11. Write about closed traverse and open traverse
12. Write about bearings and meridian.
13. What is contour mapping.
14. Write about flexible and rigid pavements.
15. What is runway
16. Write about dams and reservoirs
17. Write the sources of water

1. What are the main roles of mechanical engineering in different industries?
2. Define basic mechanical design principles.
3. List the types of engineering materials covered in this unit.
4. What are the key differences between ferrous and non-ferrous metals?
5. Name three applications of smart materials.
6. What is the working principle of a boiler?
7. Define the Otto cycle and Diesel cycle.
8. What are the key differences between 2-Stroke and 4-Stroke engines?
9. List the types of power plants covered in this unit.
10. Name a major advantage of electric vehicles over conventional vehicles.
11. What are the basic principles of casting in manufacturing processes?
12. Define CNC machining and its basic applications.
13. List the types of mechanical power transmission systems discussed in this unit.
14. What are the key differences between conventional and non-conventional machining?
15. Name the main components of a robotic system.

L2: Understand

1. Explain the process of designing a simple machine component like a shaft.
2. Describe the role of mechanical engineering in the aerospace sector.
3. Compare the properties of ceramics and composites used in engineering.
4. Discuss the importance of understanding material properties in mechanical design.
5. Summarize the technological advancements in smart materials.
6. Explain the basic operation of an IC engine.
7. Describe the differences between refrigeration and air conditioning cycles.
8. Compare the working principles of steam and hydro power plants.
9. Discuss the role of hybrid vehicles in reducing energy consumption.

10. Summarize the working principles of the Diesel cycle and its applications.
11. Explain the process of CNC machining and its advantages.
12. Describe the principles of gear drives and their applications in mechanical systems.

L3: Apply

1. Analyze the role of civil engineering in society.
2. Understanding the various disciplines of civil engineering.
3. Evaluate the use of materials in construction.
4. Create a case study on a recent innovation in civil engineering like prefabricated structures.
5. Apply the principles of the surveying to determine different measurements.
6. Solve problems related to bearings
7. Compare the flexible pavement and rigid pavements.
8. Evaluate the benefits water supply system.
9. Evaluate the benefits of dams.
10. Design a rain water harvesting.
11. Apply the basic mechanical design principles to design a simple gear system.
12. Using the properties of different engineering materials, suggest a suitable material for a specific mechanical component.
13. Design a basic component considering the design requirements and material properties.
14. Analyze how advancements in smart materials can impact the design of mechanical components.
15. Apply knowledge of engineering materials to solve a problem in a real-world mechanical system.
16. Apply the principles of thermal engineering to analyze the efficiency of a steam power plant.
17. Using the Otto cycle, calculate the performance parameters for a given engine setup.
18. Design a basic model of a hybrid vehicle considering its power source and energy efficiency.
19. Apply the knowledge of refrigeration cycles to improve the efficiency of a cooling system.
20. Analyze the impact of different thermal cycles on the performance of an IC engine.
21. Apply the principles of CNC machining to design a simple component.
22. Design a mechanical power transmission system for a specific application, considering the required drives and components.

Chairperson
Board of Studies (ME)

R24MEPC01 ENGINEERING MECHANICS 3 0 0 3

Course Objectives:

1. To get familiarized with different types of force systems.
2. To draw accurate free body diagrams representing forces and moments acting on a body to analyze the equilibrium of system of forces.
3. To teach the basic principles of center of gravity, centroid and moment of inertia and determine them for different simple and composite bodies.
4. To apply the Work-Energy method to particle motion
5. To understand the kinematics and kinetics of translational and rotational motion of rigid bodies.
6. Able to analysis of frames and trusses, different types of motion, friction and application of work - energy method.

Course Code	Course Outcomes	Mapping with POs and PSOs					DoK
		PO1	PO2	PO3	PO4	PSO1	
R24MEPC01.1	Understand the fundamental concepts in mechanics and determine the frictional forces for bodies in contact.	3	1	2	2	2	L1, L2
R24MEPC01.2	Analyze different force systems such as concurrent non concurrent systems and calculate their resultant forces and moments.	3	1	2	1	2	L1, L2, L3
R24MEPC01.3	Calculate the Centroids, Centre of gravity and moment of inertia of different geometrical shapes.	3	1	3	2	2	L1, L2
R24MEPC01.4	Determine the displacement, velocity & acceleration relations in dynamic systems.	3	1	2	2	2	L1, L2
R24MEPC01.5	Analyze the motion of the bodies with (or) without the application of force.	3	1	1	1	2	L1, L2, L3

SYLLABUS

Unit- I: Introduction to Engineering Mechanics **9 Hours**

Introduction to Engineering Mechanics – Basic Concepts and Applications

Systems of Forces: Coplanar Concurrent Forces– Components in Space– Resultant–Moment of Force and its Application –Couples and Resultant of Force Systems.

Friction: Introduction**,** limiting friction and impending motion, Coulomb's laws of dry friction, coefficient of friction, Cone of Static friction.

Self learning topic: Newton's law of motion and gravitation **COs: CO1**

Unit- II: Equilibrium of Systems of Forces **9 Hours**

Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorem, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses. Principle of virtual work with simple examples

Self learning topic: Distribution of forces in a plane **COs: CO2**

Unit- III Centroid, Centre of Gravity and Area moments of Inertia 9 Hours

Centroid: Centroids of simple figures (from basic principles)–Centroids of Composite Fig

Centre of Gravity: Centre of gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappus theorems.

Area Moments of Inertia: Definition–Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.

Self learning topic: Centroid for two dimensional bodies **COs: CO3**

Unit- IV: Kinematics, Kinetics 9 Hours

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics –D'Alembert's Principle – Work Energy method and applications to particle motion-Impulse Momentum method

Self learning topic: Cylindrical and spherical coordinates **COs: CO4**

Unit -V: Work – Energy Method 9 Hours

Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method

Self learning topic: Potential energy and equilibrium **COs: CO5**

Text Books:

1. Timoshenko S. and Young D.H.," Engineering Mechanics",5th Edition, Mc Graw Hill Publications,2013
2. Bavakatti S. S.," Engineering Mechanics Statics",4th Edition, New Age International Publications,2012
3. Tayal. A. K., "Engineering Mechanics Statics and Dynamics",6th Edition, Umesh Publications,2006

Reference Books:

1. Kurmi R.S.,"Engineering Mechanics Statics",10thEdition, S.Chand Publications,2005
2. Vijay Kumar Reddy K. and Suresh KumarJ.," Mechanics: Statics and Dynamics",3rd Edition, B S Publications,2010
3. Ferdinand P. Beer, Russell Johnston Jr .E.," Vector Mechanics for Engineers Static sand Dynamics",9th Edition, McGraw Hill Publications,2011

Web References:

1. https://www.iitg.ac.in/rkbc/me101/Presentation/L01-03.pdf

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	30
L2	40	40
L3	20	30
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

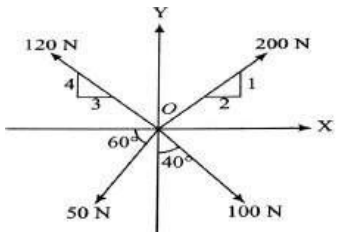
1. State the conditions for equilibrium of a rigid body in three dimensions
2. What is the principle of transmissibility?
3. State the Parallel axis theorem
4. Define centroid and centre of gravity
5. State triangular law of forces. What is the use of this law?

L2: Understand

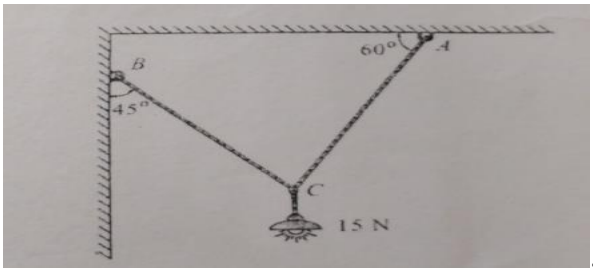
1. Explain Pappus theorem I&II
2. Differentiate between polar moment of inertia and product of inertia
3. Write impulse momentum equation
4. What is a rolling body? Explain its importance
5. Explain work-energy method for a plane motion

L3: Apply

1. Two forces of magnitude 50N and 30N are acting at a point. If the angle between the two forces is 60^0, determine the magnitude and direction of the resultant force
2. A system of four forces acting on a body is shown in figure. Determine the resultant force and its direction

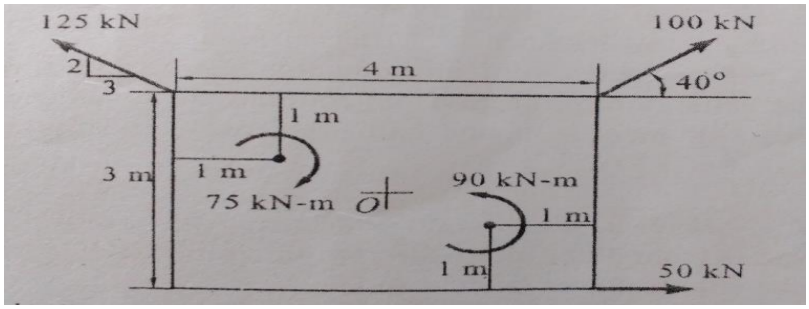


3. An electric light weighing 15N hangs from a point C by the two strings AC and BC as shown in Figure3. AC is inclined at 60^0 to the horizontal and BC at 45^0 to the vertical shown in figure. Using Lami's theorem find the forces in strings AC and BC

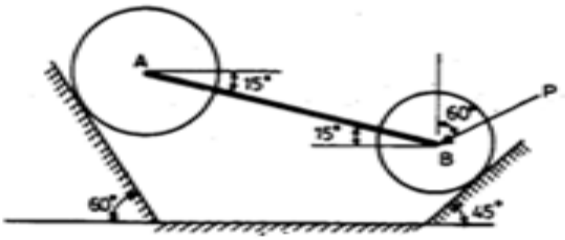


.

4. Find the sum of moment about center O of the force and couple acting on the rectangle plate shown in **Figure**



5. Two cylinders, A of weight 4000 N and B of weight 2000 N rest on smooth inclines as shown in **Figure** They are connected by a bar of negligible weight hinged to each cylinder at its geometric centre by smooth pins. Find the force P to be applied as show in the figure such that it will hold the system in the given position



Chairperson
Board of Studies (ME)

R24HS02 COMMUNICATIVE ENGLISH LAB 0 0 2 1
(Common to CSE, CSE-AI & ML, CSD Branches in Semester-I)
(Common to EEE, MECH & ECE in Semester-II)

Course Objectives:

The main objective of introducing this course, Communicative English Laboratory, is to expose the students to a variety of self-instructional, learner friendly modes of language learning. Students undergo training in basic communication skills to make them into confident communicators in all situations.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs			
		PO9	PO10	PO12	Dok
R24HS02.1	Understand and recognize the various facets of English language ability with a focus on the four basic skills- namely -LSRW abilities.	1	3	2	L1
R24HS02.2	Implement various activities for language learners to practise communication skills.	1	2	3	L2
R24HS02.3	To enhance listening and speaking comprehension, analyze the sounds, stress, rhythm, intonation, and syllable division of English speech.	1	3	2	L3
R24HS02.4	Assess the professionalism of students when taking part in group discussions, debates, JAM sessions, Presentations and Interviews.	3	1	2	L4
R24HS02.5	Equipping oneself with Interview Skills and a range of Soft Skills for life and career.	1	3	2	L5

Board of Studies : BS&H- English

Approved in BOS No: 6th August, 2024

Approved in ACM No: 01

SYLLABUS

Week1:

1. To explain and guide the students in decoding the sounds of English.
2. List all the consonant sounds and vowel sounds in English

Week2:

1. What is a syllable and describe the syllable structure.
2. Define stress, functional stress and various rules of stress.
3. What is connected speech?

Week3:

1. What is Intonation and mention the various pitch movements like rise, fall, fall-rise or rise-fall?
2. What is connected speech?

Week4:

1. To equip students to speak in English language confidently without any inhibitions.
2. Why are majority of the companies conducting JAM session as a preliminary interview?

3. What are the key skills tested in JAM round?

Week5:

1. To help students learn and understand different functions of language like greeting, asking
2. For information, giving information, meetings, requests, exchanging dialogues in formal and informal contexts.
3. Introduce yourself and others, give instructions and directions

Week 6:

1. To help the students understand and work on the digital age connector for personal correspondence, business communication, etc.
2. Write about email etiquette.
3. Draft an email to the HR Manager of Wipro Technologies requesting to consider your application for the post of Software Engineer.

Week 7:

1. To update students about the importance of Resume, the various types and the essentials of an effective resume
2. Draft a resume for a software post in reputed organization.

Week 8:

1. To educate students about the various styles of writing formal letters.
2. What is a cover letter? What are the different types of cover letters?
3. Write a job application letter for any post of your choice in a reputed company?

Week 9:

1. To help students know the importance of an SOP in their professional advancements?
2. What is an SOP and what are the different kinds and parts of an SOP?
3. Prepare an SOP to apply for a Master's Programme in any University of your choice.

Week 10:

1. To educate and guide the students about presentation skills and its importance in the technical evolving world.
2. To inform explain students about the importance of body language in various personal and professional forums
3. To help students to present papers, PPT's in seminars, workshops, conferences, research projects, interviews, etc.

Week 11:

1. To help students to give effective PPT's in various academic and professional platforms.
2. Describe various aspects that make PPT more effective.
3. Make a PPT on any topic of your choice and present it to the class.

Week 12:

1. To foster, creative, critical thinking skills, analytical skills and problem solving skills.
2. Suggest a few tips for preparing a poster.
3. Prepare posters from or outside your curriculum.

List of Activities:

1. Sounds of English (Vowels and Consonants) **COs: CO1,CO2**
2. Neutralization and Accent Rules **COs: CO1,CO2**
3. Improving communication skills /JAM. **COs: CO3,CO4**

4. Letter Writing and E-mail Writing **COs: CO1,CO2**
5. Cover letters and Resume Writing **COs: CO1,CO2**
6. Statement of Purpose. **COs: CO1,CO2**
7. Debates **COs: CO4:CO5**
8. Presentation skills- PPT and Poster **COs: CO4:CO5**
9. Group Discussions , types and practice **COs: CO4,CO5**
10. Interview skills – Mock interviews **COs: CO4,CO5**

Reference Books:

1. Prof. M. Hari Prasad, Prof. Vijaya Babu, Prof. Padmaja Kalapala, Skill Craft – A Communicative English Laboratory Workbook, Maruthi Publications first Edition, 2023
2. Meenakshi Ramana, Sangeeta-Sharma, 4thEdition, Technical Communication, Oxford Press, 2022.
3. Grant Taylor: English Conversation Practice, 1st Edition, Tata ,Mc Graw-Hill Education India, 2001.
4. Hewing,s, Martin, Cambridge Academic English(B2), Cambridge University Press,2012.
5. T. Balasubramanyam, A Textbook of English Phonetics for Indian Students, 3rd Edition, Trinity, 2022.
6. Dr. ShaliniSharma's Body Language Your Success Mantra, S. Chand publications 2010.
7. Sunitha Mishra and C.Murali Krishna's Communication Skills for Engineers Pearson Education Edition 2009.

Suggested software:

- English Wordsworth –Language Lab- Wordsworth Software

Web References for:

Spoken English

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. . https://www.youtube.com/c/ArnelsEverydayEnglish/featured
7. https://www.youtube.com/c/engvidAdam/featured
8. . https://www.youtube.com/c/EnglishClass101/featured
9. https://www.ted.com/watch/ted-ed
10. http://www.edest.org/

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

Chairperson
Board of Studies (English)

R24BS03 **Engineering Physics Lab** **0 0 2 1**
(Common to all Branches)

Course Objectives:

1. To study the concepts of optical phenomenon like interference, diffraction etc.,
2. To recognize the importance of energy gap in the study of conductivity and Hall effect in semiconductors
3. To study the parameters and applications of dielectric and magnetic materials by conducting experiments.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs					Dok
		PO1	P02	P04	PO9	PO12	
R24BS03.1	Demonstrate the modern engineering physics techniques and tools in real times applications in engineering studies.	3	1	2	1	2	L1
R24BS03.2	Develop the laboratory skills in handling of electrical and optical instruments.	2	1	1	2	1	L3
R24BS03.3	Conduct experiment independently and in team to record the measurements	2	1	2	2	1	L2

Board of Studies : Department of Physics
Approved in BOS No: 01, 5th August, 2024
Approved in ACM No: 01

Developing the following programs:

List of Experiments

1. Determination of radius of curvature of a given plano convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Determination of thickness of thin object by air wedge method.
4. Determination of wavelength of Laser Source by diffraction grating.
5. Determination of rigidity modulus of the material of the given wire using Torsional Pendulum.
6. Magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method.
7. Determination of dispersive power of the prism.
8. Determination of acceleration due to gravity and radius of Gyration by using Compound Pendulum.
9. Determination of energy gap of a semiconductor using p-n junction diode.
10. Determination of dielectric constant using charging and discharging method.
11. Sonometer: Verification of laws of stretched string.
12. Estimation of Planck's constant using photoelectric effect.
13. Study the variation of B versus H by magnetization of the magnetic material (B-H curve).
14. Determination of frequency of electrically maintained tuning fork by Melde's experiment.
15. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall

effect.

16. Determination of the resistivity of semiconductor by four probe method.
17. Determination of young's modulus for the given material of wooden scale by non- uniform bending (or double cantilever) method.
18. Determination of velocity of sound by Kundt's tube method.

Note: Any **TEN** of the listed experiments are to be conducted. Out of which any **TWO** experiments may be conducted in virtual mode.

Week 1:

1. What is the basic principle of newton's rings experiment?
2. Define Interference phenomena?.
3. Why the rings are circular?
4. What are Newton's Rings?
5. Why it is necessary for the light to fall normally on plano convex lens?
6. What is constructive interference and destructive interference?
7. What is the purpose of glass plate incline at 450 in this experiment?
8. Why the centre of the rings is dark?
9. Which light does u use in this experiment?
10. What will happen if we use White light in this experiment?
11. If u replace yellow light with green light, is there any difference in the formation of rings ?

Week 2:

1. What is diode?
2. What is energy gap?
3. What is valency band?
4. What is conduction band?
5. How many types of solid materials are there and what are those materials?
6. What is a conductor?
7. What is insulator?
8. What are Semi conductors?
9. What are the types of semi conductors are there?
10. What is intrinsic and extrinsic semi conductor?
11. What u meant by Fermi energy level?

Week 3:

1. What is the full form of laser?
2. How laser light is different from the ordinary light?
3. What is population inversion?
4. What is pumping?
5. What is laser?
6. What is meant by the term coherency?
7. What is diffraction?
8. Define Grating
9. What is active medium?
10. What is the action of the optical resonator?

Week 4:

1. What is the magnetic induction formula at a point x, away from the center of the circular

coil?

2. What will be the Magnetic field value at the center of a current-carrying coil?
3. Does earth's horizontal magnetic field value remain the same everywhere or it fluctuates?
4. What is Commutator and what its role in an experiment?
5. What is the relation between Gauss and Tesla?
6. Why do you put apparatus (Wooden Frame along with circular coil) in East-West Direction?
7. What are Tan A and Tan B Positions?
8. What is the unit of magnetic field intensity H?
9. Can you perform the experiment by using the Alternating Current?
10. What are the magnetic elements?

Week 5:

1. What is the purpose of Capacitors ?
2. What the resistor will do ?
3. What is the purpose of Inductors?
4. What is Time constant?
5. What you meant by capacity of a conductor.
6. Define potential.
7. What is capacitance.
8. Define dielectric Constant?
9. What is the significance of finding the dielectric strength of a material?
10. Give some examples of dielectric materials used in electric devices?

Week 6:

1. What is plane transmission diffraction grating?
2. In our experiment, what type of diffraction does occur and how?
3. What is meant by dispersive power of grating?
4. How the commercial gratings can be made?
5. Define grating element
6. Among Prism and grating which gives more intense spectrum and why?
7. Define diffraction grating?
8. What are the essential parts of the spectrometer?
9. Which colour in the spectrum is having more refractive index?
10. How many types of spectra are available?
11. Define grating element.

Week 7:

1. What is the significance of the beam splitter in this experiment?
2. How do you form a wedge shaped air film?
3. Why the fringes are straight?
4. Why the fringes are formed equally spaced?
5. What type of light source is required for this experiment?
6. Why the fringes are formed parallel and why not circular like Newton Ring's experiment?
7. What is the principle involved in this experiment?
8. What is meant by constructive and destructive interference?

Week 8:

1. What is prism?
2. What u meant by Angular Dispersion?

3. Dispersive power of the prism?
4. What is Refractive index?
5. What is Spectrometer?
6. What is the function of Collimator?
7. What u meant by Angle of Prism?
8. What is Dispersion of Light?
9. What is the main optical action of the prism?
10. What type of prism do u use in this experiment?
11. What are the units of Dispersive power?
12. What type of light do u use in this experiment?
13. Which colour in the spectrum is having more refractive index?

Week 9:

1. .Define Rigidity of modulus?
2. Define Moment Of Inertia?
3. What is the meaning in calling this a pendulum?
4. Difference between simple pendulum and torsional pendulum?
5. What is S.H.M ?
6. What is Young's modulus?
7. Define Time Period?
8. Mention the factors on which the rigidity modulus of a material depends?
9. What is meant by mechanical deformation?
10. Define restoring force?
11. Define stress and mention its units?
12. Define strain and mention its units?
13. If we increase the diameter of the wire, what happened to rigidity modulus?
14. Differentiate simple pendulum and torsional pendulum?

Week 10:

1. What does u mean by Frequency?
2. Define Resonance?
3. What u meant by Progressive wave?
4. How many types of progressive waves are there?
5. Difference between transverse wave and longitudinal wave?
6. What u meant by standing wave?
7. In our experiment which type of wave passing along the thread?
8. In our experiment which type of wave passing along the thread?

Week 11:

1. What is the purpose of Capacitors ?
2. What the resistor will do?
3. What is the purpose of Inductors?
4. What is Time constant?
5. What is capacitance?
6. Define potential?
7. What u meant by capacity of a conductor?
8. What is the relation between charge "Q" and capacitor?

References:

1. S. Balasubramanian, M.N.Srinivasan "A Text Book of Practical Physics"-S Chand Publishers, 2017.
2. R.K. Shukla, Anchal Srivastava, Practical Physics, New age international (2011).
3. H.G.Jerrad and D.B. Mc Neil -Theoretical and Experimental Physics.
4. Roman Kezerashvili, Physics laboratory experiments: electricity, magnetism, optics, New York: Gurami Pub., (2003).
5. Y. Aparna and K. Venkateswararao, Engineering Physics–I and II, VGS Techno series.
6. J.R.G. Patnaik, "Physics Laboratory Manual, "Paramount book distributors.
7. S. Panigrahi and B. Mallick, Engineering Practical Physics, Cengage leaning, Delhi, 2015.

Weblinks:

1. https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype
2. http:/www./iitk.vlab.co.in

Chairperson
Board of studies (Physics)

R24ES04 **IT Workshop Lab** **0 0 2 1**

(Common to All Branches)

Course Objectives:

1. To assemble and disassemble a computer.
2. To solve hardware and software problems.
3. To learn about Networking of computers and use Internet facility for Browsing and Searching.
4. To develop project documentation using MS word
5. To work with various productivity tools including Excel, PowerPoint.
6. To work with different online repositories such as GITHUB, AI CHATBOT.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PS01	PS02	
R24ES04.1	Perform Hardware troubleshooting and Perform Hardware troubleshooting	2	3	3	3	2	L2, L3
R24ES04.2	Apply different way of hooking the PC on to the internet from home and Workplace.	3	2	2	2	3	L1, L2 L3
R24ES04.3	Design word documents by learning word processing and Create presentations by using different styles and using AI Tools-Chat GPT and GITHUB	2	3	3	2	3	L2, L3, L4

SYLLABUS

PC Hardware & Software Installation **9 Hours**

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the Block diagram of the CPU along with the configuration of each peripheral and submit it to your Instructor.

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab Instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.

Task 3: Every student should individually install MS windows on the personal computer. Lab Instructor should verify the installation and follow it up with a Viva.

Task 4: Every student should install Linux on the computer. Lab instructor should verify the installation and follow it up with a Viva. **COs-CO1**

Internet &World Wide Web **6 Hours**

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally, students Should demonstrate to the instructor, how to access the websites and email. If there is no internet Connectivity preparations need to be made by the instructors to simulate the WWW on the LAN.

Task 2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN Proxy settings, bookmarks, search toolbars and pop-up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to Use the search engines. A few topics would be given to the students for which they need to search On Google. This should be demonstrated to the instructors by the student. **COs-CO2**

MS WORD **6 Hours**

Task 1: Creating project abstract Features to be covered: -Formatting Styles, Inserting table, Bullets And Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.

Task 2: Creating a Newsletter: Features to be covered: - Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word.

EXCEL **6 Hours**

Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool; give the details of the four tasks and features that would be covered in Each. Using Excel – Accessing, overview of toolbars, saving excel files, using help and resources.

Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, and auto Fill, Formatting Text**.**

Task 2: Calculating GPA -. Features to be covered: - Cell Referencing, Formulae in excel – Average, std. deviation, Charts, Renaming and Inserting worksheets, hyper linking, Count Function

POWER POINT **6 Hours**

Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.

Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.

Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides.**COs-CO3**

AI TOOLS – Chat GPT **6 Hours**

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model Responds. Try asking questions, starting conversations, or even providing incomplete sentences to See how the model completes them. Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to Brainstorm creative ideas Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Explore – GITHUB **6 Hours**

Task 1: Students should understand GITHUB and should possess accounts in it.

Task 2: Students should explore different repositories available in GITHUB and student should Create his/ her own simple repositories.

Task 3: Students should take simple experiments /presentations and upload them in their GITHUB Account.

Task 4: Students should understand how GITHUB Enterprise Cloud is used and also explore the GIT and GIT HUB resources. **COs-CO3**

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition

3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition
6. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCOPress, Pearson Education, 3rd edition
7. "Microsoft Word 2021: A Beginner's Guide"by Steve Lambert.
8. "Excel 2021: A Comprehensive Guide"by Chris Benham.
9. "Microsoft PowerPoint 2021: A Beginner's Guide" by Steve Lambert
10. GITHUB Quick Start Tutorials

WEB REFERENCES:

1. https://en.wikipedia.org/wiki/Main_Page
2. https://edu.gcfglobal.org/en/office2007
3. https://www.w3schools.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)
L1	30
L2	20
L3	30
L4	20
Total (%)	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Identify Peripherals of a computer
2. Draw a Block Diagram of the CPU and explain the components along with the functions.
3. Explain the various steps in assembling and dissembling of the CPU.
4. Write the basic utilities used while creating a PowerPoint presentation.

L2: Understand

1. How to install windows operating system.
2. What are search engines and brief the advantages of search engines.
3. Explain the process of creating a project abstract.
4. Explain how to explore GITHUB resources

L3: Apply

1. Explain the process orientation and connectivity boot camp
2. Write the different formulae used while calculating GPA
3. Explain the insertion of various templates while creating power point presentations.
4. Discuss the format for customization your browser for effective searching and online etiquette

L4: Analysing

1. Analyze a structured approach to experiment with prompts.

2. Explore different repositories available in GITHUB.
3. "Imagine a world where every person is born with a unique, magical ability that reflects their deepest desire or fear. Describe a day in the life of a character who discovers that their ability is far more powerful and dangerous than they ever imagined. How does this revelation affect their relationships, their view of themselves, and their place in society?"

Chairperson
Board of Studies (CSE)

R24MEPC02 ENGINEERING MECHANICS LAB 0 0 3 1.5

Course Objectives:

- Verify the Law of Parallelogram and Triangle of Forces.
- Determine the coefficients of friction of Static and Rolling friction and Centre of gravity of different plane Lamina.
- Analyze the system of Pulleys and Moment of Inertia of Compound Pendulum and Flywheel, Screw jack

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO4	PO6	PO7	PO12	PSO1
R24MEPC02.1	Evaluate the coefficient of friction between two different surfaces and between the inclined plane and the roller and study the mechanical characterization.	3	3	2	2	2	1	1	2
R24MEPC02.2	Verify Law of Polygon of forces and Law of Moment using force polygon and bell crank	3	3	3	2	1	2	1	2
R24MEPC02.3	Determine the Centre of gravity and Moment of Inertia of different configurations.	3	3	3	2	1	2	1	2

List of Experiments

1. Verification of Law of Parallelogram of Forces. **COs: CO2**
2. Verification of Law of Triangle of Forces. **COs: CO2**
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table. **COs: CO2**
4. Determination of coefficient of Static and Rolling Frictions **COs: CO1**
5. Determination of Centre of Gravity of different shaped Plane Lamina. **COs: CO3**
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non-concurrent, parallel force system with the help of a simply supported beam **COs: CO2**
7. Study of the systems of pulleys and draw the free body diagram of the system. **COs: CO2**
8. Determine the acceleration due to gravity using a compound pendulum **COs: CO3**
9. Determine the Moment of Inertia of a Flywheel. **COs: CO3**
10. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever. **COs: CO2, CO3**
11. To study simple and compound screw jack and determine the mechanical advantage, velocity ratio and efficiency. **COs: CO1**
12. Develop a mini project on above experimental knowledge. **COs: CO1-CO3**

Textbooks:

1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum' s Outline of Programming with C, McGraw Hill

Reference Books:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Sample Experiments

1. What is parallelogram law of forces?
2. Explain triangle law of forces?
3. What is the condition for equilibrium of a body under various concurrent and non-concurrent forces?
4. What do you mean by concurrent forces?
5. What are the reasons for the deviation in theoretical value and experimental value?
6. Why in general beam is supported by one hinge and one roller supports?
7. Define various types of supports and which type of support is used in this experiment?
8. Sketch various types of beams sections
9. What is limiting friction?
10. Define angle of repose, angle of friction and laws of friction
11. Define cone of friction.
12. Differentiate between static and dynamic friction.
13. Explain the theory of dry friction.
14. Does force of friction depends on area of contact surfaces?
15. List the practical application of this experiment?
16. Define machine, mechanical advantage, velocity ratio and efficiency?
17. What is self locking and state its mathematical condition.
18. Where is the Flywheel most commonly used? And what are its primary uses?
19. What is moment of inertia?
20. What is the formula for moment of inertia for hollow circular lamina about its centroidal axis?
21. Discuss moment of force?
22. Discuss varignon’s theorem?
23. What do you mean by principle of moment?

24. Define Static and Dynamics
25. What is the value of the first moment of area of about Centroid axis
26. Define stress and strain.
27. What is Hooke's Law?
28. What are the different types of stress?
29. Explain the concept of modulus of elasticity.
30. What is a shear force and bending moment?
31. Describe the procedure for determining the centre of gravity of a plane figure.
32. Explain the experimental setup for verifying the principle of moments.
33. How do you measure the moment of inertia of a flywheel?
34. Describe the method to find the Young's modulus of a material.
35. What are the common sources of error in a mechanics lab experiment?
36. How would you resolve a force into its components?
37. Describe the steps to solve a static equilibrium problem.
38. How can you determine the resultant of multiple forces acting at a point?
39. Explain how to draw the free body diagram of a structure.
40. What is the procedure to analyze a truss for internal forces?
41. What is the difference between mass and weight?
42. Define force.
43. What is a vector? Give examples.
44. Define scalar quantity. Give examples.
45. What are the fundamental units in the SI system?
46. What is meant by the term 'moment of force'?
47. Explain the principle of transmissibility of forces.
48. Explain the concept of work-energy principle.
49. What is impulse? How is it related to momentum?
50. Define and explain the principle of conservation of momentum.

Chairperson
Board of Studies (ME)

Code: R24MC02 NSS /NCC/ SCOUTS & GUIDES / COMMUNITY SERVICE 0 0 1 0.5

(Common to All branches of Engineering)

Course Objectives:

The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

SYLLABUS

UNIT I: Orientation

General Orientation on NSS/NCC/ Scouts & Guides/ Community Service activities, career guidance.

Activities:

i) Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
ii) Conducting orientations programs for the students –future plans-activities-releasing road map etc.
iii) Displaying success stories-motivational biopics- award winning movies on societal issues etc.
iv) Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT II: Nature & Care

Activities:

i) Best out of waste competition.
ii) Poster and signs making competition to spread environmental awareness.
iii) Recycling and environmental pollution article writing competition.
iv) Organising Zero-waste day.
v) Digital Environmental awareness activity via various social media platforms.
vi) Virtual demonstration of different eco-friendly approaches for sustainable living.

UNIT III: Community Service

Activities:

i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities- experts-etc.
ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
iii) Conducting consumer Awareness. Explaining various legal provisions etc.
iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
v) Any other programmes in collaboration with local charities, NGOs etc.

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Board of Studies : BS&H (Mathematics)
Approved in BoS No : 01, August, 2024
Approved in ACM No: 01

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, A Text Book of National Service Scheme Vol;.I, Vidya Kutir Publication, 2021 (ISBN 978-81-952368-8-6)
2. Red Book - National Cadet Corps – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., ―Introduction to Environmental Engineering‖, McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R ―Introduction to Environmental Engineering and Science‖, Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. Social Problems in India, Rawat Publications, New Delhi.

Chairperson
Board of Studies (Mathematics)

R24BS10 NUMERICAL METHODS AND TRANSFORM TECHNIQUES 3 0 0 3
(Common to MECH and EEE)

Course Objectives:

1. To elucidate the different numerical methods to solve nonlinear algebraic equations.
2. To disseminate the use of different numerical techniques for carrying out numerical integration.
3. To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS10.1	Evaluate the approximate roots of polynomials and transcendental equations by different algorithms. Apply Newton's forward and backward interpolation and Lagrange's formulae for equal and unequal intervals.	2	2	1	L1,L2,L3
R24BS10.2	Apply numerical integral techniques to different Engineering problems. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations.	2	2	1	L1,L2,L3
R24BS10.3	Apply the knowledge of Laplace transforms to solve differential equations.	2	2	1	L1,L2,L3
R24BS10.4	Compute the Fourier series of periodic signals.	2	2	1	L3,L4
R24BS10.5	Know and be able to apply integral expressions for the forward and inverse Fourier transforms to a range of non-periodic wave forms.	2	2	1	L4,L5

SYLLABUS

UNIT- I: Iterative Methods **10 hours**

Introduction- Solution of algebraic and transcendental equations: Bisection method-Secant method-Method of false position-Iteration method –Newton-Raphson method.

Interpolation: Newton's forward and backward formulae for interpolation-interpolation with unequal intervals-Lagrange's interpolation formula. **Cos-CO1**

Self-Learning Topic: Gauss's forward and backward interpolation formula

UNIT- II: Numerical Integration, Solution of ordinary differential equation with initial conditions: **10 hours**

Trapezoidal rule-Simson's $1/3^{rd}$ and $3/8^{th}$ rule-Solution of initial value problems by Taylor's series-

Picard's method of successive approximations-Euler's method – Runge-Kutta method (second and fourth order). **Cos-CO2**

Self-Learning Topic: Milne's Predictor and Corrector Method

UNIT- III: Laplace Transforms: 10 hours

Definition of Laplace transform-Laplace transform of standard functions- Properties of Laplace Transforms-Shifting theorems-Transforms of derivatives and integrals-Unit step function-Dirac's delta function-Inverse Laplace transforms-Convolution theorem (without proof)

Applications: Solving ordinary differential equations (initial value problems) and integral differential equation using Laplace transforms. **COs-CO3**

Self-Learning Topic: Solution of simultaneous differential equations by Laplace transforms.

UNIT- IV: Fourier series 10 hours

Introduction- Periodic functions- Fourier series of periodic functions-Dirchlet's conditions –Even and odd functions- Change of intervals-Half-range sine and cosine series. **COs-CO4**

Self-Learning Topic: Applications of Fourier series

UNIT- V: Fourier Transforms: 10 hours

Fourier integrals theorems (without proof)-Fourier sine and cosine integrals-Infinite Fourier transforms-Sine and cosine transforms-Properties-Inverse transforms-Convolution theorem (without proof)-Finite Fourier transforms- Parseval's identity for Fourier transforms(without proof). **COs-CO5**

Self-Learning Topic: Solve Partial differential equation by Fourier transform.

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2017, 44th Edition
2. B.V.Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2018, 10th Edition.
2. M.K.Jain,S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Compuation, New Age International Publication.

Board of Studies : Basic Science and Humanities (Mathematics)
Approved in BOS No: 01, 2nd August, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	-	25

L5	-	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT 1

1. Find a real root of $xe^x = 3$ using Regula –Falsi method. (L1)
2. Using Newton Raphson method finds a real root of $\cos x = xe^x$ and correct to four decimal places. (L2)
3. Find a real root of the equation $x\log_{10} x = 1.2$ by Regula-Falsi method correct to four decimal Places (L2)
4. If $y(1) = -3, y(3) = 9, y(4) = 30, y(6) = 132$ find the $y(x)$ (L3)

UNIT 2

1. State Simson's 1/3 rule
2. Find $y(0.1)$ and$d$ $y(0.2)$ using Picard's method given that $\frac{dy}{dx} = x + y$ given that $y = 1$ when $x = 0$ (L 2)

3.

4. By RK method of second order find $y(0.1)$ and $y(0.2)$ given that $\frac{dy}{dx} = 1 - 2xy^2$, $y(0) = 1$. (L 2)
5. By Taylor's series method find $y(0.2)$ given that $\frac{dy}{dx} = 3x + y^2$, $y(0) = 1$. (L 2)
6. Find $y(0.1)$ given that $\frac{dy}{dx} = x^2 - y^2$, $y(0) = 1$. (L 3)

UNIT 3

1. Define Laplace transform (L1)
2. Find the Laplace transform of $f(t) = \begin{cases} t^2, 0 \le t < 2 \\ t-1, 2 \le t < 3 \\ 7, t \ge 3 \end{cases}$ L2
3. Solve the differential equation $(D^2 + 9)y = \sin t, y(0)1, y'(0) = 0$ L3

UNIT 4

1. Find the Half range cosine series of $f(x) = \begin{cases} 1 & 0 < x < 1 \\ -1 & 1 < x < 2 \end{cases}$ in $[0,2]$ L3
2. Find the Fourier series of $f(x) = \frac{1}{4}(\pi - x)^2$, $0 < x < 2\pi$

   Hence deduce that $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} \ldots = \frac{\pi^2}{6}$

(L4)

UNIT 5

1. State Parseval's identity L1

2. .Find the Fourier transform of $f(x)$ defined by $f(x)=\begin{cases} x & \text{if } 0<x<1 \\ 1-x & \text{if } 1<x<2 \\ 0 & \text{if } x<2 \end{cases}$ (L2)
3. Find the Fourier cosine transform of $\frac{1}{1+x^2}$ (L3)
4. If the Fourier sine transform of $f(x)=\frac{1-\cos n\pi}{n^2\pi^2}(0\le x\le \pi)$, find $f(x)$ (L4)
5. Find the Fourier transform of $f(x)=\begin{cases} 1-x^2, & |x|\le 1 \\ 0, & |x|>1 \end{cases}$ L4
6. hence evaluate $\int_0^\infty \frac{x\cos x-\sin x}{x^3}\cos\frac{x}{2}dx$ L5

Chairperson
Board of Studies (Mathematics)

R24MEPC03 **Thermodynamics** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. Understand basic thermodynamic terms, types of systems, and how temperature is measured using the Zeroth Law.
2. Learn how energy is conserved and converted in engines, refrigerators, and other systems using the First and Second Laws.
3. Study different gas processes and understand how energy loss (entropy) affects system efficiency.
4. Learn how steam behaves during phase changes and compare engine cycles like Otto and Diesel.
5. Understand how refrigeration systems work, their components, and the role of refrigerants.

Course Code	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO11	PSO1	PSO2	PSO3	DOK
R24MEPC03.1	Understand and explain the basic concepts and laws of thermodynamics including systems, processes, and equilibrium.	3	2			2	1	1	1			L1
R24MEPC03.2	Apply the first and second laws of thermodynamics to various systems and understand limitations and efficiencies.	3	3			2		1	2		1	L2
R24MEPC03.3	Analyze different thermodynamic processes and compute work done; understand the concept of entropy and energy availability.	3	3		2	2		2	3	2	2	L3
R24MEPC04.4	Interpret steam tables and Mollier charts; evaluate the performance of air standard cycles like Otto, Diesel, and Dual.	3	2	2		2		2	3	2	3	L4
R24MEPC05.5	Describe the working of refrigeration and air conditioning systems and evaluate their performance using psychrometric principles.	2	2			3	2	2	3	2	2	L2

SYLLABUS

UNIT-I **12 Hours**

Fundamentals And Laws of Thermodynamics: Basic Concepts: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility

Zeroth Law of Thermodynamics: Introduction, Zeroth law of thermodynamics, Reversible and

Irreversible Processes.

Applications: Thermometers, IC Engines, Thermo flask, Pis1ton Cylinder arrangement without valves. **CO's:CO1**

Self-Learning Topics: Non-Equilibrium Thermodynamics, Thermoeconomics & Sustainability, Thermodynamics of Modern Energy Systems

UNIT-II **14 Hours**

First Law of Thermodynamics: PMM-I, Joule's Experiment and applications. Limitations of the First Law–Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality

Applications: Nozzles, Diffusers, Turbines, Compressors, Refrigerators, Heat Pump and Heat Engines **CO's:CO2**

Self-Learning Topics: Statistical Thermodynamics, Thermodynamics of Real Substances, Thermodynamic Modeling and Simulation

UNIT-III **14 Hours**

Thermodynamic Processes on Gases: Types of thermodynamic processes Isochoric, Isobaric, Isothermal, Hyperbolic, Isentropic, Polytrophic and Throttling processes. Represent the processes on Pressure-Volume diagrams. Derive an expression for work done in isothermal process, polytropic process and isentropic process.

Entropy: Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

Applications: Refrigerators, gas turbines, air conditioning and cooling system **CO's:CO3**

Self-Learning Topics: Jet Engines & Gas Turbines, Chemical Thermodynamics, Thermodynamic Potential Applications

UNIT-IV **14 Hours**

Properties of Steam: Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations– Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables.

Air Standard Cycles: Otto, Diesel, Dual Combustion cycles- Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles.

Applications: Steam Power Plants, Steam Engines, IC Engines. **CO's:CO4**

Self-Learning Topics: Energy Analysis and Energy Efficiency, Nano thermodynamics, Molecular

Thermodynamics, Non-Conventional Power Cycles

UNIT-V **12 Hours**

Introduction of Refrigeration: working of Air, Vapour compression, VCR system Components, COP Refrigerants.

Introduction of Air Conditioning: Psychrometric properties & processes–characterization of sensible and latent heat loads – load concepts of SHF

Applications: Refrigerators and Air Conditioners. **CO's:CO5**

Self-Learning Topics: Multi-Stage Vapour Compression Systems, Sub cooling and Superheating in VCR Systems, Advanced Psychrometric Chart Analysis, Smart HVAC Control and Automation

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009.

Reference Books:

1. J.B. Jones, and R.E. Dugan, Engineering Thermodynamics, 1/e, Prentice Hall, 1995.
2. Y.A.Cengel & M.A.Boles ,Thermodynamics – An Engineering Approach, 7/e, McGraw Hill, 2010.
3. P.Chattopadhyay, Engineering Thermodynamics, 1/e, Oxford University Press, 2011.
4. CP Arora, Refrigeration and Air-conditioning, 4/e, McGraw Hill, 2021.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_ch01/preview
2. https://onlinecourses.nptel.ac.in/noc19_me56/preview
3. https://onlinecourses.swayam2.ac.in/nou23_me01/preview
4. https://www.classcentral.com/course/youtube-applied-thermodynamics-for-engineers-47448

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	20
L3	30	40
L4	--	40
Total (%)	**100**	**100**

Sample Questions of Various Cognitive Levels

L1: Remember

1. Define a thermodynamic system and give two examples.
2. State the Zeroth Law of Thermodynamics. Why is it important?

3. Explain the classification of thermodynamic systems with suitable diagrams and examples
4. Differentiate between macroscopic and microscopic viewpoints in thermodynamics. Give suitable examples.
5. What is meant by a quasi-static process? How is it different from an irreversible process?

L2: Understand

1. What is PMM-I and why is it considered impossible?
2. State the limitations of the First Law of Thermodynamics.
3. Prove that Kelvin-Planck and Clausius statements are equivalent
4. What are the main components of a Vapour Compression Refrigeration (VCR) system?
5. Explain any two air conditioning processes using the psychrometric chart.

L3: Apply

1. What is the significance of the area under the curve in a P-V diagram for different processes, and how does it help in comparing work done?
2. Explain the limitations of using P-V diagrams alone to analyze complex thermodynamic processes. How can T-s diagrams complement this analysis?
3. Define availability and show how it can be used to quantify the loss due to irreversibility in a real process.
4. Write down all four Maxwell relations. Explain the physical significance of one of them in terms of measurable thermodynamic properties.
5. Discuss the role of Gibbs and Helmholtz functions in predicting equilibrium and spontaneity of processes, particularly in chemical and phase transformations.

L4: Analyze

1. Explain the significance of the Mollier diagram (h-s diagram) in steam turbine performance analysis. How is it used to estimate work output?
2. What is the dryness fraction of steam and how does it affect the performance of steam engines and turbines?
3. A pure substance undergoes phase transformation. With reference to the P-V and T-S diagrams, explain how properties like specific volume and entropy change from subcooled liquid to superheated vapor.
4. Derive the expression for thermal efficiency of an Otto cycle in terms of compression ratio. Then analyze how efficiency changes with increasing compression ratio.
5. Define mean effective pressure (MEP) and explain how it is used to compare performance between Otto, Diesel, and Dual cycles.

Chairperson
Board of Studies (ME)

R24MEPC04 **Mechanics of Solids** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. To find the stresses & deformations of a member due to axial loading under uniform and non-uniform conditions.
2. To interpret the variation of SF&BM indeterminate beam.
3. To analyze the structural members subjected to bending stress and shear loads.
4. To identify the slope and deflection for different support arrangements by different methods and shear stresses induced in circular shafts.
5. To analyze the stresses induced in thin and thick cylinders subjected to internal and external pressures and analyze the columns in stability point of view with different end conditions.

Course Code	Course Outcomes	Mapping with POs and PSOs						DoK
		PO1	PO2	PO3	PO4	PO5	PO11	
R24MEPC04.1	Find the stresses & deformations of a member due to axial loading under uniform and non- uniform conditions.	3	3	3	2	3	2	L1
R24MEPC04.2	Interpret the variation of SF&BM indeterminate beams	3	3	3	3	3	2	L2, L3
R24MEPC04.3	Analyze the structural members subjected to bending stress and shear loads.	3	3	3	3	3	2	L4, L5
R24MEPC04.4	Identify the slope and deflection for different support arrangements by different methods and shear stresses induced in circular shafts	3	3	3	3	3	2	L4, L6
R24MEPC04.5	Analyze the stresses induced in thin and thick cylinders subjected to internal and external pressures.	3	3	3	3	3	2	L3, L4

SYLLABUS

UNIT –I **16 Hours**

Simple Stresses & Strains : Elasticity and plasticity– Types of stresses &strains–Hooke's law – stress– strain diagram for mild steel –Working stress – Factor of safety– Lateral strain, Poisson's ratio and volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uni axial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic

constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings. **CO's: CO1**

Self Learning Topics*:* Advanced visualization of Mohr's circle using simulation tools Applications of strain energy in failure prediction

UNIT –II **16 Hours**

Shear Force And Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam. **CO's: CO2**

Self Learning Topics: Use of software like AutoCAD or SolidWorks for beam modeling, Interactive tools for understanding load distribution

UNIT –III **16 Hours**

Flexural Stresses : Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections. **CO's: CO3**

Self Learning Topics: Bending in composite and laminated beams,Concept of lateral-torsional buckling in beams

UNIT –IV **16 Hours**

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Statically indeterminate Beams and solution methods.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel. **CO's: CO4**

Self Learning Topics: Shaft design in electric vehicles or turbines, Material selection for shafts under torsion

UNIT –V **16 Hours**

Thin and Thick Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia and volume of thin cylinders – Riveted boiler shells – Thin spherical shells. Wire wound thin

cylinders. Lame's equation – cylinders subjected to inside & outside pressures –compound cylinders.

Columns: Buckling and Stability, Columns with Pinnedends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula **CO's: CO5**

Self Learning Topics: Burst testing of pressure vessels, Modern design standards for pressure vessels

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. Strength of materials/GHRyder/McMillan publishers India Ltd
2. Mechanics of materials by Gere & Timeshenko

Reference Books:

1. Strength of Materials –By Jindal, Umesh Publications.
2. Analysis of structures by Vazirani and Ratwani- Khanna Publishers
3. MechanicsofStructuresVol-III,byS.B.Junnarkar-CharotarPublishingHouse
4. Strength of Materials by S.Timshenko-D. VANNOSTRAND Company-PHI Publishers
5. Strength of Materials by Andrew Pytel and Ferdinond L.Singer Longman- Harpercollins College Division
6. Solid Mechanics, by Popov.
7. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

Web References:

1. http://nptel.ac.in/courses/112107147/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-001-mechanics-materials-i-fall-2006/
3. http://freevideolectures.com/Course/92/Mechanics-of-Solids
4. http://www.indiabix.com/mechanical-engineering/strength-of-materials/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	--
L2	30	10
L3	20	30
L4	10	30
L5	--	20

L6	--	10
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Remember

1. Defineandexplainthefollowingterms:Shearforce,bendingmoment,shearforcediagramand bending moment diagram
2. Define the following terms: slope and deflection
3. Definetheterms:Elasticity,elasticlimit,Young'smodulusandmodulusofrigidity
4. Define the terms: Longitudinal strain, Lateral strain and poisons ratio
5. What do you understand by neutral axis, section modulus and moment of resistance?
6. What is Torsion? What are the assumptions made in the derivation of shear stress produced in a circular shaft subjected to torsion?
7. Definethincylinders.Namethestressessetupinathincylindersubjectedtointernalfluidpressure
8. Findanexpressionforthechangeinvolumeofathincylindricalshellsubjectedtointernalfluid

Understand

1. Deriveanexpressionbetweenmodulusofelasticityandmodulusofrigidity
2. Drawtheshearforceandbendingmomentdiagramforacantileveroflength'L'carryingapoint load 'W' at the free end
3. Explain clearly the different types of stresses and strains
4. Explain the different types of equilibrium equations
5. Show that for a rectangular section of the maximum shear tressis1.5timestheaveragestress
6. Explain Macaulay's method
7. Explain thin and thick cylinders

Apply

1. A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter 5 cm and internal diameter 4 cm. the composite bar is then subjected to an axial pull of 45000 N. if the length of eachbarisequalto15cm,determine:i)the stresses in the rod and tube ii)load carried by each bar. Take E for steel is 2.1 x 10^5N /$mm^2$and for copper is 1.1 x 10^5N/mm^2
2. A rod 200cm long and of diameter 3.0cm is subjected to an axial pull of 30 kN. If the Young's modulus of the material of the rod is 2×104 N/mm^2, determine: (i)stress. (ii) Strain and (iii) the elongation of the rod.
3. Asimplysupportedbeamof10m longcarriesauniformlydistributedload2kN/m over entire

length and point loads 1kN and 2kN at distances 2m and 5m from the left support. Draw the sheer force and bending moment diagrams

4. A cast Iron beam has an I- section with top flange 80mm×40mm, web120mm×20mm and bottom flange 160mm×40mm.Iftensile stress is not to exceed 30 N/mm^2andcompressive stress90N/mm^2,what is the maximum uniformly distributed load the beam can carry over a simply supported span of 6m if the larger flange is in tension
5. Develop an expression for the slope and deflection of a beam subjected to uniform Bending moment
6. A thick cylinder of external and internal diameters of 300mm and 180mm is subjected to an internal pressure of 42 $N/mm^2$and external pressure 6 N/mm^2. Determine the stresses in the material. If the external pressure is doubled, what internal pressure can be maintained without exceeding the previously determined maximum stress?

Analyze

1. Two shafts of the same material and of same lengths are subjected to the same torque, if the first shaft is of a solid circular section and the second shaft is of hollow circular section, whose internal diameter is 2/3 of the outside diameter and the maximum shear stress developed in each shaft is the same, compare the weights of the shafts
2. A timber beam of rectangular section is to support a load of 20kN uniformly distributed over a span of 3.6m when beam is simply supported. If the depth of the section is to be twice the breadth, and the stress in the timber is not to exceed 7 N/mm^2, find the dimension of the cross section
3. Distinguish between the following, giving due explanation (i) Stress and strain (ii) Force and stress and (iii) Tensile stress and compressive stress
4. Compare the weights of the two shafts if the maximum shear stress developed in the two shafts is equal. A solid circular shaft and a hollow circular shaft whose inside diameter is ¾ of the outside diameter, are of the same material, of equal lengths and are required to transmit a given torque.
5. Compareslopeanddeflectionofasimplysupportedbeamandcantileverbeam.
6. Compare circumferential and longitudinal strains

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R24MEPC05 Engineering Materials & Manufacturing Processes 3 0 0 3

(Mechanical Engineering)

Course Outcomes

1. Understand the Classification and Properties of Materials**.**
2. Understand and Apply Heat Treatment and Powder Metallurgy**.**
3. Analyze and Apply Casting Processes**.**
4. Understand and Evaluate Welding and Joining Processes**.**
5. Demonstrate Bulk Forming Techniques**.**

Course Code	Course Outcomes	PO1	PO8	PO9	PO10	PO11	PSO2	DOK
R24MEPC05.1	Classify and describe the microstructure and applications of steels, cast irons, copper, aluminum, and composites.	3	3	3	3	3	2	L1, L2
R24MEPC05.2	Explain and apply heat treatment and powder metallurgy processes.	3	3	3	3	3	2	L2, L3
R24MEPC05.3	Analyze the various casting methods and casting defect mechanisms.	3	3	3	3	3	2	L2, L3
R24MEPC05.4	Compare and evaluate different welding and joining techniques and their metallurgical effects.	3	3	3	3	3	2	L1,L2, L3
R24MEPC05.5	Demonstrate bulk forming techniques such as forging, rolling, extrusion, and drawing.	3	3	3	3	3	2	L2, L4

SYLLABUS

UNIT I: 16 Hours

Introduction to Engineering Materials: Classification of steels, along with the structure and characteristics of plain carbon steels and low alloy steels. Introduction to stainless steels, including their structure and properties.

Classification and properties of cast irons: white cast iron, malleable cast iron, grey cast iron-focusing on their structures and properties. Study of the structure, properties and applications of copper and its alloys, as well as aluminium and its alloys. Introduction to composite materials.

Self-Learning Topics: Classification of Steels, Copper & Alloys and Composites. **CO's: CO1**

UNIT II: 16 Hours

Heat treatment of Steels: Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization-Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering- Methods of manufacturing sintered parts. **CO's: CO2**

Self-Learning Topics: Heat Treatment Processes, Powder Metallurgy

UNIT III: **16 Hours**

Casting: Overview of the casting process, Steps involved in making a casting, Advantages and applications of casting.

Patterns and Pattern Making: Types of patterns – Materials used for patterns – Pattern allowances and their construction.

Molding and Cores: Molding processes – Different types of cores.

Gating and Risering: Principles of gating – Functions and design of risers – Casting design considerations.

Melting Methods and Furnaces: Various methods of melting – Types of furnaces.

Solidification and Defects: Solidification of castings – casting defects, their causes and remedies.

Special Casting Processes: Basic principles and industrial applications of special casting methods – Centrifugal casting, Die casting, Investment casting, and Shell molding. **CO's: CO3**

Self-Learning Topics: Casting Fundamentals, Patterns, Solidification & Defects and Special Casting.

UNIT – IV **16 Hours**

Welding: Classification of welding processes – Types of welded joints and their characteristics.

Gas Welding: Principles of gas welding – Types of flames and their applications – Oxy- cetylene gas cutting.

Arc Welding: Basic principles – characteristics – Submerged arc welding – TIG and MIG welding.

Solid-State and Advanced Welding Techniques: Resistance welding – Friction welding – Friction stir welding – Forge welding – Explosive welding – Thermit welding.

Joining Processes: Soldering and brazing.

Welding Metallurgy: Heat-affected zones – Pre-heating and post-heating techniques – Welding defects: causes and remedies. **CO's: CO4**

Self-Learning Topics: Welding Classification, Soldering & Brazing and Welding Metallurgy.

UNIT – V **16 Hours**

Bulk Forming: Plastic deformation in metals and alloys – Recovery, recrystallization, and grain growth.

Working Processes: Hot working and cold working – Strain hardening – Annealing. Bulk Forming Techniques:

- **Forging:** Types of forging – Common forging defects and their remedies.
- **Rolling:** Fundamentals of rolling – Types of rolling mills and rolled products – Rolling forces and power requirements.
- **Extrusion:** Characteristics of extrusion – Types of extrusion processes, including impact and hydrostatic extrusion.
- **Drawing Processes:** Wire drawing and tube drawing. **CO's: CO5**

Self-Learning Topics: Hot vs Cold Working, Forging, Rolling, Extrusion and Drawing.

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Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. V. Raghavan, Elements of Materials Science, PHI Learning, 6th Edition, 2021
2. S.Kalpakjian, S R. Schmid, Manufacturing - Engineering and Technology, Pearson publications, 4th Edition, 2019
3. P.N.Rao, Manufacturing Technology –Foundry, Forming and Welding, McGrawHill Companies, Volume 1, 3rd Edition, 2021

Reference Books:

1. R.K. Rajput, Engineering Materials & Metallurgy", S. Chand Publications, 2nd Edition, 2020
2. O.P. Khanna, Welding Technology, Dhanpat Rai Publications, 22nd Edition, 2022
3. Amitabha Ghosh, and Ashok Kumar Mallik, Manufacturing Science, East West Press Private Ltd., 2nd Edition, 2020
4. H S Bava, Manufacturing Processes – II, Tata McGraw-Hill Publishing Company Limited, First Reprint, 2021

Web References:

1. https://nptel.ac.in/courses/112/
2. https://ocw.mit.edu/courses/materials-science-and-engineering/
3. https://www.asminternational.org/
4. https://www.twi-global.com/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	25	15
L2	40	35

L3	35	35
L4	-	15
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are the main types of stainless steels?
2. Define annealing in heat treatment.
3. List the basic steps in the casting process.
4. What is MIG welding?
5. Name any two bulk forming processes.

L2: Understand

1. Differentiate between low alloy steel and plain carbon steel.
2. Explain the purpose of a riser in casting.
3. Describe the working principle of oxy-acetylene gas welding.
4. What is strain hardening, and when does it occur?
5. Discuss the structure and properties of Aluminium alloys.

L3: Apply

1. Select a suitable heat treatment for hardening cutting tools and justify your choice.
2. Choose the best casting process for manufacturing a hollow cylindrical pipe and explain.
3. Suggest a welding process suitable for joining thin aluminium sheets.
4. Identify a forging defect and suggest a practical method to avoid it.
5. Apply your knowledge to classify a given steel sample based on its carbon content.

L4: Analyze

1. Compare hot working and cold working processes based on grain structure and mechanical properties.
2. Analyze the effect of tempering on the hardness and toughness of steel.
3. Distinguish between TIG and MIG welding in terms of heat source and shielding.
4. Break down the causes of porosity in castings and how to prevent it.
5. Analyze the role of composite materials in reducing vehicle weight.

L5: Evaluate

1. Evaluate the suitability of powder metallurgy for producing aerospace components.
2. Assess the benefits and drawbacks of using grey cast iron in engine blocks.
3. Justify the use of cryogenic treatment in industrial applications.

4. Critically examine the importance of pre-heating in welding high carbon steels.
5. Recommend the most appropriate forming process for making a complex aluminum part, with reasons.

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Board of Studies (ME)

R24MEPC06 **CAD/CAM** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. To understand the role of computers in industrial manufacturing and the basics of computer hardware, input/output devices, and computer graphics used in design documentation.
2. To learn the fundamentals of geometric modeling and gain hands-on knowledge of drafting and modeling systems for 2D and 3D design.
3. To understand the structure and working of CNC machine tools and develop skills in manual and computer-aided part programming.
4. To explore the concept of Group Technology, part classification, and computer-aided process planning for improving manufacturing productivity.
5. To study the components, layouts, and applications of Flexible Manufacturing Systems (FMS) and understand their role in modern automated production.

Course Code	Course Outcomes	PO1	PO3	PO5	PO11	PSO1	PSO2	DOK
R24MEPC06.1	To understand the role of computers in manufacturing and hardware components.	3	-	2	1	1	3	L1.L2
R24MEPC06.2	To apply computer graphics and geometric modeling in design and drafting.	-	3	3	1	-	3	L2,L3
R24MEPC06.3	To develop NC/CNC part programs using manual and computer-aided methods.	2	3	3	1	-	2	L3, L4
R24MEPC06.4	To analyze group technology, process planning.	-	2	2	2	3	-	L5
R24MEPC06.5	To learn how flexible manufacturing systems work**.**	1	3	3	2	2	2	L4,L5

SYLLABUS

UNIT – I **16 Hours**

Computers in industrial manufacturing, product cycle, design documentation, basic structure, CPU, memory types, input devices, display devices, hard copy devices, storage devices.

Computer Graphics: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal. **CO's: CO1**

Self-Learning Topics: Evolution of computers in industry, overview of the product life cycle in manufacturing, architecture and functions of CPU, RAM, ROM, 3D transformations

UNIT -II **14 Hours**

Geometric Modeling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

Drafting and Modeling Systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling. **CO's: CO2**

Self-Learning Topics: Fundamentals of geometric modeling, types of geometric models - wireframe, surface, solid

UNIT –III **14 Hours**

Part Programming for NC Machines: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, Numerical control codes, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Automatic tool changers, Adaptive Control. **CO's: CO3**

Self-Learning Topics: Introduction to NC and CNC machines, comparison between traditional and CNC machines

UNIT –IV **14 Hours**

Group Technology: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. Machine cell design, Advantages of GT **CO's: CO4**

Self-Learning Topics: Concept of group technology (GT) in manufacturing, various part classification and coding systems

UNIT –V **14 Hours**

Flexible Manufacturing Systems: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, Advantages and applications. **CO's: CO5**

Self-Learning Topics: Overview of flexible manufacturing systems, components of an FMS – workstations

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Approved in BOS No: 02, 13th May, 2025

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Text Books:

1. Mikell P-Grover, Emory W. Zimmers, Jr., CAD/CAM –5th Edition 2008.
2. Ibrahim Zeid - CAD/CAM Theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2nd Edition, 1992.

3. Michael E. Mortenson, Geometric modeling, Industrial Press, 3rd Edition, 2006. 4. Koren, Computer Control of Manufacturing Systems, Tata McGraw-Hill Education, 2nd Edition, 2005.

References:

1. P.N Rao, CAD/CAM Principles & Applications, TMH, 2nd Edition, 2008.
2. Chennakesava R. Alavala, CAD/CAM: Concepts and Applications, PHI Learning Pvt. Ltd., 2nd Printing, 2008.
3. David F. Rogers, Mathematical Elements for Computer Graphics, McGraw-Hill, 2nd Edition, 1990.
4. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang, Computer-Aided Manufacturing, Pearson Prentice Hall, 3rd Edition, 2006.

Web References:

1. https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials/
2. https://www.coursera.org/lecture/computer-aided-design/cad-overview-VaEjQ
3. https://www.tutorialspoint.com/numerical_control/index.htm
4. https://www.engineersgarage.com/flexible-manufacturing-systems/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	10	-
L2	30	20
L3	30	30
L4	20	30
L5	10	20
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define the term "Product Cycle" in manufacturing.
2. List any four types of input devices used in CAD/CAM systems.
3. What are the different types of memory used in computer systems?
4. Define Raster Scan in computer graphics.
5. List the basic geometric commands used in CAD systems.
6. What is CNC and DNC?
7. Mention the function of a Machining Center.

8. Name four components of Flexible Manufacturing Systems (FMS)

L2: Understand

1. Explain the role of input and output devices in industrial manufacturing.
2. Describe the coordinate system used in raster graphics.
3. Explain with a neat sketch the Product Cycle in Industrial Manufacturing.
4. Explain the need for geometric modeling in CAD.
5. Discuss the importance of coding and classification in Group Technology.
6. Describe the advantages of using FMS in production.
7. Describe how curve representation is used in geometric modeling.
8. Explain Production Flow Analysis with an example.
9. Discuss planning for FMS.

L3: Apply

1. Use geometric construction methods to model a simple mechanical part.
2. Apply transformation techniques to rotate a 3D object in CAD software.
3. Write a basic manual part program for drilling operation on a CNC machine.
4. Use display control commands to modify views in a CAD system.
5. Apply production flow analysis to identify part families.
6. Apply GT principles to design a machine cell.
7. Apply layout planning strategies for an FMS with 4 machines.

L4: Analyze

1. Analyze the structure of CNC machine tools and explain how each part contributes to machining.
2. Break down the process of part classification in Group Technology.
3. Examine different types of FMS layouts and their suitability for various manufacturing needs.
4. Compare wireframe and solid modeling techniques.
5. Differentiate between manual and computer-aided programming.
6. Analyze the impact of part classification in Group Technology
7. Differenciate curve and surface modeling in CAD.
8. Analyze how Computer Aided Process Planning (CAPP) improves process efficiency.

L5: Evaluate

1. Evaluate the effectiveness of computer-aided part programming over manual programming.
2. Judge the advantages and disadvantages of using automatic tool changers.
3. Assess the impact of adaptive control on CNC machining accuracy.
4. Justify the selection of a specific FMS layout for a job-shop environment.

5. Evaluate the pros and cons of Direct Numerical Control (DNC).
6. Justify the use of GT in a batch production environment

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R24MEPC07 **Mechanics of Solids and Material Science Lab** **0 0 3 1.5**
(Mechanical Engineering)

Course Objectives:

1. To familiarize the students on conducting various destructive tests for determining the strength of various materials under externally applied loads from the theoretical knowledge gained from Mechanics of Solids.
2. To familiarize the students on Material properties and their structures.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	
R24MEPC07.1	Perform standard mechanical tests such as impact, hardness, deflection, and torsion tests	3	2	3	3	1	3	3	L1
R24MEPC07.2	Analyze and interpret data obtained from mechanical tests to determine material properties such as strength, ductility, toughness	3	2	3	3	1	3	3	L1 L2
R24MEPC07.3	Identify and evaluate the microstructures of ferrous and non-ferrous materials, including heat-treated steels, using metallographic techniques to understand structure-property relationships.	3	2	3	3	1	3	3	L1 L2

Cycle I: List of Experiments: Mechanics of Solids Lab

1. Tension test and Compression test on Springs **CO's: CO1**
2. Rockwell & Brinell hardness test of materials. **CO's: CO1**
3. Izod & Charpy impact tests. **CO's: CO1**
4. Deflection test on Cantilever and Simply Supported beams. **CO's: CO1**
5. Torsion test on Mild Steel bar. **CO's: CO1**
6. Tensile test on Mild steel rod. **CO's: CO2**
7. Compression test on Wooden cube. **CO's: CO2**

Cycle II: List of Experiments: Materials Science Lab

1. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al. **CO's: CO3**
2. Preparation and study of the Microstructure of Mild steels, low carbon steels, high– Carbon steels. **CO's: CO3**
3. Study of the Micro Structures of Cast Irons. **CO's: CO3**
4. Study of the Micro Structures of Non-Ferrous alloys. **CO's: CO3**
5. Study of the Micro structures of Heat-treated steels. **CO's: CO3**

6. Hardenability of steels by Jominy End Quench Test. **CO's: CO3**
7. To find out the hardness of various treated and untreated steels **CO's: CO3**

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Approved in ACM No: 02

References/Manuals:

1. Text Book: Solid Mechanics by Kazimi.S.M.A, second revised Edition, Tata McGraw Hill Publishing Company Limited.
2. Laboratory Manual

Web References:

1. http://www.aboutcivil.org/strength-of-materials.html
2. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv047-Page1.htm
3. https://www.esm.psu.edu/online
4. http://www.mathalino.com/reviewer/mechanics-and-strength-of-materials/mechanics-and-strength-of-materials

Sample Experiments

1. Explain the difference between tensile and compression tests.
2. Describe how the Rockwell and Brinell hardness tests differ in principle.
3. Summarize the importance of impact tests in material selection.
4. Explain how load and elongation data are used to draw a stress-strain curve.
5. Discuss why different materials show different impact energy values.
6. Interpret the result of a compression test on a wooden cube.
7. Describe the microstructure of annealed low-carbon steel.
8. Explain how heat treatment affects the grain structure of steel.
9. Compare the microstructure of cast iron with that of mild steel.
10. Conduct a tensile test on a mild steel rod and determine the yield strength.
11. Perform a torsion test on a mild steel bar and calculate the modulus of rigidity.
12. Measure the deflection of a simply supported beam using standard formulas.
13. Plot and analyze the stress-strain curve from a tensile test.
14. Determine the Brinell hardness number from given test data.
15. Use beam theory to calculate deflection and compare with observed values.
16. Prepare and observe the microstructure of a copper sample under a microscope.
17. Identify phases in a heat-treated steel sample using a metallurgical microscope.
18. Conduct the Jominy End Quench test and interpret the hardness variation along the length.

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R24MESC01 **Computer Aided Modelling Lab** **0 0 3 1.5**

(Mechanical Engineering)

Course Objectives:

1. To develop skills in 2D drafting
2. To gain proficiency in surface modeling techniques
3. To create and visualize mechanical assemblies

Course Code	Course Outcomes	Mapping with POs and PSOs						
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
R24MESC01.1	Develop and interpret 2D orthographic and isometric drawings with appropriate dimensioning and tolerance standards.	3	2	2	1	3	2	3
R24MESC01.2	Create and manipulate 3D part models and complex surfaces using features such as pad, revolve, sweep, shell, Boolean operations, and surface modelling techniques.	3	2	2	2	3	2	3
R24MESC01.3	Perform assembly modelling of mechanical components and demonstrate proficiency in CAD data exchange formats like DXF and IGES.	3	2	3	2	3	3	3

Part- A:

The following contents to be done by any 3D software package:

1. **Part Modelling**: Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.
2. **Assembly drawings:** Any Seven of the following using solid model software
3. **Surface Modelling:** Generation of various Surfaces using surface modelling.

Part- B:

The following are to be done by any 2D software package:

1. **Drafting:** Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files.

List of Experiments:

Part- A:

Solid Modelling:

Generate any four of the following components using any solid modelling software.

i. Generation of various Parts/assemblies of Oldham's coupling.
ii. Generation of various Parts/assemblies of Plummer Block.
iii. Generation of various Parts/assemblies of Helical Gear and Pinion.
iv. Generation of various Parts/assemblies of Lathe Tool Post.
v. Generation of various Parts/assemblies of Universal Coupling
vi. Generation of various Parts/assemblies of Quick Return Mechanism (eg. with worth)
vii. Generation of various Parts/assemblies of Knuckle joint.
viii. Generation of various Parts/assemblies of Lead Screw with Nut.
ix. Generation of various Parts/assemblies of Bushed Pin Type Flexible Coupling.
x. Generation of various Parts/assemblies of Screw Jack.
xi. Generation of various Parts/assemblies of Helical Suspension Spring with Guide Rod.

Surface Modelling:

Generate any four of the following components using any Surface Modelling software.

i. Generation of Aircraft Wing Surface by using surface modelling.
ii. Generation of Smartphone Back Cover by using surface modelling.
iii. Generation of Water bottle by using surface modelling.
iv. Generation of Chair by using surface modelling.
v. Generation of Jet Engine Inlet by using surface modelling.

Part- B:

Drafting:

Generate drafting of any four components of the above.

Text Books:

1. "CAD/CAM: Computer Aided Design and Manufacturing" by Mikel P. Groover and Emory W.Zimmers.

Reference Books:

1. "CATIA V5 Workbook" by Richard Cozzens

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Sample Experiments:

1. Create orthographic projections **(**front, top, and side views) of a machine component such as a Oldham's coupling using any 2D CAD software**.**
2. Create a surface model of an aircraft wing and extract its 2D views.
3. Create a 3D model of a Knuckle joint using features like pad, revolve, and sweep.

4. Design a Universal Coupling using Boolean operations. Save and export the model using standard translators such as STEP or IGES.
5. Generate a chair using shell and sweep commands. Provide section views of your final model.
6. Assemble the parts of a Helical Gear and Pinion in 3D space and simulate the movement.
7. Create an exploded view of a Lathe Tool Post and annotate all parts.

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Board of Studies (ME)

R24MEPC04 **Manufacturing Processes Lab** **0 0 3 1.5**

(Mechanical Engineering)

Course Objective:

1. Develop Proficiency in Pattern Making and Molding Processes
2. Gain Expertise in Welding and Joining Techniques
3. Understand and Apply Sheet Metal and Advanced Manufacturing Techniques

Course Code	Course Outcomes	Mapping with POs and PSOs					
		PO1	PO8	PO9	PO10	PO11	PSO2
R24MEPC04.1	Develop proficiency in pattern making and molding processes.	3	3	3	3	3	2
R24MEPC04.2	Gain expertise in welding and joining techniques.	3	3	3	3	3	2
R24MEPC04.3	Understand and apply sheet metal and advanced manufacturing techniques.	3	3	3	3	3	2

List of Experiments:

1. Design and making of pattern **CO's: CO1**
   a. Single piece pattern
   b. Split pattern
2. Mould preparation **CO's: CO1**
   a. Straight pipe
   b. Dumble
3. Gas cutting and welding **CO's: CO2**
4. Manual metal arc welding **CO's: CO2**
   a. Lap joint
   b. Butt joint
5. Injection Molding **CO's: CO2**
6. Blow Molding **CO's: CO2**
7. Simple models using sheet metal operations **CO's: CO3**
8. To weld using Spot welding machine **CO's: CO2**
9. To join using Brazing and Soldering **CO's: CO2**
10. Bending and other operations **CO's: CO3**
11. Deep drawing and extrusion operations. **CO's: CO3**
12. To make simple parts on a 3D printing machine **CO's: CO3**

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Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

References/Manuals:

1. Manufacturing Technology -Vol I- P.N. Rao- TMH
2. Laboratory Manual

Web References:

1. https://nptel.ac.in/courses/112/
2. https://www.asminternational.org/
3. https://www.twi-global.com/

Sample Experiments:

1. What are the key differences between a single-piece pattern and a split pattern?
2. How does the choice of pattern type affect the casting process?
3. Demonstrate how to design a split pattern for a cylindrical casting.
4. What materials are commonly used for preparing a straight pipe mould?
5. Explain the importance of venting in mould preparation.
6. Prepare a mould for casting a straight pipe using appropriate materials and techniques.
7. What is the principle behind gas cutting?
8. How does the heat generated in welding affect the material properties of the workpiece?
9. Perform a gas cutting operation on a mild steel plate.
10. What are the components of a lap joint in welding?
11. Describe the steps involved in preparing a butt joint for welding.
12. Weld a lap joint using manual metal arc welding on a mild steel plate.
13. What is the function of the injection unit in an injection molding machine?
14. How does the cooling rate affect the quality of the molded part?
15. Set up an injection molding machine to produce a simple plastic component.
16. What are the types of blow molding processes?
17. Explain the role of air pressure in the blow molding process.
18. Operate a blow molding machine to produce a hollow plastic bottle.
19. What are the basic sheet metal operations?
20. How does the thickness of the sheet metal influence the choice of operation?
21. Create a simple box model using cutting and bending operations on sheet metal.
22. What is the principle of spot welding?
23. How does the electrode pressure affect the weld quality in spot welding?
24. Perform a spot-welding operation to join two mild steel sheets.
25. What are the differences between brazing and soldering?

26. Explain the significance of flux in the brazing process.
27. Join two metal parts using the brazing technique
28. What are the types of bending operations?
29. How does the radius of the bend affect the material during bending?
30. Perform a U-bend operation on a mild steel strip using a bending machine.
31. What is the difference between deep drawing and extrusion?
32. Describe the factors that influence the success of a deep drawing operation.
33. Demonstrate a simple deep drawing process to form a cup shape from a metal sheet.
34. What are the common materials used in 3D printing?
35. How does layer height affect the resolution of a 3D printed object?
36. Create a simple 3D model using CAD software

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R24HS04 **Logical Reasoning and Corporate Skills** **0 0 2 1**
(Common to all UG programmes)

Course Objectives:

1. **Develop Logical thinking skills:** Students will be able to analyze information, identify patterns, and make informed decisions.
2. **Enhance analytical skills:** Students will be able to break down complex information into its component parts, analyze each part, and draw conclusions.
3. **Understand corporate culture and etiquette:** Students will be able to understand and demonstrate corporate culture and etiquette, including professional behaviour and networking.
4. **Develop effective communication skills:** Students will be able to communicate effectively in a corporate setting, including verbal and written communication.
5. **Develop negotiation and conflict resolution skills:** Students will be able to negotiate effectively and resolve conflicts in a corporate setting.
6. **Improve teamwork and collaboration skills:** Students will be able to work effectively in teams, build strong relationships, and manage conflicts.

At the end of the course, students will be able to:

Course Code	Course Outcome	PO1	PO7	PO9	P011	Dok
R24HS04.1	Use their logical thinking and analytical abilities to solve reasoning questions from number analogy and series and letter and coding and decoding based aptitude questions company specific and other competitive tests.	2	---	---	---	L4,L5
R24HS04.2	Solve questions related to Blood Relations clock and calendar, etc. From company specific and other competitive tests.	1	---	---	---	L4,L5
R24HS04.3	Enforce corporate etiquette, and precise usage of English grammar to enhance their professional communication.	---	2	3	1	L1,L3
R24HS04.4	Master negotiation skills and telephone etiquette with emotional intelligence for corporate interactions.	---	2	3	1	L3
R24HS04.5	Enhance email writing skills by incorporating vocabulary acquired from storytelling, situational dialogues and reading activities by using various digital tools.	2	---	3	1	L2,L3

SYLLABUS

UNIT I **15 Hours**

Number Series, Letter Series, Number analogy, letter analogy, word analogy. Coding Decoding-Letter to letter, letter to digit, letter to number and symbol, Word to word coding, odd man out. Directions-Finding distance, Direction and Shadow based problem, Blood Relations-Mixed Blood Relations, Puzzle-Based Blood Relation, Single-Person Blood Relation, Symbol based Blood Relations.

Self Learning Topic: Number Puzzles

UNIT II **15 Hours**

Clocks–finding Angle, Time, Mirror image, Faulty clock, Calendars – Finding day of the week, Number of odd days, Repetition of same calendar, Seating Arrangement-Circular arrangement, linear arrangement, Order Sequence and Ranking

Self Learning Topic: Arrangement puzzles

UNIT III **10 Hours**

Corporate Etiquette – Work Place Etiquette and Conflict Resolution – Grammar Revision, Leadership and Management skills. Verbal Ability: Prepositions, Articles, tenses and conjunction

Self Learning Topic: Successful Team Leadership

UNIT IV **10 Hours**

EQ – Negotiation Skills – Telephone Etiquette – MNCs Paper Model Introduction, Situational Dialogue Practice – Team Activities Related to Spoken
English Verbal Ability: Fill in the blanks (Based on the given appropriate words)

Self Learning Topic: Group Discussion Skills

UNIT V **10 Hours**

E Mail Writing–Vocabulary, Story Telling Activity, Functional English–IELTS Vocabulary News Paper Reading.
Verbal Ability: Sentence arrangements

Self Learning Topic: Sentence Construction

Board of Studies: MBA
Approved in BOS No: 02, 13th, April, 2025
Approved in ACM No: 02

Text Books:

1. A Modern Approach to Logical Reasoning R.S Aggarwal – S.chand publications.
2. Personality Development and Soft Skills by Barun K.mitra

Reference Books:

1. Shortcuts in Reasoning (Verbal, Non-Verbal, Analytical & Critical) for Competitive Exams Disha's publications
2. Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishnan–Himalaya publishing house

Web References:

1. https://faceprep.in/ logical reasoning
2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions of Logical Reasoning & Corporate Skills

L1: Remember

1. What is the proper way to greet a client or colleague in a professional setting?
2. The book is _____ the table.
3. I'm going _____ the store to buy some milk.
4. If I _____ (know) the answer, I would tell you.
5. By next year, I _____ (study) English for five years.
6. If it _____ (rain), we would have stayed home.
7. I _____ (finish) my homework before I went to bed.

L2: Understand

1. What is your favorite childhood story? Why do you enjoy it?
2. Tell a story about a memorable experience from your life.
3. If you could tell a story to inspire others, what would it be about?
4. Rearrange the following sentences to form a coherent paragraph:
   A. The sun was setting over the ocean.
   B. The sound of the waves was soothing.
   C. We walked along the beach, enjoying the peaceful atmosphere.
   D. The smell of saltwater filled the air.
5. Put the following sentences in the correct order to tell a story:
   A. She packed her bags and said goodbye to her family.
   B. After a few months, she returned home with new experiences and stories.
   C. Emily had always wanted to travel abroad.
   D. She boarded a plane and took off for a new adventure.
6. Rearrange the following sentences to form a logical argument:
   A. Therefore, we should prioritize renewable energy sources.
   B. Fossil fuels are a finite resource and contribute to climate change.
   C. In conclusion, our reliance on fossil fuels is unsustainable.
   D. Renewable energy sources, on the other hand, are sustainable and environmentally friendly.

L3: Apply

1. What qualities do you think are essential for a good leader?
2. How would you motivate a team member who is struggling with their work?
3. Describe a time when you had to make a difficult decision as a leader.
4. The new policy aims to _____ the gap between the rich and the poor.
5. The company's _____ in the market has increased significantly over the past year.
6. The teacher asked the students to _____ their essays before submitting them.
7. The _____ of the new smart phone is its advanced camera system.
8. The company will _____ a new product line next quarter.

9. By the time I arrived, they _____ (eat) dinner.

L4: Analyzing

1. Complete the series: 2, 4, 8, and 16?
2. Find the next number: 1, 2, 4, 7, 11,?
3. Identify the pattern: 3, 6, 9, 12, ?
4. Complete the sequence: 5, 10, 15, 20, ?
5. Determine the next number: 2, 6, 12, 20, ?
6. Identify the pattern: B, D, F, H, ?
7. Complete the sequence: M, O, Q, S, ?
8. Determine the next letter: T, S, R, Q, ?
9. Complete the series: Monday, Tuesday, Wednesday, ?
10. Find the next word: January, February, March, ?
11. Determine the next word: Book, Magazine, Newspaper, ?
12. Find the odd one out: Apple, Banana, Carrot, Mango
13. Identify the odd one out: Football, Basketball, Tennis, Piano
14. Determine the odd one out: Car, Bus, Train, Book
15. Find the odd one out: Red, Blue, Green, Chair
16. Identify the odd one out: Dog, Cat, Elephant, House
17. What is the angle between the hour and minute hands of a clock at 3:15?
18. 1. What is the mirror image of the time 3:45?
19. 2. A person sees their mirror image and notices that their watch shows 9:30. What is the actual time?

L5: Evaluating

1. Five friends - A, B, C, D, and E - are sitting in a row. If A is at one end, B is next to A, and C is in the middle, who is sitting at the other end?
2. Seven people - A, B, C, D, E, F, and G - are sitting in a circle. If A is between B and C, and D is opposite A, who is sitting next to D?
3. If today is Monday, what day of the week will it be 30 days from now?
4. A meeting is scheduled for the 15th of March, which falls on a Wednesday. What day of the week will the 22nd of March be?
5. If you are facing north and turn 90 degrees to your right, which direction are you facing?
6. A person walks 5 km east and then 3 km west. How far is he from his starting point?
7. If you are facing south and walk 2 km, then turn left and walk 1 km, which direction are you facing?
8. A is the brother of B. C is the sister of A. How is B related to C?
9. A woman introduces a man as the son of her brother's father. How is the man related to the woman?
10. A man points to a woman and says, "She is the daughter of my mother's only child." How is the woman related to the man?

R24 MC03 **Environmental Science** **2 0 0 0**

(Common to all branches)

Course Objectives:

1. To make the students to get awareness on environment.
2. To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life
3. To save earth from the inventions by the engineers.

SYLLABUS

UNIT I **6 Hours**

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems , Energy resources:

Self-Learning Topics: Food resources, World Food Problems.

UNIT II **7 Hours**

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. b. Aquatic ecosystem

Biodiversity and its Conservation : Introduction ,Definition, Values of biodiversity– India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity, Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Self-Learning Topics: Desert Ecosystem, Bio-Geographical Classification of India.

UNIT III **6 Hours**

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

Self-Learning Topics : Cause, effects and control measures of :Marine Pollution,Thermal Pollution.

UNIT IV **6 Hours**

Social Issues and the Environment: From Unsustainable to Sustainable development Water conservation, rain water harvesting, – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate Changes: global warming, acid rain, ozone layer depletion. Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Wildlife Protection Act – Forest Conservation Act .

Self-Learning Topics: Water Shed Management, Water (Prevention and control of Pollution) Act

UNIT V **7 Hours**

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information

Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Board of Studies : Basic Science and Humanities Chemistry
Approved in BOS No: 05th, August, 2024
Approved in ACM No: 01

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, "Environmental Studies", Pearson education
3. S.Azeem Unnisa, "Environmental Studies" Academic Publishing Company
4. K.Raghavan Nambiar, "Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus", Scitech Publications (India), Pvt. Ltd.

References:

1. Deeksha Dave and E.Sai Baba Reddy, "Textbook of Environmental Science", Cengage Publications.
2. M.Anji Reddy, "Text book of Environmental Sciences and Technology", BS Publication.
3. J.P.Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, "Environmental Sciences and Engineering", Prentice Hall of India Private limited
5. G.R.Chatwal, "A Text Book of Environmental Studies" Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science, Prentice Hall of India Private limited.

Sample Questions

Unit –I

1. Environmental Science is Multidisciplinary in nature .Justify?
2. Explain the difference between renewable and non-renewable resources.
3. Why forests are considered a critical natural resource?
4. Discuss the positive & negative impacts of Big Dams.
5. Explain the Scope and importance of Environmental Science.
6. Apply the idea of conservation to suggest ways a community can reduce its reliance on fossil fuels.

Unit-II

1. Explain how energy flows through an ecosystem.
2. Describe the role of producers, consumers, and decomposers in an ecosystem
3. Apply the concept of ecological succession to explain how a forest might develop after a wildfire.
4. Explain the Values of Bio-Diversity
5. Evaluate the effectiveness of protected areas in conserving biodiversity.

Unit-III

1. Explain how air pollution can impact human health.
2. Examine how deforestation contributes to both air and water pollution.
3. Explain how agricultural runoff contributes to water pollution.
4. Compare the effects of chemical pollutants versus biological pollutants on freshwater

ecosystems.

5. How can a municipality implement a successful recycling program to reduce the amount of waste sent to landfills?
6. What steps should a local government take to enhance resilience against floods in an urban area?

Unit-IV

1. Describe how sustainable development aims to balance economic growth, environmental protection, and social equity.
2. Explain how a rainwater harvesting system works from collection to storage.
3. How can a government design a resettlement program that minimizes disruption to affected communities?
4. What steps can individuals take to lower their personal contribution to global warming?
5. Discuss (i) Air (Prevention and Control of Pollution) Act (ii) Wildlife Protection Act

Unit-V

1. Explain how rapid population growth can impact natural resources.
2. Examine how population growth trends influence energy consumption and
3. Discuss possible solutions for sustainable energy use.
4. Evaluate the effectiveness of population control measures in addressing environmental issues in a specific country or region.
5. How can healthcare providers ensure that people at high risk for HIV are tested and receive appropriate prevention and care services?
6. Explain the concept of gender equality and its importance in women and child welfare.

7 Discuss the Role of information Technology in Environment and human health

Chairperson
Board of Studies (Chemistry)

R24BS09 COMPLEX VARIABLES AND STATISTICAL METHODS 3 0 0 3

(Common to MECH and EEE)

Course Objectives:

1. To familiarize the complex variables.
2. To familiarize the students with the foundations of probability and statistical methods.
3. To equip the students to solve application problems in their disciplines.

At the end of the course student will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS09.1	To obtain an analytic function for a given harmonic function using C-R equations.	2	2	1	L1, L2
R24BS09.2	Make use of the Cauchy residue theorem to evaluate certain integrals.	2	2	1	L1,L2
R24BS09.3	Apply the theoretical probability distributions like Binomial, Poisson, and normal in the relevant application areas.	2	2	1	L1,L2,L3
R24BS09.4	Analyze to test various hypotheses included in theory and types of errors for large samples.	2	2	1	L4
R24BS09.5	Apply the different testing tools like t-test, F-test, chi-square test to analyze the relevant real-life problems.	2	2	1	L4,L5

SYLLABUS

UNIT- I: Functions of a complex variable and Complex integration: 10 hours

Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates –Harmonic and conjugate harmonic functions – Milne –Thompson method. Complex integration: Line integral– Cauchy's integral theorem–Cauchy's integral formula. **COs-CO1**

Self- learning Topics: Evaluating contour integrals, Integration along a smooth path

UNIT- II: Series expansions and Residue Theorem: 10 hours

Radius of convergence –Expansion in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated –Essential – Pole of order m –Residues–Residue theorem (without proof) and evaluation of real integrals of the form $\int_{-\infty}^{\infty} f(x)\,dx$, **COs-CO2**

Self- learning Topics: Approximating a function or data using a series of function is a fundamental tool for data analysis.

UNIT- III: Probability and Distributions: 10 hours

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability Density function and Cumulative distribution functions – Mathematical Expectation and Variance –Binomial, Poisson,

Uniform and Normal distributions. **COs-CO3**

Self -learning Topics: To understand risk and return on investment.

UNIT-IV: **Sampling Theory:** **10 hours**

Introduction –Population and Samples–Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions– Introduction to t, χ^2 and F-distributions–Point and Interval estimations –Maximum error of estimate. **COs-CO4**

Self- learning Topics: Estimate health outcomes, behaviors and attitudes within a population.

UNIT- V: Tests of Hypothesis: **10 hours**

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors –Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples)–Tests on proportions. **COs-CO5**

Self- learning Topics: Hypothesis Testing is employed to ensure product quality and process efficiency.

Textbooks:

1. **B.S.Grewal,** Higher Engineering Mathematics, Khanna Publishers, 44thEdition, 2017.
2. **Miller and Freund's,** Probability and Statistics for Engineers, Pearson, 7thedition, 2008.

Approved in BOS No: 01, 02 August, 2024 Mathematics

Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	InternalAssessment#1(%)	InternalAssessment#2(%)
L1	30	10
L2	30	10
L3	40	30
L4	-	25
L5	-	25
Total(%)	**100**	**100**

Sample Questions based on cognitive levels

Unit 1

1) Show that $u(x,y)$ is harmonic in some domain and find a harmonic conjugate $v(x,y)$ When $u(x,y)=2x-x^3+3xy^2$. (L1)

2) Show that the function $f(z)=\sqrt{|xy|}$ is not analytic at the origin even though CR equations are satisfied. (L 1, L2)

3) 3) Find the analytic function $f(z)=u+iv$ if $u+v=\dfrac{2\sin 2x}{e^{2y}-e^{-2y}-2\cos 2x}$ (L 1)

4) If $f(z)=\begin{cases}\dfrac{x^3y(y-ix)}{x^6+y^2}, & z\neq 0\\ 0, & z=0\end{cases}$ prove that $\dfrac{f(z)-f(0)}{z}\to 0$ as $z\to 0$ along any radius vector but not as $z\to 0$ along the curve $y=ax^3$. (L1, L2)

Unit 2

Cauchy Integral formula

1) Use Cauchy's integral formula to calculate $\int_C \dfrac{\sin\pi z+\cos\pi z}{(z-1)(z-2)}dz$ where C is $|z|=4$. (L 3)

2) Evaluate $\int_C \dfrac{\sin^2 z}{\left(z-\frac{\pi}{6}\right)^3}dz$ where C is the circle $|z|=1$. (L 5)

3) Use Cauchy Integral formula to evaluate

4) $\int_C \dfrac{\cos\pi z^2}{(z-1)(z-2)}dz$ Where C is the curve $|z|=3$. (L 3)

Laurent series expansion

1) 1)Expand $f(z)=\dfrac{1}{[(z-1)(z-2)]}$ in the region:

(i) $|z|<1$ (ii) $1<|z|<2$ (iii) $|z|>2$ (L2)

2) Evaluate $\int_C \dfrac{z-3}{z^2+2z+5}dz$ where C is the circle

(i) $|z|=1$ (ii) $|z+1-i|=2$ (iii) $|z+1+i|=2$ (L2)

Unit 3

1) Define: (i) Binomial (ii) Poisson (iii) Uniform and (iv) Normal distributions. (L1)
2) State and prove Chebyshevs Inequality. (L3)
3) Fit the Poisson distribution for the following data (L3)

X	0	1	2	3	4	5
Y	147	147	74	25	6	1

Unit 4

1) Explain point and interval estimations. (L2)

2) Explain the types of errors in sampling. (L2)
3) A random sample of 125 teachers in a large metropolitan area revealed a mean weekly salary of Rs. 527 with a standard deviation Rs. 45. With what degree of confidence can we assert that the average weekly salary of all teachers in the metropolitan area is between 495 to 532? (L3)

Unit 5

1) Define: t, F and chai square test. (L1)

2) Write the test statistic for (L3)
   (i) The test of significance for single mean for the test of significance for single proportion and difference of means
3) Find the maximum difference that we can expect with probability 0.95 between the means of sample sizes 10 and 12 from normal population if their standard deviations are found to be 2 and 3 respectively. (L5)

Chairperson
Board of Studies (Mathematics)
Chairperson

R24MEPC09 **Fluid Mechanics & Hydraulic Machines** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. **Understand** the properties of fluids and principles of fluid statics and kinematics
2. **Apply** Bernoulli's and momentum equations to analyze practical fluid flow situations.
3. **Analyze** flow through pipes and evaluate jet impact on vanes in fluid machinery.
4. **Evaluate** performance parameters of hydraulic turbines and their components.
5. **Assess** and compare the performance of centrifugal and reciprocating pumps.

Course Code	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO9	PO10	PO11	PSO1	PSO2	DOK
R24MEPC09.1	Understand the fundamental properties of fluids and apply fluid statics principles to pressure measurement devices.	3	3	2	2	2	-	1	2	2	2	L1, L2
R24MEPC09.2	Analyze different fluid flow types using kinematic and dynamic equations including continuity, Bernoulli's and momentum equations.	3	3	3	2	3	-	1	2	3	3	L2, L3
R24MEPC09.3	Evaluate energy losses in pipe systems and the impact of fluid jets on different vane geometries.	3	3	3	2	3	-	-	2	3	3	L3
R24MEPC09.4	Illustrate the working principles and performance characteristics of impulse and reaction turbines along with their governing systems.	3	2	3	2	3	1	1	3	3	3	L3, L4
R24MEPC09.5	Compare the construction, operation, and performance of centrifugal and reciprocating pumps in various engineering applications.	3	2	3	2	3	1	1	3	3	3	L3, L4

SYLLABUS

UNIT-I **15 Hours**

Fluid statics: Physical properties of fluids: Specific mass, Specific weight, Specific Volume – Specific gravity, Viscosity, Surface tension & Capillarity, Vapour pressure and Compressibility – Pressure: Pascal's law, Hydrostatic law, Atmospheric Gauge and Vacuum pressure –Measurement of pressure, Pressure gauges – Manometers: Simple & Differential manometers.

Fluid Kinematics: Description of fluid flow: Path line, Streamline, Streak line, Stream tube, Velocity & Acceleration – Classification of fluid flows: Steady & Unsteady, Uniform & Non-

uniform, Rotational & Irrotational flows – Reynolds Experiment: Laminar & Turbulent flows - Continuity equation for 1D, 2D and 3D flows– Stream function, Velocity potential function and Flow net analysis.

Applications: Marine Ship Design, Pressure Measurement in Industrial Devices **CO's: CO1**

Self-Learning Topic: Fluid Statics Applications in Weather Forecasting and Oceanography.

UNIT-II **15 Hours**

Fluid dynamics: Surface and Body forces – Euler's and Bernoulli's equations for flow along a stream line for 3D flow – Momentum equation and its applications: Force on pipe bend– Flow between parallel plates, Flow through long tubes, Flow through inclined tubes.

Measurement of flow: Pitot tube, Venturi meter and Orifice meter, Flow nozzle and Turbine flow meter. **CO's: CO2**

Self-Learning Topic: Design and Optimization of Flow Measuring Devices in Aerospace and Automotive Applications.

UNIT-III **15 Hours**

Closed Conduit Flow: Darcy Weisbach equation – Minor losses in pipes: Pipes in series and pipes in parallel – Total energy line and Hydraulic gradient line

Basics of turbo machinery: Impact of jet on vanes: Impact of jet on Flat, Inclined & Curved vanes (Stationary & Movable), Impact of jet on series of curved vanes. **CO's: CO3**

Self-Learning Topic: Computational Fluid Dynamics (CFD) in Pipe Flow and Jet Systems

UNIT-IV **20 Hours**

Hydraulic Turbines: Classification of turbines: Impulse and Reaction turbines – Pelton Wheel, Franci's turbine and Kaplan turbine – working proportions, work done, efficiencies, hydraulic design – Draft tube: Theory, functions and efficiency

Performance of hydraulic turbines: Geometric similarity – Unit and Specific quantities – Characteristic curves – Governing of turbines – Selection of type of turbine – Cavitation –Surge tanks – Water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications. **CO's: CO4**

Self-Learning Topic: Modern Trends in Hydro Power and Smart Fluidic Control Systems

UNIT-V **10 Hours**

Centrifugal pumps: Classification, working, and work done – Manometric head– Losses and efficiencies – Specific speed – Pumps in series and parallel – Performance curves – NPSH.

Reciprocating pumps: Working, Discharge, Slip and indicator diagrams

Applications: Municipal Water Supply and Treatment Systems, Hydropower Plant Operations and Management, Industrial Fluid Handling Systems **CO's: CO5**

Self-Learning Topic: Pump Selection and Troubleshooting in Real-World Industrial Systems

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. Hydraulics, Fluid Mechanics and Hydraulic Machinery, P.N.Modi, S.M.Seth, Standard Book House Publications.
2. Fluid Mechanics and Hydraulic Machines, R.K.Rajput, S.Chand Publications.

Reference Books:

1. Fluid Mechanics and Fluid Power Engineering, D.S.Kumar, S.K.Kotaria& Sons Publications.
2. Fluid Mechanics and Machinery, D.Rama Durgaiah, NewAge Publications.
3. Hydraulic Machines,T.R.Banga, S.C.Sharma, Khanna Publications.
4. Instrumentation for Engineering Measurements, James W.Dally, WilliamE.Riley, John Wiley and Sons Publications.

Online Learning Resources:

- https://archive.nptel.ac.in/courses/112/105/112105206/
- https://archive.nptel.ac.in/courses/112/104/112104118/
- https://www.edx.org/learn/fluid-mechanics
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
- www.coursera.org/learn/fluid-powerera

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	30
L3	30	40
L4	--	30
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Convert a pressure of 2 bar into kPa and mm of Hg.
2. A fluid has a specific gravity of 0.85. Find its density and specific weight.
3. A manometer shows a height difference of 30 cm of mercury. What is the pressure in kPa?
4. Identify the type of turbine best suited for a head of 500 m.

5. A liquid has a viscosity of 0.01 Pa.s and flows at 25°C. Name the liquid.

L2: Understand

1. Explain with a diagram the variation of pressure in a fluid at rest.
2. Compare the velocity profiles of laminar and turbulent flows in pipes.
3. Draw and interpret the characteristic curves of centrifugal pumps.
4. Describe how a Venturimeter works and how flow rate is derived.
5. Explain the phenomenon of capillarity and how it affects pressure readings.

L3: Apply

1. A pipe of 200 mm diameter carries water at a velocity of 3 m/s. Calculate the discharge.
2. A Venturimeter is installed in a horizontal pipe carrying water. The inlet diameter is 100 mm, throat diameter is 50 mm, and pressure difference is 5 kPa. Find the discharge.
3. Calculate the pressure drop in a pipe 50 m long, 150 mm in diameter, with a flow velocity of 2 m/s. Take Darcy friction factor as 0.02.
4. Water flows over a flat plate 2 m long with a thickness of 0.1 mm. Compute shear stress assuming dynamic viscosity of 1×10^{-3} Pa.s.
5. Find the force exerted by a jet of water (diameter = 0.05 m, velocity = 20 m/s) on a stationary flat vertical plate.

L4: Analyze

1. A hydraulic system lifts a load of 500 kg using a piston of 100 mm diameter. Find the pressure required.
2. Analyze the energy loss due to sudden contraction in a pipeline. Given diameters and flow velocities.
3. A Pelton wheel receives water from a height of 250 m. Analyze the power developed if the flow rate is 2 m^3/s and efficiency is 85%.
4. Determine whether the flow in a pipe of 25 mm diameter and velocity 0.3 m/s is laminar or turbulent. Take $\nu = 1 \times 10^{-6}$ m^2/s.
5. A water hammer effect occurs in a 200 m pipeline. Analyze pressure rise if the valve is closed suddenly.

Chairperson
Board of Studies (ME)

R24MEPC10 **Theory of Machines** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. To introduce the fundamental concepts of mechanisms and machines, including types of kinematic pairs, constrained motion, and inversions, to build a strong foundation for analyzing motion systems.
2. To examine various lower pair mechanisms such as pantographs, straight-line motion mechanisms, steering systems, and Hooke's joints, and understand their kinematic behavior and practical relevance.
3. To develop the ability to perform velocity and acceleration analysis of planar mechanisms using graphical methods such as the relative velocity method and the instantaneous center method.
4. To impart knowledge on gyroscopic effects and turning moment diagrams, enabling analysis of dynamic behavior in rotating and reciprocating systems like vehicles and engines.
5. To explore the design principles and functional characteristics of higher pair mechanisms, including cams and governors, with a focus on motion programming and control.

Course Code	Course Outcome (CO)	PO1	PO2	PO3	PO4	DoK
R24MEPC10.1	Explain the basic types of mechanisms and their motion characteristics.	3	2	-	-	L1
R24MEPC10.2	Analyze and synthesize lower pair mechanisms (pantographs, straight-line, steering, Hooke's joint) for practical engineering applications.	3	3	2	1	L2, L3
R24MEPC10.3	Analyze cam profiles for various follower motions.	3	3	-	2	L3
R24MEPC10.4	Evaluate gyroscopic effects and interpret turning moment diagrams for various engines and vehicles.	3	2	-	2	L4
R24MEPC10.5	Design cam profiles for specified follower motions and compare governor types based on sensitivity and performance.	3	2	3	2	L5

SYLLABUS

UNIT-I **14 Hours**

Introduction of Mechanisms and Machines:

Mechanisms: Elements or Links, Classification, Rigid Link, flexible and fluid link, Types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs lower and higher pairs, closed

and open pairs, constrained motion, completely, partially or successfully constrained and incompletely Constrained.

Machines: Mechanism and machines, classification of machines, kinematic chain inversion of mechanism, inversions of quadric cycle, chain, single and double slider crank chains.

Applications: Robotics (manipulator arm design), Automotive transmissions, Packaging machinery linkages **CO's: CO1**

Self-Learning Topics: History and evolution of mechanical linkages, Simulation tools for mechanism analysis (e.g., Working Model, ADAMS), Role of kinematic pairs in robotics

UNIT-II **14 Hours**

Lower Pairs: Pantograph – straight line motion mechanisms –Peaucellier mechanism (Exact St. Line) -Watt mechanism (Approximate St. Line). Steering Gear mechanisms -Condition for correct steering-Working principle of Davis & Ackerman's steering gear mechanisms**.** Hooke's joint: Ratio of shaft velocities – maximum and minimum speed of driven shaft – condition for equal speeds – Angular acceleration of driven shaft – Double Hooke's joint.

Applications: Mechanical linkages in drawing machines and plotters (Pantograph), Steering mechanisms in automobiles (Davis & Ackerman), universal joints in drive systems (e.g., in CV joints) **CO's: CO2**

Self-Learning Topics: Study of 3D kinematics and the application of lower pairs in robotics, Virtual simulation of Pantograph and Watt mechanisms

UNIT–III **12 Hours**

Velocity & Acceleration Analysis by Relative Velocity Method: Velocity and acceleration analysis of simple planar mechanisms, Angular velocity and angular acceleration of links, velocity of rubbing, Coriolis component of acceleration.

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Applications: Automotive suspension design (velocity analysis of suspension systems), Robotics (velocity and acceleration analysis of robotic arms), Mechanical system optimization in manufacturing (e.g., conveyor systems) **CO's: CO3**

Self-Learning Topics: Study of advanced concepts in velocity and acceleration analysis, Real-world case studies: Analysis of machinery using relative velocity

UNIT–IV **12 Hours**

Precession: Gyroscopes, effect of precession motion on the stability of moving vehicles such as, aero planes and motor car.

Turning moment Diagrams: Single cylinder double acting steam engine, Four Stroke Cycle

Internal Combustion Engine, Multi-cylinder Engine, and Flywheel.

Applications: Gyroscopic stability in ships, aircraft, and satellites, Internal combustion engine design, Vibration analysis in machinery **CO's: CO4**

Self-Learning Topics: Detailed study of gyroscopic effects on aircraft stability using simulations, Exploration of turning moment diagrams and their relation to engine efficiency, Precession in space exploration and satellites

UNIT–V **10 Hours**

Cams: Types of cams, Types of followers, Follower displacement programming, Derivatives of follower Motion, Layout of cam profiles-knife edge and roller follower.

Governors: introduction, Watt Governor, Porter Governor**,** Proell Governor- Problematic

Applications: Engine valve timing systems, Automatic control systems, Manufacturing processes **CO's: CO5**

Self-Learning Topics: Exploring the design of cams and followers in cam profiles software, Study of governor systems in modern engine management systems, Simulation of cam mechanisms in automotive and industrial applications.

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. Rattan S.S, "Theory of Machines" Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Edition -2005.
2. Sadhu Singh, "Theory of Machines," Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 2ND Edi. 2006.
3. Jagadish Lal, 'Theory of Machine', Dhanpat Rai Publications, New Delhi..

Reference Books:

1. Shigley. J. V. and Uickers, J.J., "Theory of Machines & Mechanisms" OXFORD University press.2004
2. "Theory of Machines -I", by A.S.Ravindra, Sudha Publications, Revised 5th Edi. 2004

Web References:

1. http://archive.nptel.ac.in/courses/112/106/112106270/
2. http://www.youtube.com/watch?v=JQ5Elv36el4
3. http://onlinecourses.nptel.ac.in/noc24_me44/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Short Answer Questions

Level-1: Remembering

1. Define a kinematic link and list its types.
2. What is a mechanism? How is it different from a machine?

Level-2: Understanding

1. Explain the difference between rigid, flexible, and fluid links.
2. Classify kinematic pairs with suitable examples.
3. What are the different types of constrained motion? Explain with examples.
4. Explain gyroscopic couple with an example.
5. Describe the effect of gyroscopic forces on an airplane.

Level-3: Applying

1. Construct the Peaucellier mechanism and describe its function.
2. Apply the condition for correct steering to Davis steering mechanism.
3. Show how Hooke's joint transmits motion between two shafts.
4. Calculate the angular velocity of a link in a given four-bar mechanism.
5. Determine the velocity of a slider in a slider-crank mechanism using the relative velocity method.
6. Apply Kennedy's theorem to locate the instantaneous centers of a planar mechanism.
7. Analyze the Coriolis component of acceleration in a reciprocating engine mechanism.
8. Examine the rubbing velocity between two turning links and its impact on mechanism performance.
9. Apply the concept of turning moment diagram to a single cylinder engine.
10. Determine the energy fluctuation in a flywheel using turning moment data.
11. Draw the cam profile for a knife-edge follower with uniform velocity motion.
12. Show the displacement diagram for a roller follower.

Level-4: Analyzing

1. Analyze the angular acceleration of the driven shaft in a Hooke's joint.
2. Compare Davis and Ackermann steering mechanisms in terms of geometry.
3. Show how Hooke's joint transmits motion between two shafts.
4. Analyze the gyroscopic effect on a vehicle negotiating a curve.
5. Analyze the motion of the follower for a tangent cam.
6. Compare the performance of Porter and Proell governors.

Level-5: Evaluating

1. Evaluate the effect of friction on the sensitivity of a governor.

Long Answer Questions

Level-1: Remembering

1. Describe various types of kinematic links and kinematic pairs with sketches.
2. Define mechanism and machine. Explain with examples how they are classified.

Level-2: Understanding

1. Explain different types of constrained motion with neat diagrams.
2. Discuss the inversions of four-bar chain and slider crank chain mechanisms.
3. Illustrate and explain different types of kinematic chains with real-world examples.
4. Explain the principle of precession and its application in mechanical systems.

Level-3: Applying

1. Design and explain a pantograph mechanism and its practical applications.
2. Apply the velocity ratio expression for a Hooke's joint with given data.
3. Perform a complete velocity and acceleration analysis for a given four-bar mechanism.
4. Use the instantaneous center method to determine the linear velocity of all points in a slider-crank mechanism
5. Construct a turning moment diagram for a four-stroke engine and analyze its features.
6. Apply the concept of flywheel design in regulating speed fluctuations.
7. Design a cam profile for a radial cam with specified follower motion.
8. Apply follower displacement equations to develop a cam layout.

Level-4: Analyzing

1. Analyze the working and condition for equal speed in a double Hooke's joint.
2. Differentiate and evaluate the practical performance of Peaucellier vs Watt mechanisms.
3. Investigate how improper geometry affects the steering in a Davis system.
4. Analyze a complex mechanism using the relative velocity and acceleration method,

identifying all acceleration components.

5. Evaluate the motion and forces acting on a slider in a high-speed crank-slider mechanism.
6. Investigate the effect of Coriolis acceleration in mechanisms involving reciprocating parts.
7. Analyze the stability of a motor car taking a turn considering gyroscopic forces.
8. Investigate the effect of varying torque in a multi-cylinder engine using turning moment diagrams
9. Analyze the motion and equilibrium of a Proell governor under dynamic conditions.
10. Investigate the influence of mass and geometry in the operation of a Porter governor.

Level-5: Evaluating

1. Evaluate different types of governors based on their sensitivity and stability under varying load conditions.

Chairperson
Board of Studies (ME)

R24MEPC11 **Machine Tools & Metrology (Mechanical Engineering)** **3 0 0 3**

Course Objectives:

1. To gain fundamental knowledge of machining processes.
2. To understand the principles of lathe, shaping, slotting and planning machines.
3. To demonstrate the principles of drilling, milling and boring processes.
4. To understand the concepts of finishing processes and the system of limits and fits.
5. To gain knowledge about the concepts of surface roughness and optical measuring instruments.

Course Code	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	DoK
R24MEPC11.1	Understand the fundamental machining and apply Principles and operation of lathe, drilling and Boring Machines	2	2	2	-	-	2	-	L2
R24MEPC11.2	Apply the principles of shaping, slotting planning, and milling machines.	-	-	-	3	-	2	-	L2
R24MEPC11.3	Analyze the concepts of finishing processes	3	-	3	3	-	-	3	L3, L4
R24MEPC11.4	Analyze the concepts of the system of limits and fits	-	3	-	-	3	-	3	L3, L4
R24MEPC11.5	Learn the concepts of surface roughness and optical measuring instruments	1	2	3	-	3	2	-	L5

UNIT-I

Rotary Machines **16 Hours**

Elementary treatment of metal cutting theory – element of cutting process – Types of cutting tool, Geometry of Single point cutting tools. Chip formation and types of chips.

Lathe: Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - work holders and tool holders – accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes – cutting speed and feed-depth of cut.

Drilling and Boring Machines: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills – geometry of twist drill - operations performed –cutting speed and feed – machining time calculations - Boring Machines –

fine Boring Machines – jig boring machines - deep hole Drilling Machines **CO's: CO1**

Self Learning Topics: Cutting speed, feed and depth of cut- rotary machines

UNIT-II **16 Hours**

Reciprocating Machines Shaping, Slotting and Planning Machines: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time calculations.

Milling Machines:

Introduction - principle of working – specifications – milling methods - classification of Milling Machines –types of cutters - geometry of milling cutters – methods of indexing, accessories to milling machines - cutting speed and feed – machining time calculations **CO's: CO2**

Self Learning Topics: Cutting speed, feed and depth of cut- reciprocating machines

UNIT–III

Finishing Processes: **16 Hours**

Introduction, Construction and working, Classification- cylindrical and surface grinders, tool and cutter grinders, Abrasives, Bonds and bonding processes, Specification and selection of a grinding wheel, Honing, Lapping, Broaching & Polishing, Buffing, Super finishing and burnishing operations- comparison to grinding. **CO's: CO3**

Self Learning Topic: Comparing of Finishing Processes

UNIT–IV

Limits, Fits and Tolerances: **16 Hours**

Introduction, nominal size, tolerance, limits, deviations, different types of fits -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability, deterministic & statistical tolerances, selective assembly- International standard system of tolerances, selection of limits and tolerances for correct functioning, simple problems related to limits and fits, Taylor's principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges – inspection of gauges. Measurement of angles using Bevel protractor and Sine bar. Measurement of flatness using straight edges, surface plates. **CO's: CO4**

Self Learning Topics: Performance on linear measurements using Vernier Calliper and angular measurement of given specimen by using Vernier bevel protractor and sine bar

UNIT–V **16 Hours**

Surface Roughness Measurement: Differences between surface roughness and surface waviness – Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, simple problems - method of measurement of surface finish – Profilograph, Talysurf, ISI symbols for indication of surface finish. Machine Tool Alignment Tests on lathe, milling and drilling machines. Coordinate

Measuring Machines: Types and Applications of CMM.

Optical Measuring Instruments: Tools maker's microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. Optical comparators.

CO's: CO5

Self Learning Topics: Measurement of thread parameters using Optical Projector, Surface roughness using Talysurf and Alignment test on lathe.

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Text Books:

1. Manufacturing Processes / JP Kaushish/ PHI Publishers-2nd Edition, 2013
2. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill, 2019
3. Engineering Metrology – R.K. Jain/Khanna Publishers, 2022
4. B. S Raghuwanshi, Workshop Technology Vol-II, Dhanpatrai & Co., 11th Edition, 2013

References:

1. Metal cutting and machine tools /Geoffrey Boothroyd, Winston A. Knight / Taylor & Francis
2. Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
3. Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers
4. Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH
5. Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid /Pearson Publications 5th Edition

Web References:

1. https://nptel.ac.in/courses/112106179
2. https://onlinecourses.nptel.ac.in/noc24_me99/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L2 (Understanding)	50	-
L3 (Applying)	30	20
L4 (Analyzing)	20	40
L5 (Evaluating)	-	40

Total	**100**	**100**

Sample Questions of Various Cognitive Levels

Understanding (L2)

1. Describe the mechanism of metal cutting
2. Differentiate between orthogonal and oblique cutting
3. Discuss various operations performed on lathe machine
4. Explain working of shaper, slotter and planer
5. Explain the quick return mechanism used in shaper, slotter and planer
6. Describe the various drilling and boring machines
7. Explain working of various milling machines
8. Describe the working of various grinding machines
9. Explain working and applications of lapping and honing process
10. Explain fits & tolerances and employ plug and ring gauges for dimensional inspections
11. Discuss the use of slip gauges, dial test indicator, and angle gauges
12. Describe Auto collimator, Tool maker's microscope and N.P.L. Flatness interferometer
13. Explain numerical assessment of surface finish for different surface texture using Talysurf surface meter
14. Explain measurement of effective diameter, angle of thread and thread pitch
15. Describe measurement of gear elements and generate gear tooth profile

Applying (L3)

1. Determine the cutting speed and machining time per cut when the work having 40 mm diameter is
2. Rotated at 300 rpm. The feed given is 0.1mm/rev and length of cut is 65mm
3. A C.I. plate measuring 300mm×100mm×40mm is to be rough shaped along its wider face. Calculate the machining time take approach = 25mm; over travel = 25mm; cutting speed = 12m/min; return speed = 20m/min; allowance on either side of the plate width = 5mm and feed per cycle = 1 mm.
4. Determine limit dimensions for a clearance fit between mating parts of diameter 40 mm, providing a minimum clearance of 0.10 mm with a tolerance on the hole equal to 0.025mm and on shaft 0.05mm using both systems.
5. Design the general type GO gauges and NOGO gauges for components having 20H7/f8 fit. Given Gauge tolerance =work tolerance =10% of work tolerance. Assume the data following: Upper deviation of shaft 'f' is -5.5D0.41 , The standard tolerance unit i=0.45 D1/3+0.001D , where D is the geometric mean of the lower and upper limits of diameter

step in which the diameter consideration lies. D is in mm. 20mm falls in diameter steps of 18-30mm. The standard tolerance for IT7=16i and IT8=25i

6. In the measurement of surface roughness, heights of 20 successive peaks and troughs were measured from a datum and were 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35 and 20 microns. If these measurements were obtained over a length of 20 mm. determine the CLA and RMS value of the rough surface.

Analyzing (L4)

1. Distinguish between various taper turning methods and evaluate which method is most suitable for long tapers
2. Compare the effectiveness of various thread cutting methods on a lathe in terms of accuracy and efficiency
3. Analyze the relationship between cutting speed, feed, and depth of cut, and how they influence surface finish and tool life
4. Break down the construction of a typical engine lathe and explain the function of each major part
5. Analyze the impact of twist drill geometry (point angle, helix angle, lip relief angle) on drilling performance and accuracy
6. Classify the various types of drilling machines based on their construction and application scope
7. Analyze the advantages and limitations of jig boring machines compared to conventional boring machines
8. Compare the constructional features and applications of fine boring machines and deep hole drilling machines.
9. Compare the working principles and applications of shaping, slotting, and planning machines.
10. Differentiate between horizontal and vertical slotting machines based on their construction and use-cases
11. Break down the various components of a shaping machine and explain the function of each part.
12. Classify the operations performed on shaping machines based on the direction and nature of cutting
13. Analyze the factors affecting machining time calculation in slotting and shaping machines.
14. Compare the up milling and down milling methods in terms of chip formation, surface finish, and tool life.

15. Analyze how the geometry of milling cutters (rake angle, clearance angle, helix angle) influences cutting efficiency.
16. Distinguish between various milling machines (horizontal, vertical, universal, CNC) based on their construction and capabilities.
17. Compare the functionality and application of different types of milling cutters (e.g., slab, face, side-and-face, form).
18. Evaluate the steps required to calculate machining time for a given milling operation and the variables that influence it.
19. Compare and contrast the construction and working principles of cylindrical grinders and surface grinders.
20. Analyze the differences in tool design and application between a tool and cutter grinder and a universal cylindrical grinder.
21. Distinguish between various abrasive materials (e.g., aluminum oxide, silicon carbide, CBN, diamond) based on their properties and applications.
22. Break down the components of a grinding wheel and explain how each part (abrasive, bond, grade, structure) affects performance
23. Analyze the factors that go into the selection of a grinding wheel for a specific material and operation.
24. Compare honing and lapping processes in terms of accuracy, surface finish, and typical applications
25. Distinguish between polishing, buffing, and burnishing with respect to their tools, abrasives, and resulting surface finishes.
26. Analyze why superfinishing operations are sometimes preferred over grinding for certain high-precision applications, despite slower material removal rates.
27. Compare and contrast the hole basis system and shaft basis system in terms of manufacturing ease and part interchangeability.
28. Analyze how the unilateral and bilateral tolerance systems affect the manufacturing process and inspection strategy.
29. Break down the different types of fits (clearance, interference, and transition) and explain how each affects assembly and function
30. Analyze how Taylor's Principle governs the design of Go and No-Go gauges and improves quality control.
31. Classify the various types of gauges (plug, ring, snap, taper, profile, position, gap), and explain their specific applications
32. Compare the Bevel Protractor and the Sine Bar in terms of precision and typical angle

measurement scenarios

33. Differentiate between surface roughness and surface waviness with respect to their causes, measurement, and implications in functional performance.
34. Compare the measurement techniques of Profilograph and Talysurf, highlighting their construction, working principles, and limitations.
35. Break down a typical surface finish profile and explain how numerical values (e.g., Ra vs Rz) provide insight into process control.
36. Examine the procedures involved in performing a machine tool alignment test, and identify the instruments typically used.
37. Distinguish between the different types of CMMs (manual, DCC, portable, bridge type) in terms of design, applications, and accuracy.
38. Compare the working principles, accuracy, and applications of a toolmaker's microscope and an autocollimator
39. Evaluate the effectiveness of optical comparators in comparison to electronic and mechanical comparators.

Creating (L6)

1. Design a Go and No-Go gauge for a shaft with given tolerance values using Taylor's principle.
2. Create a comparison chart of different surface roughness parameters (Ra, Rz, RMS, Rt) including definitions, formulas, and application scenarios.

Chairperson
Board of Studies (ME)

R24HS03 Universal Human Values-Understanding Harmony & Human Ethical Conduct

(Common to CSE, CSE (DS), CSE (AI&ML), ECE, EEE, ME) **2 0 0 2**

Course Objectives:

The main objectives of the course are to:

- To enable students to recognize the vital connection between **values and skills**, emphasizing how their integration leads to lasting happiness and prosperity core aspirations shared by all human beings.
- To guide students in developing a **holistic outlook on life and profession** grounded in a deep understanding of human nature and existence. This perspective supports the cultivation of **Universal Human Values** and encourages a natural transition toward **value-based living**.
- To illustrate the practical outcomes of a holistic understanding, particularly in fostering **ethical behavior**, **trust-based and fulfilling relationships**, and **harmonious interaction with nature**.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs & PSOs											DoK
		PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	
R24HS03.1	Develop an understanding of human values.	2	2	-	-	2	3	3	2	2	-	3	L1, L2
R24HS03.2	Achieve harmony within self and body.	2	-	-	-	-	3	3	2	-	-	3	L2, L3
R24HS03.3	Build trustful and respectful relationships.	2	-	-	2	3	2	3	3	3	-	3	L3, L4
R24HS03.4	Understand harmony in nature.	2	2	-	-	-	3	3	2	2	-	3	L4, L5
R24HS03.5	Practice ethical and value-based living.	2	2	-	-	2	2	3	2	2	-	3	L5, L6

SYLLABUS

Unit I: Introduction to Value Education (6 lectures and three tutorials for practice session)

Lecture 1: Introduction to Human Development – Physical, Emotional, and Intellectual Dimensions

Lecture 2: Core Concepts of Value Education in Contemporary Society

Tutorial 1: Practice Session PS1 – Reflective Sharing on Life Values and Personal Experiences

Lecture 3: Self-awareness and Self-exploration: Tools for Inner Clarity

Lecture 4: Aspirations of the Human Being – Joy, Fulfillment, and Meaning

Tutorial 2: Practice Session PS2 – Exploring Self-awareness and Emotional Intelligence

Lecture 5: Challenges to Human Fulfillment in Modern Life

Lecture 6: Mindfulness and Ethical Decision-Making as a Path to Human Aspiration Fulfillment

Tutorial 3: Practice Session PS3 – Identifying Personal Ethical Dilemmas and Responses **CO's CO1**

Self-Learning Concepts: Explore how education influences the development of core human values, the significance of emotional intelligence in personal growth, the role of mindfulness in enhancing self-awareness, the impact of consumerism and modern lifestyle on ethical choices, and reflect on one's own aspirations and value system – all of which build a foundation for inner development.

Unit II: Harmony in the Human Being (6 lectures and three tutorials for practice session)

Lecture 7: Human Being: Alignment of Thoughts, Emotions, and Actions

Lecture 8: Needs and Desires: Distinguishing Between Essentials and Superfluous

Tutorial 4: Practice Session PS4 – Mind Mapping Personal Needs and Desires

Lecture 9: The Role of Body, Mind, and Consciousness in Well-being

Lecture 10: Cultivating Harmony within the Self – Practices and Techniques

Tutorial 5: Practice Session PS5 – Journaling: Tracking Inner Conflicts and Clarity

Lecture 11: Body Awareness and Physical Well-being Practices (Yoga/Meditation)

Lecture 12: Sustainable Self-Regulation and Lifestyle Choices for Health

Tutorial 6: Practice Session PS6 – Wellness and Lifestyle Assessment Activity **CO's-CO2**

Self-Learning Concepts: Understand the benefits of journaling for emotional and mental clarity, examine the relationship between diet, exercise, and mental well-being, explore how to identify and manage sources of stress, study the scientific basis of meditation and mindfulness, and create a personalized routine for achieving physical and emotional balance – fostering harmony within the self.

Unit III: Harmony in the Family and Society (6 lectures and three tutorials for practice session)

Lecture 13: Foundations of Healthy Relationships – Emotional and Ethical Dimensions

Lecture 14: Cultivating Trust and Empathy in Family and Social Contexts

Tutorial 7: Practice Session PS7 – Role-play on Building Trust in Relationships

Lecture 15: Respect and Empathy – Cornerstones of Human Interaction

Tutorial 8: Practice Session PS8 – Group Activity: Expressing Respect in Conversations

Lecture 16: Conflict Resolution and Emotional Safety in Social Interaction

Lecture 17: Principles of Ethical Leadership and Community Engagement

Lecture 18: Global Citizenship and Social Justice in the Modern World

Tutorial 9: Practice Session PS9 – Simulation: Creating a Model Ethical Society **CO's-CO3**

Self-Learning Concepts: Learn how to practice active listening and empathy, recognize and overcome personal biases in relationships, analyze inspiring examples of ethical leadership and community service, understand the concept of emotional safety in interpersonal dynamics, and explore the role of volunteerism in building a responsible and connected society – enhancing harmony in relationships and the social fabric.

Unit IV: Harmony in the Nature/Existence (4 lectures and two tutorials for practice session)

Lecture 19: Ecological Intelligence and Human-Nature Relationship

Lecture 20: Sustainability and Resource Responsibility – A Human Imperative

Tutorial 10: Practice Session PS10 – Case Study: Local Environmental Issue & Action Plan

Lecture 21: Systems Thinking – Viewing Nature as an Interconnected Whole

Lecture 22: Eco-Spirituality and the Harmony of Existence

Tutorial 11: Practice Session PS11 – Nature Walk + Reflection on Human-Nature Coexistence

CO's-CO4

Self-Learning Concepts: Study the principles of minimalism as a lifestyle for environmental consciousness, calculate and reduce your carbon footprint, compare environmental issues in urban and rural areas, explore sustainable agriculture and local food movements, and research the involvement of youth in global climate action – deepening your understanding of harmony with nature.

Unit V: Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and tutorials for practice session)

Lecture 23: Personal Integrity and Professional Ethics – Building the Link

Lecture 24: Ethics in the Digital Age – Responsibility and Cyber Citizenship

Tutorial 12: Practice Session PS12 – Case Analysis: Ethical Dilemma in Technology Use

Lecture 25: Humanistic Leadership and Social Entrepreneurship

Lecture 26: Corporate Social Responsibility and Sustainable Business Models

Tutorial 13: Practice Session PS13 – Designing a Value-based Startup Idea

Lecture 27: Innovation with Purpose: Case Studies in Ethical Innovation

Lecture 28: Life Planning and Career Pathways Anchored in Values

Tutorial 14: Practice Session PS14 – Action Plan: Aligning Career with Core Human Values

CO's-CO5

Self-Learning Concepts: Explore ethical concerns in the digital age such as data privacy and responsible AI use, understand the concept of human-centered design in business, study successful examples of green and socially responsible enterprises, formulate your own personal code of ethics, and analyze real-life ethical dilemmas encountered in the workplace – promoting value-based professionalism and ethical living.

Practice Sessions for UNIT I – Introduction to Value Education

PS1 Sharing about Oneself

PS2 Exploring Human Consciousness

PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being

PS4 Exploring the difference between the Needs of the self and body

PS5 Exploring Sources of Imagination in the Self

PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust

PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to Fulfill Human Goals

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Board of Studies: Master of Business Administration
Approved in BoS No: 02, 13th May, 2025
Approved in ACM No: 02

Text Book and Teachers Manual

1. **R R Gaur, R Asthana, G P Bagaria**, A Foundation Course in Human Values and Professional
2. Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 **R R Gaur, R Asthana, G P Bagaria**, Teachers' Manual for A Foundation Course in Human
3. Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books:

1. **JeevanVidya: EkParichaya**, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. **Human Values, A.N. Tripathi**, New Age Intl. Publishers, New Delhi, 2004.
3. **The Story of Stuff** (Book).
4. **The Story of My Experiments with Truth** - by Mohandas Karamchand Gandhi
5. **Small is Beautiful** - E. F Schumacher.
6. **Slow is Beautiful** - Cecile Andrews
7. **Economy of Permanence** - J C Kumarappa
8. **Bharat Mein Angreji Raj** – PanditSunderlal
9. **Rediscovering India** - by Dharampal
10. **Hind Swaraj or Indian Home Rule** - by Mohandas K. Gandhi
11. **India Wins Freedom** - Maulana Abdul Kalam Azad
12. **Vivekananda** - Romain Rolland (English)
13. **Gandhi** - Romain Rolland (English)

Web References:

1. **https://www.uhv.org.in/uhve**

2. https://fdp-si.aicte-india.org/UHVII.php
3. https://www.aicte-india.org/sites/default/files/Model_Curriculum/Minor%20Degree%20in%20UHV.pdf

Mode of Conduct:

1. Lecture hours are to be used for interactive discussion, where proposals about the topics are to be made and students are to be motivated to reflect, explore, and verify them.
2. Tutorial hours are to be used for practice sessions.
3. While analyzing and discussing the topic, the faculty mentor's role is to point to essential elements to help sort them out from the surface elements. In other words, it allows the students to explore the critical components.
4. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with oneself and do self-observation, self-reflection, and self-exploration.
5. Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" rather than" extraordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors in a group setting.
6. Tutorials (experiments or practical) are essential for the course. The difference is that the laboratory is part of everyday life; it is helpful in how you behave and work in real life. Worksheets, home assignments, and/or activities are included depending on the nature of the topics.
7. The practice sessions (tutorials) would also support student in performing actions commensurate to their beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on fundamental human values.
8. It is recommended that this content be placed before the student as it is, in the form of an introductory foundation course, without including anything else or excluding any part of this content. Additional content maybe offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Internal Assessment Pattern

Cognitive Level	Internal Assessment # 1 (%)	Internal Assessment # 2 (%)
L1	15	-
L2	34	-
L3	34	15
L4	17	34
L5	-	34
L6	-	17
Total (%)	**100**	**100**

Sample Short and Long Answers to Questions of Various Cognitive Levels

L1: Remember

1. What is meant by Natural Acceptance?
2. Define Right Understanding.
3. List the four orders of nature.
4. What are the basic human aspirations?
5. State the meaning of Sanyam (self-regulation).
6. What is meant by prosperity?
7. Name the two parts of a human being.
8. What is the role of the body according to Value Education?
9. List the feelings essential in human-to-human relationships.
10. What is meant by co-existence?

L2: Understand

1. Explain the relationship between Right Understanding and Relationship.
2. Describe the harmony between the self and the body.
3. Interpret the concept of continuous happiness and prosperity.
4. Discuss the difference between the needs of the self and the body.
5. Explain the meaning of justice in relationships.
6. Describe the importance of self-exploration.
7. Clarify the concept of mutual fulfillment in nature.
8. Discuss how education helps in holistic development.
9. Explain the vision of a universal human order.
10. Describe what is meant by 'respect' as the right evaluation.

L3: Apply

1. Apply the concept of Natural Acceptance in making ethical decisions.
2. Illustrate harmony in the family with an example from your own life.
3. Demonstrate how you can practice self-regulation in your daily routine.
4. Use the idea of mutual fulfillment in a plan for an eco-friendly campus.
5. Apply the idea of Right Understanding to resolve a conflict.
6. Show how holistic development can be integrated into your lifestyle.
7. Implement practices that promote harmony in your social group.
8. Use the concept of the body as an instrument to improve physical health.
9. Plan a group activity that promotes trust and respect.
10. Apply the principles of co-existence in managing natural resources.

L4: Analysing

1. Differentiate between happiness and prosperity with examples.
2. Analyze the role of the self and body in human behavior.
3. Compare trust and respect in family relationships.
4. Examine how lack of Right Understanding leads to disharmony.
5. Distinguish between self-regulation and external regulation.
6. Investigate the root causes of conflict in society.
7. Analyze the systems in nature that demonstrate harmony.
8. Examine how justice arises from mutual fulfillment.

9. Break down the structure of a universal human order.
10. Explore the interconnection between individual values and societal peace.

L5: Evaluating

1. Evaluate the relevance of Value Education in modern society.
2. Assess the impact of materialism on human happiness.
3. Judge the effectiveness of education in achieving holistic development.
4. Critique current societal systems in light of natural co-existence.
5. Appraise the role of mutual trust in building strong relationships.
6. Defend the need for harmony at all levels of human existence.
7. Evaluate the importance of distinguishing between self and body.
8. Justify the inclusion of Value Education in professional courses.
9. Compare the traditional vs. modern views on personal success.
10. Argue whether self-exploration is sufficient for understanding human values.

L6: Create and Develop

1. Design a value-based weekly routine for students.
2. Construct a model society based on mutual trust and justice.
3. Formulate strategies to integrate value education into school curricula.
4. Develop a plan for promoting harmony in a multicultural community.
5. Compose an essay on the role of harmony in personal and professional life.
6. Create a campaign to raise awareness on sustainable coexistence with nature.
7. Design a self-assessment tool for personal value alignment.
8. Develop a short workshop on self-exploration for college students.
9. Write a story that illustrates the principles of Right Understanding.
10. Create a visual mind map connecting harmony at the individual, family, and societal levels.

Chairperson
Board of Studies (MBA)

R24MEPC12 **Fluid Mechanics & Hydraulic Machinery Lab** **0 0 3 1.5**

(Mechanical Engineering)

Course Objectives:

- To give the practical exposure about fundamentals of fluid mechanics and hydraulics.
- To provide practical knowledge about the turbo-machinery
- To provide practical knowledge about the centrifugal pump and reciprocating pump.

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO4	PO5	PO8	PSO1	PSO2
R24MEPC12.1	Conduct experiments to evaluate the impact of jets and performance of impulse turbines (e.g., Pelton wheel).	3	2	1	3	2	1	1	2
R24MEPC12.2	Analyze and interpret the performance characteristics of reaction turbines such as Francis and Kaplan turbines.	3	2	1	3	2	2	1	2
R24MEPC12.3	Evaluate the efficiency and operational behavior of various pumps and flow meters used in fluid systems.	3	2	1	3	2	2	1	2

List of Experiments

1. Impact of jets on Vanes. C**O's: CO1**
2. Performance Test on Pelton Wheel. **CO's: CO1**
3. Performance Test on Francis Turbine. **CO's: CO2**
4. Performance Test on Kaplan Turbine. **CO's: CO2**
5. Performance Test on Single Stage Centrifugal Pump. **CO's: CO3**
6. Performance Test on Multi Stage Centrifugal Pump. **CO's: CO3**
7. Performance Test on Reciprocating Pump. **CO's: CO3**
8. Calibration of Venturi meter. **CO's: CO3**
9. Calibration of Orifice meter. **CO's: CO3**
10. Determination of friction factor for a given pipeline. **CO's: CO3**
11. Determination of loss of head due to sudden contraction in a pipeline. **CO's: CO3**
12. Turbine flow meter. **CO's: CO3**

Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html)

2. To calculate Total Energy at different points of venture meter. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html).
3. To calculate the flow (or point) velocity at center of the given tube using different flow rates. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html)
4. To determine the hydrostatic force on a plane surface under partial submerge and full submerge condition. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/cop/introduction.html).
5. To determine the discharge coefficient of a triangular notch. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html)
6. To determine the coefficient of impact of jet on vanes. (https://fm-nitk.vlabs.ac.in/exp/impact-of-jet).
7. To determine friction in pipes. (https://fm-nitk.vlabs.ac.in/exp/friction-in-pipes/index.html).

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Sample Experiments

1. What is the function of a Pelton wheel?
2. Define manometric efficiency of a pump.
3. What is the formula for discharge through a Venturimeter?
4. What is the difference between a turbine and a pump?
5. Name the types of losses that occur in pipelines.
6. Explain the working principle of a Kaplan turbine.
7. How does a centrifugal pump convert mechanical energy into pressure energy?
8. Describe the significance of impact of jet experiment.
9. Why is the Francis turbine classified as a reaction turbine?
10. What happens when sudden contraction occurs in a pipe?
11. How do you calculate the efficiency of a Pelton wheel from experimental data?
12. Apply Bernoulli's theorem to explain how a Venturimeter works.
13. How would you determine the discharge in a turbine flowmeter?
14. How is the friction factor calculated using the Darcy-Weisbach equation?
15. How can the slip of a reciprocating pump be calculated?
16. Compare the working principles of Pelton and Francis turbines.
17. How do performance curves differ between single-stage and multi-stage centrifugal pumps?
18. Why does cavitation occur in pumps and how can it be identified experimentally?
19. What differences would you expect in head loss due to sudden contraction vs friction loss?

20. Analyze the effect of vane angle on force exerted by a jet.
21. Justify the use of a Kaplan turbine in low head applications.
22. Interpret the pump performance curves and suggest reasons for efficiency drop.
23. Assess why turbine flowmeters are preferred in specific applications.
24. Evaluate the suitability of reciprocating pumps for high-pressure applications.
25. Why should orifice meters not be used for highly viscous fluids?

Chairperson

Board of Studies (ME)

R24MEPC13 **Theory of Mechanics Lab** **0 0 3 1.5**

(Mechanical Engineering)

Course Objectives:

- Determine natural and forced vibration frequencies and Analyze whirling of shafts and gyroscopic motion.
- Perform static and dynamic balancing and Study and interpret motion in governors, cams, and slider-crank/four-bar mechanisms
- Experiment with belts, pulleys, and gears to understand friction and gear characteristics and demonstrate teamwork and manage projects effectively.

Course Code	Course Outcomes	Mapping with POs and PSOs										
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PSO1**	**PSO2**
R24MEPC13.1	Apply fundamental principles of vibrations, gyroscopic effects, and mechanical balancing to analyze the performance of machine elements.	3	3		2	3	2			2	3	
R24MEPC13.2	Analyze the working and motion characteristics of mechanical systems such as governors, cams, linkages, and power transmission elements.	3		3	2	2		2			3	2
R24MEPC13.3	Demonstrate effective teamwork, communication, and problem-solving skills through project-based learning.	3	2		3	2			2	2	3	2

List of Experiments:

1. To determine whirling speed of shaft theoretically and experimentally. **CO's: CO1**
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation. **CO's: CO1**
3. To analyze the motion of a motorized gyroscope when the couple is applied along its spin axis **CO's: CO1**
4. To determine the frequency of undamped free vibration of an equivalent spring mass system. **CO's: CO1**
5. To determine the frequency of damped force vibration of a spring mass system

CO's: CO1

6. To study the static and dynamic balancing using rigid blocks. **CO's: CO1**
7. To plot follower displacement vs cam rotation for various Cam Follower systems.

CO's: CO2

8. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism **CO's: CO3**
9. To find coefficient of friction between belt and pulley. **CO's: CO3**
10. To study various types of gears- Spur, Helical, Worm and Bevel Gears **CO's: CO2**
11. Study of friction clutches and brakes. **CO's: CO2**
12. To determine the position of sleeve against controlling force and speed of a Proell governor and to plot the characteristic curve of radius of rotation. **CO's: CO2**
13. To verify the Dunkerley's Rule **CO's: CO3**
14. To experimentally determine the mechanical advantage (MA) of a compound pulley system and compare it with the theoretical value. **CO's: CO3**

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

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Text Books:

1. "Theory of Machines" by S.S. Rattan
2. "Theory of Machines and Mechanisms" by Joseph E. Shigley and John U. Ood
3. "Applied Mechanism and Machine Theory" by C.M. Gupta and P.K. Khurmi

Reference Books:

1. "Theory of Machines and Mechanisms" by Jagdish Lal
2. "Theory of Machines" by R.S. Khurmi and J.K. Gupta
3. "Machine Design: An Integrated Approach" by Robert L. Norton

Virtual Lab:

1. **Mechanical Engineering Labs**: https://www.vlab.co.in/broad-area-mechanical-engineering vlab.co.in+2vlab.co.in+2Wikipedia+2
2. **Dynamics of Machines Lab**: https://dom-nitk.vlabs.ac.in/iitb.vlabs.co.in+4dom-nitk.vlabs.ac.in+4mm-nitk.vlabs.ac.in+4
3. **Mechanics of Machines I Lab**: https://mm-nitk.vlabs.ac.in/mm-nitk.vlabs.ac.in

Sample Questions:

1. What is whirling speed?
2. What is the function of a Hartnell governor?
3. What is gyroscopic precession?
4. What is natural frequency?
5. What is damping?
6. What is the difference between static and dynamic balancing?
7. What is a cam follower system?
8. What is a slider-crank mechanism?
9. What is the coefficient of friction?
10. Name different types of gears.
11. What are friction clutches and brakes?
12. Explain why a shaft vibrates at its whirling speed.
13. Explain the relationship between sleeve position, controlling force, and speed in a Hartnell governor.
14. Explain how a motorized gyroscope reacts to an applied couple.
15. Explain the concept of undamped free vibration.
16. Explain the concept of damped forced vibration.
17. Explain the importance of balancing rotating masses.
18. Explain the relationship between cam profile and follower motion.
19. Explain the relationship between crank rotation and slider displacement.
20. Explain how friction affects power transmission in a belt drive.
21. Explain the working principle of different gear types.
22. Explain the working principles of friction clutches and brakes.
23. How would you calculate the whirling speed of a shaft in a specific industrial application?
24. How would you adjust a Hartnell governor to maintain a desired engine speed?
25. How would you apply the principles of gyroscopic motion in the design of a navigation system?
26. How would you determine the natural frequency of a spring-mass system?
27. How would you determine the frequency of damped forced vibration in a system?
28. How would you balance a rotating component using rigid blocks?
29. How would you plot a follower displacement diagram for a given cam profile?
30. How would you plot the displacement, velocity, and acceleration curves for a slider?
31. How would you determine the coefficient of friction between a belt and pulley?

32. How would you calculate the gear ratio for a gear train?
33. How would you calculate the torque capacity of a friction clutch?
34. Analyze the factors that affect the whirling speed of a shaft.
35. Analyze the characteristic curve of a Hartnell governor.
36. Analyze the effects of varying the applied couple on the motion of a gyroscope.
37. Analyze the factors that affect the natural frequency of a vibration system.
38. Analyze the effects of damping on the vibration response of a system.
39. Analyze the effects of unbalance on the vibration of a rotating machine.
40. Analyze the effects of different cam profiles on follower motion.
41. Analyze the motion characteristics of a slider-crank or four-bar mechanism.
42. Analyze the factors that affect the coefficient of friction in a belt drive.
43. Analyze the advantages and disadvantages of different gear types.
44. Analyze the factors that affect the performance of friction clutches and brakes.
45. Evaluate the importance of considering whirling speed in the design of high-speed rotating machinery.
46. Evaluate the advantages and disadvantages of using a Hartnell governor compared to other types.
47. Evaluate the impact of gyroscopic effects on the stability of rotating machinery.
48. Evaluate the importance of knowing the natural frequency of a machine component.
49. Evaluate the effectiveness of different damping methods in reducing vibrations.
50. Evaluate the effectiveness of different balancing methods.
51. Evaluate the suitability of different cam follower systems for specific applications.
52. Evaluate the advantages and disadvantages of using these mechanisms in different applications.
53. Evaluate the efficiency of different belt drive systems.
54. Evaluate the suitability of different gear types for specific applications.
55. Evaluate the suitability of different friction clutches and brakes for specific applications.
56. Design a system to prevent or mitigate the effects of whirling in a long shaft.
57. Design a modified Hartnell governor for a specific industrial application with unique speed control requirements.
58. Design a gyroscopic stabilizer for a ship or aircraft.
59. Design a system to minimize undamped free vibrations in a given situation.
60. Design a damping system for a machine to reduce vibrations caused by external forces.
61. Design a balancing procedure for a complex rotating assembly.

62. Design a cam profile to achieve a specific follower motion.
63. Design a slider-crank or four-bar mechanism for a specific application.
64. Design a belt drive system for a specific power transmission requirement.
65. Design a gear train for a specific speed reduction or torque multiplication.
66. Design a friction clutch or brake system for a specific application.

Chairperson
Board of Studies (ME)

R24MESC02 **Drones & Digital Fabrication Lab** **0 0 3 1.5**

(Mechanical Engineering)

Course Objectives:

- To provide hands-on experience with 3D modeling and FDM-based 3D printing technologies.
- To introduce basic drone hardware, safety protocols, and flight operations.
- To build familiarity with design-to-manufacturing workflows using additive manufacturing.

Course Code	Course Outcomes	Mapping with POs and PSOs						
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
R24MESC02.1	Create simple 3D models and print them using FDM printers.	3	2	3	2	3	2	1
R24MESC02.2	Understand and operate FDM 3D printers and engraving machines.	3	2	2	2	3	2	2
R24MESC02.3	Assemble and operate basic drones for manual control and testing.	2	2	3	3	2	1	2

List of Experiments

3D Modeling & Printing (Any 7):

1. Introduction to CAD software and modeling a keychain. **CO's: CO1**
2. Designing and printing a gear mechanism. **CO's: CO1**
3. Modeling and printing a mobile stand. **CO's: CO2**
4. Creating and printing a threaded fastener (bolt and nut). **CO's; CO2**
5. Designing a box with a snap-fit lid and printing. **CO's: CO1**
6. Printing a small mechanical linkage (e.g., four-bar mechanism). **CO's: CO2**
7. Engraving a nameplate or logo using the engraving machine. **CO's: CO2**

Drone-Based Experiments (Any 4–6):

1. Study of drone components and assembling a basic quadcopter. **CO's: CO3**
2. Safety precautions and pre-flight checklist demonstration. **CO's: CO3**
3. Manual flying of a drone in a confined indoor space. **CO's: CO3**
4. Measuring hover stability and battery performance. **CO's: CO3**

Virtual Lab:

1. Virtual 3D Printing Simulation lab using Vlabs. https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html
2. Simulation of drone flight path using DroneSim Pro or similar tools – https://www.dronesimpro.com

3. Virtual slicing and G-code simulation using Cura – https://ultimaker.com/software/ultimaker-cura
4. Simulation of drone flight path using open-source software

Board of Studies: Mechanical Engineering

Approved in BOS No: 02, 13th May, 2025

Approved in ACM No: 02

Sample Experiments

1. Define FDM in 3D printing.
2. Name basic components of a quadcopter.
3. What is STL file format?
4. What is the use of slicing software?
5. Explain the working of an FDM printer.
6. Describe the role of propellers in drone stability.
7. Why is support structure used in 3D printing?
8. How does a drone maintain hover?
9. Design a simple 3D printable tool holder.
10. Calibrate the bed level on an Ender 3 printer.
11. Manually control a drone to navigate a basic path.
12. Compare PLA and ABS materials in 3D printing.
13. Analyze slicing settings affecting print quality.
14. Compare indoor and outdoor flight behaviors of a drone.
15. Evaluate the performance of a drone in hovering test.
16. Suggest design modifications for improving 3D print accuracy.
17. Assess the feasibility of using a drone for simple delivery tasks.
18. Design and print a custom-fit part to improve drone balance.
19. Develop a 3D printed prototype of a wearable/mechanical tool.

Chairperson
Board of Studies (ME)

R24HS05 Numerical Ability & Professional Communication skills 0 0 2 1
(Common to all UG Programmes)

Course Objectives:

1. **Develop problem-solving skills**: Students will be able to apply numerical concepts and techniques to solve problems in various contexts.
2. **Enhance data analysis skills**: Students will be able to collect, analyze, and interpret numerical data to inform decision-making.
3. **Develop effective communication skills**: Students will be able to communicate effectively in various professional settings, including verbal and non-verbal communication.
4. **Improve presentation skills**: Students will be able to deliver clear, concise, and engaging presentations to different audiences.
5. **Enhance writing skills**: Students will be able to write clear, concise, and well-structured professional documents, such as reports, emails, and memos.
6. **Develop interpersonal skills**: Students will be able to build and maintain effective relationships with colleagues, clients, and stakeholders.

At the end of the course, students will be able to:

Course Code	Course Outcomes	PO1	PO7	PO9	P011	Dok
R24HS05.1	Use their logical thinking and analytical abilities to solve Quantitative aptitude questions from company specific and other competitive tests..	2	---	---	---	L4
R24HS05.2	Solve questions related to time and distance and time and work etc. from company specific and other competitive tests.	1	---	---	---	L5
R24HS05.3	Comprehend the essentiality of LSRW skills in paper presentations, seminars, workshops, conferences etc. with teams and to solve different types of questions based on vocabulary, structure, grammar and verbal reasoning.	2	2	3	1	L1, L2
R24HS05.4	Attain the knowledge of soft skills in various conditions, Solve questions based on sentence completion and fill in the blanks	---	1	3	---	L2, L3
R24HS05.5	Explore diverse fields through English , To solve different types of questions based on vocabulary, structure, grammar and verbal reasoning	---	---	3	---	L4

SYLLABUS

UNIT-I: Numerical computation **15 Hours**

Application based on Numbers –Classification of Number System, Prime and Composite, Even and Odd Numbers, Divisibility Rule, BODMAS Rule, Unit digit, fractions, LCM &HCF**.** Percentages and its Applications, Profit Loss and Discount, Simple interest and Compound interest. Averages, Ratio Proportion, Application of Ratios**,** Partnerships, Shares and dividends.

Self Learning Topic: Problems on Ages

UNIT-II: Numerical Estimation **15 Hours**

Time and work, Application of Time-work (pipes and cisterns) , Time and Distance, circular Tracking, concept of Boats & steams. Mixtures and allegations, application of percentage and Ratios and Averages in Mixtures

Self Learning Topic: Problems on Trains

UNIT-III **5 Hours**

Abstract Preparation – Noticing Key Words –Literature Survey – Using Academic Verbs Verbal Ability: Sentence correction, Resume Writing and Cover letter

Self Learning Topic: Project Report

UNIT-IV **5 Hours**

Organizational Skills – Time Management – IELTS Test Papers Exercises Verbal Ability: sentence completion

Self Learning Topic: Jumbled Sentences

UNIT-V **5 Hours**

Analogy, origin of Words, Idioms and phrases, MNC's question papers Verbal Ability: Error Identification

Self Learning Topic: Speaking and writing diction (Choice of Words)

Board of Studies: MBA
Approved in BOS No: 02, 13th May, 2025
Approved in ACM No: 02

Text Books:

1. Quantitative Aptitude for competitive examinations by R.S.Agrawal - S.Chand publications.
2. Business Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishna – Himalaya publishing house

Reference Books:

1. Numerical Aptitude and Reasoning Ability tests in Competitive exams by Prof.A.Balasubramanian.
2. Numerical Ability and Mathematical Aptitude by Dr.A.B.Rao
3. Communication skills and soft skills by E.Suresh Kumar , p.sreehari & j.savithri

Web References:

1. https://faceprep.in/ logical reasoning

2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions from Numerical Ability

1. What is the unit digit of 2^10?
2. Find the unit digit of 17^5.
3. What is the unit digit of 3 × 7 × 9 × 11?
4. Determine the unit digit of 123^4.
5. Find the unit digit of 2^20 + 3^15.
6. Is 432 divisible by 3?
7. Check if 756 is divisible by 9.
8. Determine if 1240 is divisible by 8.
9. Is 531 divisible by 11?
10. Check if 2700 is divisible by 15.
11. Simplify: 2 × 3 + 12 ÷ 4 - 5
12. Evaluate: 18 - 3 × 2 + 12 ÷ 4
13. Simplify: 9 + 8 ÷ 2 × 3 - 1
14. Evaluate: 15 - 2 × 3 + 8 ÷ 2
15. Simplify: 24 ÷ 4 × 2 + 10 – 3
16. Find the HCF of 12 and 18.
17. Determine the HCF of 24 and 30.
18. The HCF of two numbers is 6 and their LCM is 72. What are the two numbers?
19. The LCM of two numbers is 120 and their HCF is 10. If one of the numbers is 24, what is the other number?
20. A shirt is marked at $80 and sold at a 20% discount. What is the selling price?
21. A student scored 75% marks in an exam. If the total marks were 200, how many marks did the student score?
22. A number is increased by 25% and then decreased by 10%. What is the net percentage change?
23. A book is bought for $50 and sold for $60. What is the profit percentage?
24. A shopkeeper sells an item at a 15% loss. If the cost price is $100, what is the selling price?
25. A person buys a product for $80 and sells it for $100. What is the profit percentage?
26. Find the simple interest on $1000 at 5% per annum for 2 years.
27. A sum of money amounts to $1200 in 3 years at 8% per annum simple interest. What is the principal amount?
28. What is the rate of interest if a sum of $500 amounts to $600 in 4 years at simple interest?

Model Questions from professional communication skills

1. You're working with a team member who has a different work style. How would you adapt your communication approach?
2. A client is unhappy with the project's progress. How would you handle the situation?
3. You're part of a team, and there's a conflict between two members. How would you facilitate a resolution?
4. How would you use body language to convey confidence during a presentation?
5. You're in a virtual meeting, and your internet connection is unstable. How would you

handle the situation?

6. You're meeting a client for the first time. What nonverbal cues would you use to build rapport?
7. You're presenting a project update to a client. How would you structure your presentation to ensure effective communication?
8. A colleague is not meeting their deadlines, affecting the team's project timeline. How would you approach the conversation?
9. You're in a meeting, and a team member is dominating the discussion. How would you politely intervene?
10. You're tasked with writing a report on a project's progress. How would you structure the report?

Chairperson
Board of Studies (MBA)

R24ES13 **Design Thinking & Innovation** **0 1 2 2**

(Common to All Branches)

Course Objectives:

1. The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation.
2. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

Course Code	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO9	PO10	PO11	PSO1	PSO2	DOK
R24ES13.1	Define the concepts related to design thinking. Explain the fundamentals of Design Thinking and innovation	3	3	2	2	2	-	1	2	2	2	L1, L2
R24ES13.2	Apply the design thinking techniques for solving problems in various sectors.	3	3	3	2	3	-	1	2	3	3	L3
R24ES13.3	Analyse to work in a multidisciplinary environment	3	3	3	2	3	-	-	2	3	3	L4
R24ES13.4	Evaluate the value of creativity	3	2	3	2	3	1	1	3	3	3	L5
R24ES13.5	Formulate specific problem statements of real time issues	3	2	3	2	3	1	1	3	3	3	L3, L6

SYLLABUS

UNIT-I **10 Hours**

Introduction to Design Thinking: Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry. **CO's: CO1**

UNIT-II **10 Hours**

Design Thinking Process: Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development. **CO's: CO2**

UNIT-III **10 Hours**

Innovation: Art of innovation, Difference between innovation and creativity, role of creativity and

innovation in organizations- Creativity to Innovation- Teams for innovation- Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation. **CO's: CO3**

UNIT IV **10 Hours**

Product Design: Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications- Innovation towards product design- Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

CO's: CO4

UNIT V **10 Hours**

Design Thinking in Business Processes: Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs- Design thinking for Startups- Defining and testing Business Models and Business Cases- Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

CO's: CO5

Board of Studies: Mechanical Engineering

Approved in BOS No: 02,13th May, 2025

Approved in ACM No: 02

Text Books:

1. Tim Brown,Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons..

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritinaholden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)

L1	10	--
L2	30	--
L3	30	20
L4	30	30
L5	--	30
L6	--	20
Total (%)	**100**	**100**

Chairperson
Board of Studies (ME)

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

(Approved by A.I.C.T.E., New Delhi & Permanently Affiliated to JNTU-GV, Vizianagaram)
NAAC "A+" Accredited Institute
Cherukupally (Village), Near Tagarapuvalasa Bridge, Vizianagaram (Dist), AP, Pin -531162.
www.aietta.ac.in, principal@aietta.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

Program: **B.Tech- Mechanical Engineering** **Regulation: R24**

Course Structure: III Year I Semester (or) Semester-V

S. No	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	PC	R24MEPC14	Design of Machine Members	3	0	0	3
2	PC	R24MEPC15	Thermal Engineering	3	0	0	3
3	HS	R24HS08	Managerial Economics and Financial Accounting	2	0	0	2
4	PE-I	R24MEPE01 R24MEPE02 R24MEPE03 R24MEPE04 R24MEPE05	1. Instrumentation and Control Systems 2. Nano Technology 3. Design for manufacturing 4. Joining Processes 5. 12 Week MOOCS Swayam/NPTEL Course recommended by the BoS	3	0	0	3
5	OE-I	R24MEOE01 R24MEOE02 R24MEOE03 R24MEOE04 R24MEOE05	1. Principles of Robotics 2. Manufacturing Technology 3. Introduction to Hybrid Vehicles 4. Fundamentals of Thermodynamics 5. Engineering Materials	3	0	0	3
6	PC	R24MEPC16	Thermal Engineering Lab	0	0	3	1.5
7	SC	R24MESC03	Python programming Lab	0	1	2	2
8	PC	R24MEPC17	Machine Tools & Metrology Lab	0	0	3	1.5
9	HS	R24HS07	Quantitative Aptitude and Effectual Communication Skills	0	0	2	1
10	CSP	R24MECSP01	Evaluation of Community Service Project	0	0	0	1
			Total	**14**	**00**	**10**	**21**

Category	Courses	Credits
PC- Professional Core Courses	4	9
PE- Professional Elective Courses	1	03
OE- Open Elective Courses	1	03
HS- Humanity Science and Management Courses	2	03
SC- Skill Oriented Courses	1	2
CSP- Community Service Project	1	01
Total	10	21

R24MEPC14 **Design of Machine Members** **3 0 0 3**

(Design Data Handbook required)

(Professional Core)

Course Objectives:

1. **To apply** the various design procedures, principles and various stresses in the design of machine elements. To apply different materials of construction and their properties and factors determining the selection of material for various applications
2. **To develop** good and careful problem formulation and solution skills for designing selected machine components and systems
3. **To learn** the design of temporary and Permanent Joints.
4. **To impart** fundamental knowledge of belt drives, gears and shaft couplings, and to develop the ability to model and analyze these power transmission elements for reliable and economical mechanical systems
5. **To Design** mechanical springs by evaluating stresses, deflections, and energy storage under different loading scenarios.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC 14.1	Analyse stresses and material behavior in basic machine parts	3	2	2	2	1	-	-	-	-	1	1	2	1	L1 L2
R24MEPC 14.2	Design elements for fatigue and fluctuating loading	3	2	3	2	1	-	-	-	-	2	1	2	2	L2 L3
R24MEPC 14.3	Design and evaluate fasteners and welded joints	3	2	3	1	1	-	-	-	-	2	1	3	2	L3 L4
R24MEPC 14.4	Analyze and solve problems on belt drives, gear trains and shaft couplings for efficient mechanical power transmission in engineering applications.	3	2	2	1	1	-	-	-	-	2	1	3	2	L4 L5
R24MEPC 14.5	Analyze the stress, deflection, and energy storage behavior of helical springs under various loading conditions.	3	2	2	2	1	-	-	-	1	1	1	2	3	L5 L6

SYLLABUS

UNIT-I **14 Hours**

Fundamentals of design and Stresses in Machine Members:

Mechanical Engineering Design: General considerations in the design of Engineering Materials and their properties – selection – Manufacturing consideration in design. BIS codes of steel. Simple

stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

CO's: CO1

Self-Learning Topics: Role of stress analysis in mechanical product design and failure prevention, Basics of principal stresses and failure theories in real components, Introduction to standard IS/BIS codes for steels (IS 800, IS 2062, IS 808) and their use in selecting sections, Overview of software tools for stress analysis (ANSYS Mechanical, basic FEA demos) as extension of classroom formulas.

UNIT-II **14 Hours**

Strength of Machine Elements: Stress concentration, theoretical stress concentration factor, fatigue stress concentration factor, notch sensitivity, design for fluctuating stresses, endurance limit, estimation of endurance strength- Gerber parabola, Goodman's line, Soderberg's line, modified Goodman's line. **CO's: CO2**

Self-Learning Topics: Study of 3D kinematics and the application of lower pairs in robotics, Virtual simulation of Pantograph and Watt mechanisms

UNIT–III **12 Hours**

Fasteners (Temporary and Permanent Joints): Forms of screw threads, thread nomenclature, definition of Indian standard threads, bolts subjected to initial tension, tensile load and eccentric loading. Welded joints: Strength of welded joints, design of welded joints for static loads, eccentrically loaded welded joints. **CO's: CO3**

Self-Learning Topics: Types of temporary and permanent joints with examples; Indian standard screw thread forms and nomenclature; basic idea of bolt preload, eccentric loading of bolt/weld groups and design of fillet/butt welds for static loads

UNIT–IV **12 Hours**

Belt Drives: Types of belt drives, flat belt drives, causes of slip, creep in belts, analysis of open and crossed belt drives, centrifugal tension.

Gears: Types of Gears, nomenclature of Gears, Law of gear, Epicyclical Gear- problems.

Shaft Couplings: Rigid couplings – Muff, Split muff and Flange couplings, Universal Coupling

CO's:CO4

Self-Learning Topics: Types of belt drives and belt sections (flat, V, timing) and the phenomena of slip, creep and centrifugal tension; comparison of open vs crossed belt drives; construction and working of rigid (muff, split muff, flange) and universal couplings with typical industrial use cases.

UNIT–V **10 Hours**

Helical Springs: Types of Springs, Terminology used in Springs, Stresses in Helical Springs of Circular Wire, Deflection of Helical Springs of Circular Wire, Surge in Springs, Energy Stored in Helical Springs of Circular Wire, Springs in Series, Springs in Parallel. **CO's:CO5**

Self-Learning Topics: The types and functions of helical springs used in mechanical systems. Calculate stresses, deflection, and energy storage in circular wire springs. Compare spring behaviors in series and parallel configurations for design applications.

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. R.L. Norton, Machine Design an integrated approach, 2/e, Pearson Education, 2004.
2. V.B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
3. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

Reference Books:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F. Spotts and T.E. Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education),2013.
4. K. Mahadevan & K. Balaveera Reddy, Design data handbook, CBS Publications, 4/e, 2018.

Web References:

1. **https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-ofmachineelements-1-nptel**
2. **https://www.digimat.in/nptel/courses/video/112105124/L01.html**
3. **https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html**
4. **https://archive.nptel.ac.in/courses/112/105/112105125/**
5. **https://www.coursera.org/learn/machine-design1**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level-1: Remembering

1. Define simple stress and simple strain.
2. List the different types of stresses with one example each.
3. State the meaning of "factor of safety" in design.
4. Define stress concentration.
5. What is a fatigue stress concentration factor?
6. Define endurance limit.
7. Define temporary joint and permanent joint with one example each.
8. List the standard forms of screw threads used in machine design.
9. Define pitch and lead of a screw thread.
10. List the main types of belt drives.
11. Define slip in a belt drive.
12. Define centrifugal tension in belts.
13. Define journal bearing.
14. What is bearing modulus?

15. Define basic static load rating of a rolling bearing.

Level-2: Understanding

1. Distinguish between simple stress and combined stress with suitable examples.
2. Explain the terms ductile material and brittle material using the stress–strain curve.
3. Why are BIS codes of steels used in design?
4. Explain the causes of stress concentration in machine members with examples.
5. What is notch sensitivity? How does it affect fatigue strength?
6. Distinguish between mean stress and alternating stress.
7. Explain the term "Indian standard threads" and its importance in machine design.
8. Explain the difference between fillet weld and butt weld.
9. Why is initial tension provided in a bolted joint?
10. Distinguish between open belt drive and crossed belt drive.
11. Explain how slip affects the velocity ratio of a belt drive.
12. Differentiate between muff coupling and flange coupling.
13. Explain hydrodynamic lubrication in journal bearings.
14. Distinguish between full journal bearing and partial journal bearing.
15. Explain the term "bearing life" (L10 life) in rolling bearings.

Level-3: Applying

1. A steel rod of given diameter and length is subjected to axial tensile load; calculate the normal stress and elongation.
2. For a circular shaft subjected to bending moment and torque, determine the maximum principal stress.
3. Using any one theory of failure, check whether a component is safe under a given biaxial state of stress.
4. For a stepped shaft with a shoulder fillet, determine the theoretical stress concentration factor using given data.
5. Calculate the alternating and mean stresses for a component subjected to a fully reversed bending load.
6. Using Goodman's line, check whether a rotating shaft under given mean and alternating stresses is safe.
7. For a given bolted joint under direct tensile load, calculate the stress in the bolt.
8. Determine the size of a fillet weld for a bracket carrying a given static load.
9. Calculate the required bolt diameter for a flange coupling subjected to a specified torque.
10. For a given flat belt drive, calculate belt tensions and power transmitted.
11. Determine the maximum permissible speed of a belt considering centrifugal tension.
12. Calculate the length of a belt for open and crossed belt arrangements between two pulleys of given diameters and centre distance.
13. Using given bearing modulus and load, check whether a journal bearing operates under hydrodynamic lubrication.
14. For a given radial load and desired life, select a suitable rolling bearing from catalog data.
15. Determine the expected rating life in hours for a rolling bearing operating at a specified speed.

Level-4: Analyzing

1. Analyse the effect of a keyway on the torsional strength of a shaft.

2. For a stepped shaft carrying several loads, identify the critical section and justify your choice.
3. Compare maximum principal stress theory and maximum shear stress theory for a given stress state.
4. Analyse the effect of a drilled hole on the fatigue life of a flat plate under fluctuating tension.
5. Compare the design results obtained using Gerber, Goodman and Soderberg criteria for the same loading data.
6. Examine how changes in surface finish and size factor influence the endurance strength of a rotating shaft.
7. Analyse the load distribution in a group of bolts subjected to an eccentric shear load.
8. Compare the behavior of a riveted joint and welded joint for similar static loading.
9. Analyse possible failure modes in a fillet-welded joint loaded in shear and tension.
10. Analyse how changes in belt tension and coefficient of friction affect power transmission capacity.
11. Compare open and crossed belt drives with respect to direction of rotation, belt life and power capability.
12. Analyse the effect of angular misalignment on the performance of a rigid coupling.
13. Analyse how changes in clearance ratio affect the performance of a journal bearing.
14. Examine the influence of lubricant viscosity and speed on the load carrying capacity of a journal bearing.
15. Analyse the effect of load and reliability factor on the required dynamic capacity of a rolling bearing.

Level-5: Evaluating

1. Evaluate whether a given factor of safety is adequate for a component subjected to shock loading.
2. Justify the choice of a particular failure theory for designing a ductile shaft under combined bending and torsion.
3. Judge the suitability of a proposed material change for improving strength and stiffness of a given component.
4. Evaluate which fatigue design criterion (Gerber, Goodman, modified Goodman or Soderberg) is most suitable for a given application and justify your choice.
5. Judge the suitability of a proposed design modification (such as adding fillets or changing diameter) to improve the fatigue life of a shaft.
6. Critically comment on a design that ignores stress concentration in a highly stressed region.
7. Evaluate whether a bolted joint or a welded joint is more suitable for a given machine part, considering disassembly and load conditions.
8. Judge the adequacy of a proposed weld layout in terms of strength, accessibility and ease of fabrication.
9. Assess the suitability of using high-tensile bolts instead of mild-steel bolts for a given joint.
10. Evaluate whether a belt drive or a gear drive is more suitable for a given application (speed, power and distance).
11. Judge the suitability of a proposed coupling selection for a high-speed shaft considering balancing, alignment and maintenance.

12. Comment on a proposed change in belt material and width for improving reliability of a drive.
13. Evaluate the suitability of using journal bearings instead of rolling bearings in a high-speed machine.
14. Judge whether the selected bearing (type and size) is appropriate for the stated load, speed and life requirement of an application.
15. Critically comment on operating a bearing beyond its rated life and load capacity.

Chairperson

Board of Studies (ME)

R24MEPC15 **THERMAL ENGINEERING** **3 0 0 3**
(Professional Core)

Course Objectives:

1. **To understand** the working principles, classification, and performance analysis of Internal Combustion engines**,** including SI and CI engines.
2. **To study** the Rankine cycle and analyze the operation and efficiency of boilers used in power plants.
3. **To analyze** the working and performance characteristics of nozzles, steam turbines, and condensers used in thermal engineering systems.
4. **To analyze** the performance of reciprocating and rotary compressors**,** including efficiency and multistage compression.
5. **To understand** the Brayton cycle and the working of various jet propulsion systems**.**

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC15 .1	Explain the working principles of SI and CI engines**,** analyze valve-timing diagrams, and evaluate engine performance using various testing methods and performance parameters.	3	2	1	3	1	1	_	_	1	_	1	1	3	L1 L2
R24MEPC15 .2	Analyze the Rankine cycle and vapour power systems**,** evaluate the effect of operating conditions on efficiency, and distinguish between different types of boilers and their applications.	3	2	2	1	–	2	_	_	1	_	1	1	3	L1 L2

R24ME PC15 .3	Apply the concepts of nozzles, steam turbines, and condensers to evaluate. Performance, characteristics, efficiency, governing methods, and condenser operations in thermal systems.	3	2	1	1	–	1	_	_	1	_	1	1	3	L3 L4
R24ME PC15 .4	Analyze the performance of reciprocating and rotary compressors, calculate efficiencies, and evaluate the effects of clearance volume and multistage compression.	3	2	2	1	2	1	_	_	1	_	1	3	2	L3 L4
R24ME PC15 .5	Explain and analyze gas turbine cycles and jet propulsion systems**,** including performance improvement techniques and comparison of different jet engines.	3	2	2	1	–	2	_	_	1	_	1	2	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

I.C. Engines: Classification, Working of SI & CI, two and four stroke engines – Ideal and actual valve timing diagrams – Comparison of ideal and actual air standard cycles (p-v diagram) –Determination of fuel properties – Fuel injection system, ignition, cooling, lubrication and Governing system Testing and Performance: Performance parameters, measurements of brake power, indicated power, friction power- William's line method, Morse test, motoring test, Calculation of various performance parameter, heat balance sheet. **CO's: CO1**

Self-Learning Topics: Comparison of SI vs CI engine performance, Study of actual vs ideal valve timing diagrams, Methods to improve engine efficiency and reduce losses

UNIT-II **14 Hours**

Vapour Power Cycles: Vapour power cycle, simple Rankine cycle, mean temp of heat addition thermodynamic variables effecting efficiency and output of Rankine cycle.

Boilers: Subcritical and supercritical boilers, fluidized bed boilers, fire-tube and water-tube boilers, mountings and accessories, Draught system. **CO's: CO2**

Self-Learning Topics: Effect of pressure and temperature on Rankine cycle efficiency, Comparison of fire-tube and water-tube boilers, working and advantages of supercritical boilers

UNIT–III **12 Hours**

Nozzles: Type of nozzles - air and steam nozzles, Compressible flow through nozzle condition for maximum discharge - nozzle efficiency.

Steam Turbines: Classification of steam turbines -impulse turbine and reaction turbine - compounding in turbines - velocity diagrams in impulse and reaction turbines, efficiency, degree of reaction - governing of turbines

Steam Condensers: Classification of steam condensers: jet and surface condensers; Sources and effects of air leakage in condensers; Vacuum efficiency and condenser efficiency; Determination of mass of cooling water. **CO's:CO3**

Self-Learning Topics: Analysis of maximum discharge condition in nozzles, Comparison of jet and surface condensers, Effect of air leakage on condenser performance

UNIT–IV **12 Hours**

Reciprocating Compressors: Principle of operation, Work required Isothermal Efficiency, Volumetric efficiency and Effect of clearance volume, Multistage Compression.

Rotary Compressors: Roots blower and Vane 's sealed compressor-principle of working and applications. Centrifugal and Axial flow compressors: Construction, Principle of operation and applications. **CO's: CO4**

Self-Learning Topics: Effect of clearance volume on compressor performance, Advantages of multistage compression, Comparison of reciprocating vs centrifugal compressors

UNIT–V **10 Hours**

Gas power Cycle: Simple gas turbine plant, Brayton cycle, closed cycle and open cycle for gas Turbines, Methods to improve performance: regeneration, inter-cooling and reheating. Jet **Propulsion Systems:** Principle of Operation –Classification of jet propulsive engines – Working Principles with schematic diagrams analysis and performance characteristics of turbojet, turboprop, ramjet and pulsejet; thrust power and propulsion efficiency **CO's: CO5**

Self-Learning Topics: Methods to improve Brayton cycle efficiency, Comparison of open and closed cycle gas turbines, Performance comparison of turbojet and turboprop engines

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. 1. Ganesan V, Internal Combustion Engines, Tata McGraw Hill.
2. M.L. Mathur and F.S. Mehta, Thermal Engineering, Jain brothers.
3. R K Rajput, Thermal Engineering, Lakshmi publications
4. P.L. Ballaney, Thermal Engineering, Khanna.

Reference Books:

1. Cengal Y.A and Boles M.A, Thermodynamics: An Engineering Approach
2. Yahya, S. M., Turbines, Compressors and Fans, Tata McGraw Hill
3. Nag P.K, Engineering Thermodynamics, Tata McGraw-Hill.
4. Onkar Singh, Thermal Turbomachines, Wiley India.

Web References:

1. https://learnmech.com/valve-timing-diagram-for-ic-petro/
2. https://www.engineeringenotes.com/mechanical-engineering/ic-engine/ic-engineworking classification-types-methods-construction-and-notes-thermal-engineering/51576
3. https://www.engineeringenotes.com/thermal-engineering/vapour-power-

cycles/vapourpower-cycles-carnot-rankine-and-modified-rankine-cycle-thermodynamics/51016
4. https://www.mechstudies.com/rankine-cycle-actual-diagrams-equations-formula/
5. https://egyankosh.ac.in/bitstream/123456789/31859/1/Unit-10.pdf
6. https://www.sathyabama.ac.in/sites/default/files/course-material/2020- 10/Unit%203_8.pdf
7. https://gcoeara.ac.in/learning_material/mech/UNIT-III_Steam_Turbine.pdf
8. https://gcekbpatna.ac.in/assets/documents/lecturenotes/FLOW_THROUGH_NOZZLES.pdf
9. https://testbook.com/mechanical-engineering/air-compressor-types-and-parts
10. https://boilersinfo.com/compressor-and-classification-of-compressor-operationindustrial-uses/
11. https://scienceinfo.com/brayton-cycle/
12.https://archive.nptel.ac.in/content/storage2/courses/112106133/Module_4/1_introduction df

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	40
L4 (Analyzing)	-	40
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define SI engine.
2. Define valve timing diagram.
3. What is a fire-tube boiler?
4. What is a boiler accessory?
5. List the working strokes of two-stroke and four-stroke engines.
6. Define cooling, lubrication and governing systems of I.C. engines.
7. State the factors affecting Rankine cycle efficiency and output.
8. Define draught system and list its types.
9. Explain motoring test for determining friction power.
10. Describe the procedure for preparing heat balance sheet.

Level 2: Understanding

1. Explain the working of an SI engine.
2. Differentiate between two-stroke and four-stroke engines.
3. Explain the purpose of governing systems in engines.
4. Explain the working of the Rankine cycle.

5. Explain the working of a fluidized bed boiler.
6. Explain the classification and working of SI and CI engines with neat sketches.
7. Compare ideal and actual air-standard cycles using p-v diagrams.
8. Explain the concept of mean temperature of heat addition in vapour power cycles.
9. Explain subcritical and supercritical boilers with their advantages and applications.
10. Why is steam generation important in thermal power plants?

Level-3: Applying

1. Calculate nozzle efficiency for given inlet and outlet conditions.
2. Apply the condition for maximum discharge through a steam nozzle.
3. Determine the blade velocity coefficient in an impulse turbine.
4. Calculate the angular velocity of a link in a given four-bar mechanism.
5. Determine the velocity of a slider in a slider-crank mechanism using the relative velocity method.
6. Derive the condition for maximum discharge through a convergent-divergent nozzle.
7. A turbine develops 1500 kW power while steam consumption is 8 kg/kWh. Determine specific steam consumption.
8. Explain the working principle of steam condensers and apply them in thermal power plants.
9. Derive the expression for work done in isothermal compression.
10. A condenser receives 5000 kg/hr of exhaust steam. Cooling water enters at 25°C and leaves at 40°C. Determine mass of cooling water required.

Level-4: Analyzing

1. Analyze the effect of nozzle efficiency on steam turbine performance.
2. Analyze the effect of air leakage in condensers.
3. Differentiate between jet condensers and surface condensers.
4. Calculate the volumetric efficiency of a reciprocating compressor.
5. Determine the work required for single-stage compression.
6. Apply multistage compression principles to reduce work input.
7. Analyze the effect of reheating on gas turbine output.
8. Compare impulse and reaction turbines using velocity diagrams and efficiency.
9. Analyze different compounding methods used in steam turbines.
10. Compare jet condensers and surface condensers with applications.

Level-5: Evaluating

1. Evaluate the advantages of regeneration in gas turbines.
2. Justify the use of intercooling in multistage compression.
3. Evaluate propulsion efficiency in jet engines.
4. Evaluate different techniques used to improve Brayton cycle efficiency.
5. Evaluate turbojet, turboprop, ramjet, and pulsejet engines based on efficiency and applications.
6. Justify the selection of jet propulsion systems for aerospace applications.
7. A simple Brayton cycle operates between pressure limits of 1 bar and 6 bar. Air enters compressor at 300 K and turbine inlet temperature is 1100 K. Determine thermal efficiency and net work output.
8. A gas turbine plant develops 5000 kW power. Calculate air flow rate if specific work

output is 250 kJ/kg.

9. Air enters a compressor at 1 bar and 27°C and leaves at 5 bar. Determine compressor work assuming isentropic compression.
10. In a Brayton cycle, turbine inlet temperature is increased from 900 K to 1200 K. Evaluate the effect on cycle efficiency and output.

Chairperson
Board of Studies (ME)

R24MEPE01 INSTRUMENTATION AND CONTROL SYSTEMS 3 0 0 3

(PROFESSIONAL ELECTIVE-I)

Course Objectives

1. **To introduce** the fundamental concepts of measurement systems, including instruments, errors, and dynamic characteristics.
2. **To provide** knowledge of various transducers and their applications in displacement, acceleration, force, and motion measurement.
3. **To develop** understanding of strain, pressure, temperature, flow, and moisture measurement techniques.
4. **To familiarize** students with different industrial measurement devices and their working principles.
5. **To introduce** basic concepts of control systems, including system classification, stability, and frequency response methods

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 01.1	Explain the principles, characteristics, error analysis, and working of displacement measuring instruments and transducers used for linear and angular measurements.	3	2	1	-	1	-	-	-	-	-	1	1	1	L1 L2
R24MEPE 01.2	Analyze and apply the principles of acceleration, force, load, torque, and speed measuring instruments for engineering measurement systems.	3	3	2	1	1	-	-	-	-	-	1	2	2	L3 L4
R24MEPE 01.3	Investigate strain and pressure measurement methods using strain gauges and advanced pressure measuring devices for engineering applications.	3	3	2	2	1	-	-	-	-	-	1	2	2	L3 L4

R24MEPE 01.4	Assess temperature, flow, and moisture measurement techniques used in process industries and smart sensing systems.	3	3	2	2	1	-	-	-	-	-	1	2	2	L3 L4
R24MEPE 01.5	Evaluate the performance of control systems, stability criteria, Bode plots, and AI-based intelligent controllers in automation applications.	3	3	3	1	2	-	-	-	-	-	2	2	2	L4 L5

SYLLABUS

UNIT – I **12 Hours**

Introduction: Basic principles and functional descriptions of measuring instruments with example – Dynamic performance characteristics, classification of errors, Error measurement analysis.

Displacement measurement: Principles of Resistive, inductive and capacitive transducers to measure linear and angular displacement. Digital Sensors and Wireless Measurement Techniques. **CO's:CO1**

Self-Learning Topics: Smart sensors and IoT-based measurement systems, Calibration techniques and uncertainty analysis, advanced displacement sensors (LVDT, Optical encoders)

UNIT - II **14 Hours**

Measurement of acceleration: Principles of seismic instruments, seismic instrument based capacitive and inductive accelerometer and micrometer.

Force, load, and torque and speed measurements: Principles and functionalities of elastic force meters, strain gauge load cell, electrical and strain gauge torsion meters and stroboscope speed measurement. Non-contact Measurement using Laser and Optical Sensors. **CO's: CO2**

Self-Learning Topics: MEMS-based accelerometers and applications, Load cells in industrial automation, non-contact speed measurement (Laser/Optical)

UNIT - III **12 Hours**

Strain measurement: Measurement procedure using Electrical resistance strain gauges, Gauge factor and measurement of tensile and compressive strains

Pressure measurement: Measurement procedure using Thermal conductivity gauge, Ionization type pressure gauges, McLeod pressure gauge, Bourdon tubes, Bellows, Diaphragm gauges. Digital Pressure Transmitters and Smart Pressure Sensors. **CO's:CO3**

Self-Learning Topics: Strain gauge rosettes and stress analysis, Wheatstone bridge advanced applications, Digital pressure sensors vs conventional gauges.

UNIT - IV **12 Hours**

Temperature measurement: Principles of Expansion, Resistive, Thermocouples, Pyrometers.

Flow measurement: Principles of Rota meter, Turbine flow meter, Hot-wire anemometer, Magnetic flow meter, Ultrasonic flow meters. Infrared and Thermal Imaging based Temperature Measurement.

Moisture Measurement: Principles of Dew point meter. **CO's:CO4**

Self-Learning Topics: Infrared thermograph (thermal imaging), Ultrasonic flow meters – industrial applications, Smart temperature sensors (RTD vs Thermistor vs IC sensors)

UNIT - V **12 Hours**

Control system and controllers: Introduction, Importance, Classification, Open and closed systems with examples. RH Stability Criterion, Introduction to Bode Plots. AI and Machine Learning based Intelligent Controllers**.** **CO's:CO5**

Self-Learning Topics: PID controllers and tuning methods, PLC and SCADA basics, MATLAB/Simulink for control system simulation.

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books

1. Mechanical Measurement & control, Dr.D.S. Kumar, S.K. Kataria & Sons Publications, 4th Edition, 2006.
2. Control Systems Engineering, I.J. Nagrath, M. Gopal, New Age Publications, 6th Edition, 2017.

Reference Books

1. Measurement systems: Application and design, Earnest. O. Doeblin, Adaptation by
2. Manik and Dhanesh, Tata McGraw Hill Publications, 6thEdition, 2011.
3. Mechanical and Industrial Measurements, R.K. Jain, Khanna Publications, 2nd Edition, 1995.
4. A Course in Electrical & Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai Publications, 18th Edition, 2021.
5. Experimental Methods for Engineers, J P Holmann, McGrawHill Publications, 8th Edition, 2011.

Web References:

1. http://archive.nptel.ac.in/courses/112/104/112104039/
2. http://www.youtube.com/watch?v=ZJw7kJt6YdQ
3. http://onlinecourses.nptel.ac.in/noc24_ee44/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	20	-
L2 (Understanding)	30	10
L3 (Applying)	30	30
L4 (Analyzing)	20	40
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define measurement system.
2. What is an instrument?
3. Define dynamic characteristics.
4. List types of errors in measurement.

5. Define transducer.
6. Explain basic principles of measuring instruments.
7. Describe classification of errors.
8. Explain displacement measurement techniques.
9. Describe strain measurement procedure.
10. Explain the working principle of LVDT.

L2: Understand

1. Explain classification of errors.
2. Describe working of resistive transducer.
3. Explain principle of seismic instruments.
4. Describe strain gauge working.
5. Explain Bourdon tube pressure gauge.
6. Explain dynamic performance characteristics of instruments.
7. Describe working of seismic instruments.
8. Explain different pressure measurement methods.
9. Discuss temperature measurement techniques.
10. List the applications of thermocouples.

L3: Apply

1. Apply capacitive transducer for displacement measurement.
2. Demonstrate use of accelerometer in vibration measurement.
3. Apply strain gauge for load measurement.
4. Use thermocouple for temperature measurement.
5. Apply rota meter for flow measurement.
6. Apply strain gauge method to measure strain.
7. Apply accelerometer for vibration analysis.
8. Demonstrate flow measurement using turbine flow meter.
9. Apply thermocouple for industrial temperature measurement.
10. Compare capacitive and inductive transducers for displacement measurement.

L4: Analysing

1. Compare inductive and capacitive transducers.
2. Analyze performance of accelerometers.
3. Compare different pressure measurement methods.
4. Analyze flow measurement techniques.
5. Compare open and closed loop systems.
6. Analyze errors in measurement systems.
7. Compare pressure measuring instruments.
8. Analyze different flow measurement techniques.
9. Compare open loop and closed loop control systems.
10. Analyze the advantages of ultrasonic flow meters over conventional flow meters.

L5: Evaluating

1. Evaluate suitability of thermocouples for high temperature measurement.
2. Justify use of ultrasonic flow meters.
3. Evaluate advantages of closed loop control systems.
4. Assess performance of strain gauges.

5. Evaluate different control system techniques.
6. Evaluate performance of different transducers.
7. Assess suitability of pressure gauges for industrial use.
8. Evaluate control system stability using RH criterion.
9. Justify use of Bode plots in control system analysis.
10. Evaluate RH stability criterion and Bode plot techniques for control system analysis.

Chairperson
Board of Studies (ME)

R24MEPE02 **NANO TECHNOLOGY** **3 0 0 3**

(Professional Elective-I)

Course Objectives:

1. **To introduce** the basic concepts, history and scope of nanotechnology and nanomaterials
2. **To understand** the classification and characterization techniques of nanomaterials
3. **To familiarize** with tools and techniques used in nanoscience and nanotechnology
4. **To study** various physical and chemical methods for synthesis of nanomaterials
5. **To explore** industrial and real-world applications of nanomaterials in different sectors

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 02.1	Analyse stresses and material behavior in basic machine parts	3	2	1	-	-	-	1	-	-	-	-	2	1	L1 L2
R24MEPE 02.2	Design elements for fatigue and fluctuating loading	2	3	2	2	2	-	1	-	-	-	-	2	2	L2 L3
R24MEPE 02.3	Design and evaluate fasteners and welded joints	2	2	2	3	3	-	1	-	-	-	-	3	2	L3 L4
R24MEPE 02.4	Analyze and solve problems on belt drives, gear trains and shaft couplings for efficient mechanical power transmission in engineering applications.	2	2	3	2	2	-	2	-	-	-	-	2	3	L4 L5
R24MEPE 02.5	Analyze the stress, deflection, and energy storage behavior of helical springs under various loading conditions.	2	2	2	1	1	-	3	-	-	-	1	2	2	L5

SYLLABUS

UNIT-I **10 Hours**

Introduction to Nanomaterials:

Introduction: Basic idea of nanotechnology, simple history and scope, Classification of nanostructured materials, Fascinating nanostructures, everyday examples and simple applications of nanomaterials, challenges and future prospects explained at basic level. **CO's: CO1**

Self-Learning Topics: Basics of principal stresses and failure theories , Introduction to stress analysis using ANSYS Mechanical

UNIT-II **14 Hours**

Classification of nano materials: Nonmaterial's characterization: Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, SEM, TEM, Atomic Forced Microscopy **CO's: CO2**

Self-Learning Topics: Working principles of XRD, SEM and TEM, Simulation of mechanisms using Solid works

UNIT–III **12 Hours**

Tools for Nanoscience and Technology: Tools for measuring properties of Nanostructures, Tools to Make Nanostructures. Nano scale Bio-structures, Modelling **CO's: CO3**

Applications: Design of bolted joints in machine assemblies, Design of welded joints in pressure vessels and structures

Self-Learning Topics: Types of temporary and permanent joints, Basics of modeling using MAT Lab

UNIT–IV **12 Hours**

Synthesis of nano materials:

Physical Methods: Mechanical Methods, Methods based on Evaporation, Sputter Deposition, Chemical Vapor Deposition, Electric Arc Deposition, Ion Beam Technique, Molecular Beam Epitaxial.

Chemical Methods: Synthesis of Metal nanoparticles by colloidal route, Sol-Gel Method, Hydrothermal synthesis, Microwave Synthesis **CO's: CO4**

Self-Learning Topics: Types of belt drives and power transmission concepts, Study of industrial nonmaterial synthesis techniques

UNIT–V **10 Hours**

Applications of Nano Materials: Nano-medical and healthcare applications, Textiles, Paints, Energy, Defense and Space Applications, Future transportation benefits. **CO's: CO5**

Self-Learning Topics: Role of nanotechnology in renewable energy, Overview of nonmaterial's in defense and space applications

Text Books:

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

Reference Books:

1. Nano: The Essentials by T. Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L. Schodek.
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
6. Electron Transport in Mesoscopic systems – S. Dutta, Cambridge University press.

Web References:

1. **https://www.elprocus.com/nanomaterials-classifications-and-its-properties/**
2. **https://ion2.upm.edu.my/article/properties_and_classification_of_nanomaterials-6906**
3. **https://www.elprocus.com/nanotechnology-types-advantages-and-disadvantages/**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define nanotechnology and nanomaterials.
2. List the classification of nanostructured materials.
3. Define particle size and particle size distribution.
4. List different characterization techniques of nanomaterials.
5. Define nanostructures and nanoscience tools.
6. List tools used to measure nanostructure properties.
7. Define physical and chemical synthesis methods.
8. List different nanomaterial synthesis techniques.
9. List applications of nanomaterials in healthcare.
10. Define nanotechnology in energy applications.

Level 2: Understanding

1. Explain the scope and importance of nanotechnology.
2. Describe everyday applications of nanomaterials.
3. Explain the working principle of XRD.
4. Describe SEM and TEM techniques.
5. Explain tools used to make nanostructures.
6. Describe nanoscale bio-structures.
7. Explain Chemical Vapor Deposition (CVD).
8. Describe the sol-gel method.
9. Explain nanomaterials in textile applications.
10. Describe nanotechnology in defense and space.

Level 3: Applying

1. Apply nanomaterials in the design of shafts and axles.
2. Illustrate the use of nanomaterials in crane hooks under combined loading.
3. Apply characterization techniques in fatigue-resistant design.
4. Use stress concentration factors in crankshaft design.
5. Apply nanotechnology in bolted joint design.
6. Illustrate the use of nanotechnology in welded joints.
7. Apply CVD in nanomaterial production.
8. Illustrate nanomaterial synthesis using sol-gel method.

9. Apply nanomaterials in energy systems.
10. Illustrate nanotechnology in transportation.

Level 4: Analyzing

1. Analyze the advantages of nanomaterials over conventional materials.
2. Examine the challenges in nanomaterial applications.
3. Analyze the importance of particle size in nanomaterials.
4. Compare SEM and TEM techniques.
5. Analyze different tools used in nanoscience.
6. Examine modelling techniques in nanotechnology.
7. Analyze physical vs chemical synthesis methods.
8. Examine advantages of hydrothermal synthesis.
9. Analyze the role of nanomaterials in modern industries.
10. Examine the impact of nanotechnology in healthcare.

Level 5: Evaluating

1. Evaluate the future prospects of nanotechnology.
2. Justify the use of nanomaterials in automotive applications.
3. Evaluate suitable characterization methods for nanomaterials.
4. Justify the role of nanomaterials in fatigue design.
5. Evaluate the importance of modelling in nanoscience.
6. Justify the use of nanotechnology in machine assemblies.
7. Evaluate suitable synthesis methods for industrial use.
8. Justify the selection of synthesis technique for nanomaterials.
9. Evaluate benefits of nanotechnology in future transportation.
10. Justify the use of nanomaterials in advanced applications.

Chairperson

Board of Studies (ME)

R24MEPE03 **DESIGN FOR MANUFACTURING** **3 0 0 3**

(Professional Elective-I)

Course Objectives:

1. **To Understand** the fundamental concepts, need and benefits of Design for Manufacturing (DFM) and Design for Manufacturing and Assembly (DFMA) in product development.
2. **To Apply** appropriate design guidelines for machined components considering dimensional tolerances, surface finish and ease of machining to improve manufacturability.
3. **To Apply** design principles for metal casting, extrusion and sheet-metal components, including process selection, allowances, and basic rules for defect-free and economical production.
4. **To Apply** design guidelines for welded, brazed and forged components, considering joint configuration, distortion, thermal effects and forging die design aspects.
5. **To Analyze and design** simple products and components suitable for assembly automation by considering system configuration, part feeding, escapement/placement devices and basic line performance.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 03.1	Explain the concepts, need and benefits of Design for Manufacturing (DFM) and Design for Manufacturing and Assembly (DFMA) in product and process design.	3	2	2	1	1	1	1	1	1	2	1	3	1	L2 L3
R24MEPE 03.2	Apply suitable design guidelines for machined components considering process capabilities, dimensional tolerances and surface finish to improve manufacturability.	3	3	3	2	2	1	1	1	1	2	1	3	2	L3 L4
R24MEPE 03.3	Apply design principles for metal casting, extrusion and sheet-metal components, including process selection, allowances and basic rules to obtain defect-free and economical products	3	3	3	2	2	1	2	1	1	2	1	3	2	L3 L4

R24MEPE 03.4	Apply appropriate design guidelines for welded, brazed and forged components, considering joint configuration, thermal effects, forging die features and overall structural performance.	3	3	3	2	1	2	2	1	1	2	1	3	1	L3 L4
R24MEPE 03.5	Analyze and design simple products and components for assembly automation by considering system configuration, parts feeding, escapement/placement devices and basic productivity measures.	2	2	3	2	3	1	1	1	2	3	2	2	3	L4 L6

SYLLABUS

UNIT-I **10 Hours**

Introduction to DFM & DFMA: Meaning of Design for Manufacturing (DFM) and Design for Manufacturing and Assembly (DFMA). Why DFMA is used in industry-reduce cost, reduce number of parts, make assembly simple. Basic idea of how DFMA works in product design (simple flow only). Simple advantages of DFMA with examples. **CO: CO1**

Self learning: Watch one NPTEL or YouTube intro video on DFMA and prepare a half-page note on how DFMA reduces part count and assembly time.

UNIT-II **12 Hours**

Machining processes: Overview of various machining processes-general design rules for Machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design, recommendations for machined parts. **CO: CO2**

Self-learning: Revise basic machining operations (turning, milling, drilling, grinding) from one online video or textbook chapter and write key points for each.

UNIT-III **12 Hours**

Metal Casting: Overview of different casting processes, How to choose the right casting process, Basic design rules for castings. Casting tolerances and allowances, Use of solidification simulation in casting design, Product design guidelines for sand casting.

Extrusion and Sheet Metal Work: Design guidelines for extruded sections, Basic design principles for punching, blanking, bending, and deep drawing. Keeler–Goodman forging line diagram, Component design rules for blanking. **CO: CO3**

Self-learning: Watch a short video on sand casting and a video on sheet-metal operations (blanking, bending, and deep drawing) and write process steps in your notebook.

UNIT-IV **12 Hours**

Metal joining: Appraisal of various welding processes, factors in design of elements – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design– parting lines of

dies –drop forging die design – general design recommendations**.** **CO: CO4**

Self-learning: Prepare an one-page summary comparing welding, brazing, and forging with at least one real-life example for each.

UNIT-V **12 Hours**

Design for Assembly Automation: Basics of automated assembly systems, Different system configurations used in automation, Parts delivery systems at workstations. Escapement and placement devices in automated assembly. Simple quantitative analysis of assembly systems. Multi-station assembly systems. **CO: CO5**

Self-learning: Watch a video of an automated assembly line (e.g., bottling or car assembly) and note different stations (feeding, assembly, and inspection).

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text Books

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson.
2. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press.

Reference Books

1. James G. Bralla (Ed.), *Design for Manufacturability Handbook*, McGraw-Hill.
2. George E. Dieter, Linda C. Schmidt, *Engineering Design*, McGraw-Hill.
3. Serope Kalpakjian, Steven R. Schmid, *Manufacturing Engineering and Technology*, Pearson.

Web References:

1. http://www.globalspec.com/reference/58149/203279/design-for-manufacturability-handbook-second-edition.
2. http://pressbooks.palni.org/designmanufactureassembly/chapter/chapter-1/
3. http://archive.org/details/manufacturingeng0000kalp_r2g8
4. http://dl.ojocv.gov.et/admin_/book/Manufacturing%20Engineering%20And%20Technology%20Seventh%20Edition%20By%20Steven%20R.%20Schm

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20

Total	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Design for Manufacturing (DFM).
2. What is DFMA? Write its full form.
3. Define machining.
4. What is meant by surface roughness in machining?
5. What is metal casting?
6. Define blanking in sheet-metal work.
7. Define welding.
8. What is forging?
9. What is an automated assembly system?
10. Define parts feeding in automated assembly.

L2: Understand

1. Why is DFMA important in product design?
2. How does DFMA help in reducing the number of parts in a product?
3. Explain why providing fillets instead of sharp corners is good for machining.
4. Why are standard hole sizes preferred in design for machining?
5. Why is uniform wall thickness preferred in casting design?
6. Explain the term “deep drawing” in sheet-metal forming.
7. Why can welding cause distortion in components?
8. Why is proper parting line selection important in forging die design?
9. What is the difference between single-station and multi-station assembly systems?
10. Why is part orientation important in automated assembly?

L3: Apply

1. For a simple pen, suggest two changes to make it easier to assemble.
2. Give an example of a product where DFMA has reduced assembly time and explain briefly.
3. A component has a very deep narrow slot. Suggest one design change to improve machinability.
4. A part drawing shows many different hole diameters. How can you modify the design to reduce machining time?
5. For a thick casting with sharp inside corners, suggest two design changes to reduce casting defects.
6. Suggest two design rules while locating holes near a bend in sheet-metal parts.
7. A welded frame is showing distortion after welding. Suggest two design or process modifications to reduce distortion.
8. For a forged connecting rod, suggest where you would place the parting line and why.
9. For a small plastic bottle, suggest how its shape can help automatic feeding and orientation.
10. A product requires manual tightening of many screws in assembly. Suggest a design change suitable for automated assembly.

L4: Analyzing

1. Compare DFM and DFMA with respect to their main focus in product development.
2. Analyze how reducing part count can affect reliability and maintenance of a product.

3. Analyze the effect of very tight dimensional tolerances on machining cost and time.
4. Compare machining a part with multiple setups versus a part designed for minimum setups.
5. Compare sand casting and die casting from a design point of view for medium-volume production.
6. Analyze how bend radius and sheet thickness influence failure in bending operations.
7. Compare welded joints and forged components with respect to strength and production quantity.
8. Analyze how joint design (lap, butt, T-joint) influences stress distribution in welded structures.
9. Compare manual assembly and automated assembly for high-volume consumer products.
10. Analyze the effect of unbalanced assembly line stations on overall line productivity.

L5: Evaluating

1. Propose DFMA-based changes to redesign a simple consumer product (e.g., electric kettle or stapler) to reduce part count and assembly time.
2. Evaluate a given product (you may choose any household item) and write a short note on how well DFMA principles are followed.
3. Design a simple component drawing suitable for turning and drilling operations, applying at least four design for machining guidelines.
4. Evaluate two alternative designs of a part (one complex, one simple) and justify which is better from machinability and cost point of **–III: Casting, Extrusion & Sheet Metal (CO3)**
5. Design a simple sand-cast component and list at least five design features you have used to improve castability.
6. Propose a sheet-metal bracket design for mounting a small motor and explain how your design eases manufacturing and assembly.
7. Design a simple welded frame for a small trolley and justify your choices of joint type and weld location based on design guidelines.
8. Propose a forged part for an automotive application and explain how forging design rules (fillets, draft, grain flow) are applied.
9. Design a basic layout of an automated assembly system for a ball-point pen, indicating major stations and material flow.
10. Evaluate whether a medium-volume mechanical product (e.g., hand drill or mixer) should be assembled manually or by automation, giving reasons.

Chairperson

Board of Studies (ME)

R24MEPE04 **JOINING PROCESS** **3 0 0 3**

(Professional Elective-I)

Course Objectives:

1. **To describe** basic principles of metal joining process
2. **To interpret** the theory and procedure involved in the fusion welding process
3. **To analyze** the basic concepts of the pressure welding.
4. **To analyze** the basic steps of soldering operational steps of brazing.
5. **To illustrate** the concepts of modern welding processes

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 04.1	Understand the fundamentals of metal joining processes, their classification, safety practices, and the metallurgical significance of joining in manufacturing.	3	2	1	-	1	1	1	-	1	-	1	1	2	L1 L2
R24MEPE 04.2	Explain the principles, equipment, procedures, advantages, limitations, and applications of fusion welding processes such as gas welding, arc welding, and thermit welding.	3	3	2	1	2	1	1	1	1	-	1	2	3	L2 L3
R24MEPE 04.3	Analyze pressure welding processes including resistance welding, cold welding, and forge welding, along with their advantages, limitations, and industrial applications.	2	3	2	2	2	1	1	2	1	1	1	3	3	L3 L4
R24MEPE 04.4	Demonstrate knowledge of soldering and brazing processes, including operational steps, role of fluxes, metallurgical aspects, alloys used, and adhesive joining techniques	2	3	3	2	3	2	1	2	2	1	2	3	3	L4 L3

R24MEPE 04.5	Evaluate modern welding processes such as electron beam welding, laser beam welding, submerged arc welding, ultrasonic welding, underwater welding, and magnetic pulse welding, and identify their applications in advanced manufacturing.	3	3	3	1	2	2	1	2	2	2	2	3	3	L5 L4

SYLLABUS

UNIT-I **12 Hours**

Metal Joining Processes: Joining process as a manufacturing route, relevance of joining process to metallurgy. Different types of joining process, classification of joining process, safety aspects in Metal joining processes, types of joints used in welding. Industry 4.0-based smart welding.

CO's: CO1

Self-Learning Topics: Basics of joining processes as a manufacturing route, metallurgy of welding, classification of joining processes

UNIT-II **10 Hours**

Fusion Welding Process: Classification of welding process, gas welding, arc welding process (equipment, fluxes, electrodes, procedures, limitations and advantages of various arc welding process), relative advantages and limitations and applications of gas welding and arc welding, thermit welding. Inverter Welding Technology **CO's: CO2**

Self-Learning Topics: Gas welding, arc welding processes (equipment, electrodes, fluxes, and procedures), Thermit welding, advantages, limitations, and applications.

UNIT–III **12 Hours**

Pressure Welding: Resistance welding, cold welding, forge welding. relative advantages, limitation and applications of pressure welding. spot welding, explosion welding, flash welding. Robotic Resistance Spot Welding **CO's: CO3**

Self-Learning Topics: Resistance welding, spot welding, forge welding, cold welding, flash welding, and explosion welding with working principles and applications.

UNIT–IV **12 Hours**

Soldering and Brazing: Basic operational steps of Soldering, Basic operational steps of Brazing, flux and its role in joining process, different types of fluxes, metallurgical aspects of soldering and brazing, applications of soldering and brazing, soldering and Brazing Alloys, adhesive joining. Lead-free soldering. **CO's: CO4**

Self-Learning Topics: Soldering and brazing processes,flux types and functions, soldering/brazing alloys, metallurgical bonding, and adhesive joining.

UNIT–V **10 Hours**

Modern Welding Processes: Electron beam welding, Laser beam welding, submerged arc welding, Ultrasonic welding, under water welding, Magnetic pulse welding. Additive Manufacturing-Based Joining. **CO's: CO5**

Self-Learning Topics: Electron beam welding, laser beam welding, submerged arc welding, ultrasonic welding, underwater welding, and magnetic pulse welding.

Board of Studies : Mechanical Engineering
Approved in BOS No: 03
Approved in ACM No: 03

Text Books:

1. Welding Technology O.P.Khanna Dhanpat Rai Publications Ltd. New Delhi
2. Soldering, welding and brazing Lankester George Allen and Unwin, London.
3. Modern arc welding techniques S.V. Nadkarni Oxford IBH Publishers.

References:

1. Engineering Metallurgy I and II R.A.Higgins The English University Press Ltd.
2. Welding Technology R.S.Parmar Khanna Publishers, New Delhi
3. Welding Engineering Richard little Tata McGraw Hill, New Delhi

Web References:

1. **https://archive.nptel.ac.in/courses/112/107/112107217/**
2. **https://archive.nptel.ac.in/courses/112/107/112107219/**

Internal Assessment Pattern:

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1 – Remember

1. Define welding.
2. List any two types of welding processes.
3. What is flux?
4. Define soldering.
5. What is Thermit welding?
6. Describe different types of welding joints with neat sketches.
7. Explain the classification of metal joining processes.
8. Write two applications of welding.
9. Define metal joining process.
10. What is arc welding?

L2 – Understand

1. Explain the role of flux in welding.
2. Differentiate between soldering and brazing.
3. What is arc welding?

4. State the principle of resistance welding.
5. What is submerged arc welding?
6. Explain the working principle of gas welding with a neat diagram.
7. Discuss the equipment and process of arc welding.
8. Compare gas welding and arc welding.
9. Explain limitations of gas welding.
10. Discuss advantages of pressure welding.

L3 – Apply

1. Suggest a suitable welding process for thin sheets.
2. Which joining process is used for electrical connections? Why?
3. Identify a welding method suitable for underwater applications.
4. Which flux is used in brazing?
5. Select a suitable welding process for joining dissimilar metals and justify your choice.
6. Explain the procedure of spot welding and its applications.
7. Illustrate the steps involved in brazing process with diagram
8. Solve selection of welding process for sheet metal fabrication.
9. Compare brazing and welding joints in strength.
10. Analyze resistance welding applications in industries.

L4 – Analyze

1. Why is arc welding preferred over gas welding in industries?
2. Analyze the need for pressure welding.
3. What are the limitations of cold welding?
4. Compare forge welding and resistance welding.
5. Analyze the advantages and limitations of different arc welding processes.
6. Compare pressure welding processes with fusion welding processes.
7. Analyze the metallurgical aspects of soldering and brazing.
8. Evaluate underwater welding challenges and solutions.
9. Recommend best welding technique for nuclear reactor components.
10. Design a suitable joining method for aluminum alloys in aircraft structures.

L5 – Evaluate

1. Justify the use of laser beam welding in precision applications.
2. Why is electron beam welding preferred in aerospace industries?
3. Evaluate the need for modern welding techniques.
4. Which welding process is most economical? Justify briefly.
5. Valuate different modern welding processes and justify their industrial applications.
6. Justify the selection of welding process for a high-strength structural application.
7. Critically evaluate underwater welding and its challenges.
8. Develop a welding monitoring system using IoT technology.
9. Develop a sustainable welding method with zero carbon emissions.
10. Propose a new nano-scale joining technique for micro-devices.

Chairperson

Board of Studies (ME)

R24MEOE01 **PRINCIPLES OF ROBOTICS** **3 0 0 3**
(OPEN ELECTIVE-I)

Course Objectives:

1. To understand the fundamentals, configurations, components, and applications of industrial robots.
2. To study different types of end effectors and gripper mechanisms used in robotics.
3. To learn mathematical modeling, kinematics, and transformations of robotic manipulators.
4. To understand robot programming, path planning, and sensor integration techniques.
5. To study advanced robotic systems, safety practices, maintenance, and recent trends in robotics.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE01.1	Understand the basic concepts, configurations, components, and applications of industrial robots.	3	2	1	-	2	1	1	-	1	-	2	2	1	L1 L2
R24MEOE01.2	Explain the working and selection of different end effectors and grippers used in robotic systems.	3	2	2	1	2	-	-	-	1	-	1	3	1	L2 L3
R24MEOE01.3	Apply mathematical modeling, kinematics, and coordinate transformations in robotic manipulators.	3	3	2	2	3	-	-	-	1	-	1	3	2	L3 L4
R24MEOE01.4	Analyze robot programming, path planning, and sensor integration techniques in robotics.	2	2	3	2	3	1	-	1	2	1	2	3	2	L3 L4
R24MEOE01.5	Evaluate safety methods, maintenance procedures, and modern trends in industrial robotics.	2	1	2	1	2	3	3	2	2	1	3	2	2	L4 L5

SYLLABUS

UNIT-I **14 Hours**

INTRODUCTION TO ROBOTICS- industrial robots, functions and applications of robots, advantages and limitations, robot classification, robot components, drives, sensors, controllers, robotic work cell, robot joints, degrees of freedom, robot configuration, Types of Robot Configurations, work envelope, accuracy, repeatability and robot applications in industries.

CO's: CO1

Self-Learning Topics: Evolution of industrial robots and modern trends, comparison between industrial robots and service robots, study of different robot configurations such as Cartesian, Cylindrical, Spherical, Articulated and SCARA robots.

UNIT-II **14 Hours**

END EFFECTORS-Introduction to end effectors, types of grippers, mechanical, pneumatic, hydraulic, magnetic and vacuum grippers, gripper selection, two-finger and three-finger grippers, internal and external grippers, adaptive grippers and process tools as end effectors. **CO's: CO2**

Self-Learning Topics: Comparison of different types of grippers, design of simple robotic grippers, applications of soft robotic grippers, and study of adaptive and intelligent grippers.

UNIT–III **14 Hours**

MATHEMATICAL MODELING OF ROBOTS-Vectors and matrices, link equations, direct kinematics, coordinate transformations, rotation matrices, inverse transformations, homogeneous transformation matrices, inverse kinematics, two-joint manipulator, D-H parameters, Jacobian transformation, velocity and force analysis. **CO's:CO3**

Self-Learning Topics: Detailed study of D-H parameters with examples, numerical problems on forward and inverse kinematics, workspace analysis of robotic manipulators, and applications of Jacobian matrix in robotics.

UNIT–IV **12 Hours**

ROBOT PROGRAMMING AND APPLICATIONS-Introduction to robotic programming, on-line and off-line programming, teaching methods, robot programming languages, path planning, motion interpolation, smooth motion generation, tactile, position, velocity and force sensors, sensor feedback in robotics. **CO's:CO**4

Self-Learning Topics: Comparison between on-line and off-line programming, study of robot programming languages, simulation of path planning techniques, and applications of sensors in robotic systems.

UNIT–V **10 Hours**

ADVANCED ROBOTICS-Safety programming, emergency stop, safety interlocks, troubleshooting, maintenance procedures, collaborative robots, humanoid robots and artificial intelligence in robotics. **CO's: CO5**

Self-Learning Topics: Safety standards in industrial robotics, case studies on robot maintenance and troubleshooting, introduction to collaborative robots (Cobots), and role of artificial intelligence in modern robotics.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.

Reference Books:

1. JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
2. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, *Robot Modeling and Control*, Wiley India, 2006.

Web References:

1. http://archive.nptel.ac.in/courses/112/108/112108093/
2. http://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-me39/
3. https://onlinecourses.nptel.ac.in/noc26_me01/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	30
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level-1: Remembering

1. Define an industrial robot.
2. List the advantages of robots in industries.
3. What is a robotic work cell?
4. Differentiate between accuracy and repeatability.
5. Describe the basic components and structure of an industrial robot.
6. Explain different robot configurations with neat sketch.
7. Explain the classification of robots with neat sketches.
8. Discuss the components of an industrial robot in detail.
9. Explain robot coordinates and reference frames.
10. Describe the applications of robots in industries.

Level-2: Understanding

1. Define end effector.
2. List different types of robotic grippers.
3. What is a vacuum gripper?
4. Explain the working of pneumatic grippers.
5. State the advantages of hydraulic grippers.
6. Explain different types of robotic grippers with applications.

7. Discuss the design considerations for robotic grippers.
8. Compare pneumatic, hydraulic, and vacuum grippers.
9. Explain adaptive grippers and their applications.
10. Explain the working principle of magnetic grippers.

Level-3: Applying

1. Define direct kinematics.
2. What is a rotation matrix?
3. Define homogeneous transformation matrix.
4. Explain inverse kinematics.
5. What are D-H parameters?
6. Explain direct and inverse kinematics of robotic manipulators.
7. Derive homogeneous transformation matrices for robotic systems.
8. Discuss the importance of rotation matrices in robotics.
9. Evaluate different methods used in robot kinematics.
10. Discuss the Denavit–Hartenberg convention with examples.

Level-4: Analyzing

1. Define robotic programming.
2. Differentiate between on-line and off-line programming.
3. What is robot teaching?
4. Define path planning in robotics.
5. What are tactile sensors?
6. Explain different methods of robotic programming.
7. Discuss on-line and off-line programming techniques.
8. Explain robot teaching methods with examples.
9. Describe different robot programming languages.
10. Explain path planning techniques in robotics.

Level-5: Evaluating

1. Define safety programming in robotics.
2. What is an emergency stop system?
3. Explain safety interlocks in robotic systems.
4. What are common programming errors in robots?
5. Define troubleshooting in robotics.
6. Explain safety programming techniques used in robotics.
7. Discuss the importance of emergency stop and safety interlocks.
8. Explain troubleshooting methods for robotic systems.
9. Discuss maintenance procedures for industrial robots.
10. Explain the role of collaborative robots in industries.

Chairperson
Board of Studies (ME)

R24MEOE02 **Manufacturing Technology** **3 0 0 3**
(Open Elective-I)

Course Objectives:

1. **To introduce** students to various manufacturing processes and their applications.
2. **To provide** knowledge about the principles and operations of machine tools.
3. **To understand** the selection criteria for manufacturing processes based on product design and material.
4. **To impart** practical skills through laboratory sessions and hands-on training.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE02.1	Understand and classify various manufacturing processes and select appropriate processes based on material, design, and production requirements.	3	2	2	1	2	1	-	-	-	-	2	2	3	L1, L2
R24MEOE02.2	Explain different metal casting processes, including sand casting, die casting, investment casting, and centrifugal casting, along with gating system design and solidification principles	3	2	2	2	1	2	1	-	-	-	2	1	3	L2, L3
R24MEOE02.3	Analyze bulk deformation and sheet metal forming processes, including their mechanics, applications, and suitability for different materials	3	3	2	2	2	1	-	-	-	-	2	2	3	L3, L2
R24MEOE02.4	Apply machining principles, select appropriate machine tools and cutting parameters, and evaluate machining performance including surface finish and	3	3	2	2	3	1	-	-	-	-	2	3	2	L4, L3

	tolerances.														
R24MEOE02.5	Evaluate various joining processes such as welding, brazing, soldering, mechanical fastening, and adhesive bonding, along with defects and inspection techniques.	3	2	2	1	2	1	1	1	1	-	2	2	2	L5, L4

SYLLABUS

UNIT-I **12 Hours**

Introduction to Manufacturing Processes:

Overview of manufacturing processes, Classification of manufacturing processes: Casting, forming, machining, joining, and additive manufacturing, Selection of manufacturing processes based on material, design, and production requirements, Recent advancements in manufacturing technologies. **CO's: CO1**

Self-Learning Topics: Process selection based on material, design and production needs, and comparison of traditional vs modern manufacturing systems with sustainability concepts.

UNIT-II **12 Hours**

Metal Casting Processes:

Sand casting: Molding materials, pattern making, and core making, **Die casting**: Types of die casting, applications, and advantages, **Investment casting**: Process steps, materials used, and applications, **Centrifugal casting**: Types and applications, Gating system design and solidification of casting. Eco-friendly sustainable foundry practices. **CO's: CO2**

Self-Learning Topics: Pattern allowances, core design, gating systems, die casting, investment casting, centrifugal casting, and solidification basics.

UNIT–III **12 Hours**

Forming Processes:

Bulk deformation processes: Rolling, forging, extrusion, and drawing, Bending, deep drawing, and spinning, Processing of polymers and composites, Analysis of forming processes and their applications. Incremental sheet forming, hydro forming **CO's: CO3**

Self-Learning Topics: Rolling, forging, extrusion, drawing, sheet metal operations, and basic polymer/composite forming processes

UNIT–IV **12 Hours**

Machining Processes:

Introduction to machining: Principles and operations, Lathe, milling machine, drilling machine, and grinding machine, Materials, geometry, and selection, Cutting speed, feed, depth of cut, and their effects on machining performance, Surface finish and tolerances in machining. CNC machining. **CO's: CO4**

Self-Learning Topics: Turning, milling, and drilling, grinding, machine tools, cutting tool materials, and machining parameters affecting performance.

UNIT–V **10 Hours**

Joining Processes:

Welding: Types of welding processes (arc welding, MIG, TIG, resistance welding), welding defects, and inspection, **Brazing and soldering:** Processes, applications, and advantages, **Mechanical fastening:** Riveting, bolting, and clinching, **adhesive bonding:** Types of adhesives, applications, and advantages. Friction stirs welding. **CO's: CO5**

Self-Learning Topics: Arc welding, MIG, TIG, resistance welding, brazing, soldering, fastening methods, and adhesive bonding.

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Manufacturing Engineering and Technology by Serope Kalpakjian and Steven R. Schmid.
2. Fundamentals of Modern Manufacturing by Mikell P. Groover.
3. Manufacturing Processes for Engineering Materials by Serope Kalpakjian.

Reference Books:

1. Manufacturing Engineering and Technology – Serope Kalpakjian & Steven Schmid
2. Manufacturing Technology: Materials, Processes, and Equipment – Helmi A. Youssef et al.

Web References:

1. **https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-me51/**
2. **https://www.youtube.com** Ekeeda (Engineering simplified) , Gate Academy / Made Easy / Engineers Academy

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	20	-
L2 (Understanding)	40	-
L3 (Applying)	40	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remember

1. Define manufacturing process.
2. List any two casting processes.
3. What is forging?
4. Define machining.
5. What is welding defect?
6. Explain classification of manufacturing processes with examples.
7. Describe types of welding joints with neat sketches.

8. Discuss the role of automation in manufacturing industries.
9. Differentiate between primary and secondary manufacturing processes.
10. List types of welding processes.

L2 – Understand

1. Explain pattern in casting.
2. What is the principle of extrusion?
3. Define cutting speed in machining.
4. What is the purpose of flux in welding?
5. Differentiate between brazing and soldering.
6. Explain sand casting process with neat diagram.
7. Discuss die casting process and its applications.
8. Explain working principle of lathe machine.
9. Describe MIG and TIG welding processes.
10. Explain extrusion process.

L3 – Apply

1. Select a suitable casting process for automobile engine blocks.
2. Suggest a forming process for making aluminium sheets.
3. Identify suitable machining process for cylindrical parts.
4. Choose a welding process for thin sheet metals.
5. Explain selection criteria of manufacturing processes for different materials.
6. Demonstrate extrusion process with applications.
7. Apply machining parameters (speed, feed, depth of cut) and explain their effects.
8. Illustrate brazing process with suitable example.
9. Compare lathe, milling, and drilling operations.
10. Explain selection of joining processes for applications.

L4 – Analyze

1. Compare sand casting and die casting.
2. Analyze rolling and forging processes.
3. Distinguish between machining and non-traditional manufacturing processes.
4. Compare arc welding and resistance welding.
5. Compare various casting processes and their industrial applications.
6. Analyze sheet metal forming processes and their limitations.
7. Compare conventional and modern machining processes.
8. Analyze welding defects and methods of inspection.
9. Propose improvements to reduce defects in die casting processes.
10. Evaluate CNC machining vs conventional machining for precision manufacturing

L5 – Evaluate

1. Justify the selection of investment casting for precision components.
2. Evaluate advantages of CNC machining over conventional machining.
3. Assess the suitability of adhesive bonding in aerospace applications.
4. Which manufacturing process is most economical for mass production? Justify**.**
5. Evaluate selection of manufacturing process for automobile components.
6. Justify the use of modern welding techniques over conventional welding.
7. Critically evaluate machining parameters affecting surface finish.

8. Assess the role of additive manufacturing in modern industries.
9. Propose a cost-effective manufacturing system for rural industries.
10. Develop a hybrid manufacturing process combining casting, machining, and additive manufacturing.

Chairperson

Board of Studies (ME)

R24MEOE03 INTRODUCTION TO HYBRID VEHICLES 3 0 0 3

(Open Electives-I)

Course Objectives:

1. **To familiarize** students with the fundamentals, need, and applications of hybrid vehicles.
2. **To understand** the architecture and major components used in hybrid electric vehicles.
3. **To gain** knowledge of electric propulsion systems and different motors used in hybrid vehicles.
4. **To study** various hybrid electric vehicle configurations and their performance characteristics.
5. **To understand** energy storage systems, battery management systems, and emerging technologies used in hybrid vehicles.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24ME OE03.1	Explain the fundamentals, need, advantages, and applications of hybrid vehicles.	3	1	–	–	–	2	–	–	1	–	1	–	2	L1, L2
R24ME OE03.2	Describe the architecture and major components of hybrid electric vehicles.	3	2	1	–	1	–	–	–	1	–	1	2	2	L2, L3
R24ME OE03.3	Analyze electric propulsion systems and select suitable motors for hybrid vehicles.	3	3	2	1	2	–	–	–	1	–	1	3	2	L3. L4
R24ME OE03.4	Compare different hybrid electric vehicle configurations and evaluate their performance.	3	3	2	2	1	1	–	–	1	–	1	2	3	L3, L4
R24ME OE03.5	Analyze various energy storage systems, battery management systems, and emerging technologies used in hybrid vehicles.	3	3	2	2	2	2	–	–	1	–	2	2	3	L4, L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Hybrid Vehicles, need for hybrid vehicles, history and evolution of hybrid vehicles, advantages and disadvantages of hybrid vehicles, environmental impact and energy conservation, classification of hybrid vehicles, and applications of hybrid vehicles. **CO's: CO1**

Self-Learning Topics: Latest hybrid vehicle technologies and global HEV market trends.

UNIT-II **14 Hours**

Hybrid Vehicle Architecture Components of hybrid vehicles, internal combustion engine in HEVs, electric motor and generator, energy storage system, transmission system, series hybrid configuration, parallel hybrid configuration, series–parallel hybrid configuration, and plug-in hybrid electric vehicles (PHEVs). **CO's: CO2**

Self Learning Topics: Case studies of Toyota Prius and modern PHEV architectures.

UNIT–III **12 Hours**

Electric Propulsion System Basics of electric propulsion, traction motors for hybrid vehicles, DC motors, induction motors, permanent magnet synchronous motors (PMSM), brushless DC motors (BLDC), and motor characteristics and selection. **CO's:CO3**

Self-Learning Topics: Comparison of motors used in modern electric and hybrid vehicles.

UNIT–IV **12 Hours**

Hybrid Electric Vehicles Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs – Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples – Merits and Demerits. **CO's:CO4**

Self-Learning Topics: Emerging HEV configurations and future hybrid mobility solutions.

UNIT–V **10 Hours**

Energy Storage Systems Batteries used in hybrid vehicles, lead-acid batteries, nickel-metal hydride (NiMH) batteries, lithium-ion batteries, battery charging methods, battery management system (BMS), super capacitors, fuel cells, and energy management in hybrid vehicles. **CO's: CO5**

Self-Learning Topics: Recent advancements in lithium-ion batteries and hydrogen fuel cells.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. Tom Denton, Hayley Pells - Electric and hybrid vehicles, Third Edition, 2024

Reference Books:

1. Kumar - L. Ashok -and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2. Chau - Kwok Tong. Electric vehicle machines and drives: design -analysis and application. John Wiley & Sons - 2015.
3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge University Press - 2015.

Web References:

1. MOOC at https://www.edx.org/learn/electric-cars
2. https://archive.nptel.ac.in/courses/108/106/108106170

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	30
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define a Hybrid Electric Vehicle (HEV).
2. List any two advantages of hybrid vehicles.
3. What is regenerative braking?
4. Name the different types of hybrid vehicle configurations.
5. What is the function of a Battery Management System (BMS)?
6. Explain the history, evolution, and need for hybrid electric vehicles.
7. Discuss the classification, advantages, and disadvantages of hybrid vehicles.

Level 2: Understanding

1. Explain the need for hybrid electric vehicles.
2. Differentiate between series and parallel hybrid configurations.
3. Explain the role of traction motors in HEVs.
4. Describe the working principle of a lithium-ion battery.
5. Explain the environmental benefits of hybrid vehicles.
6. Describe the architecture and major components of a hybrid electric vehicle with neat sketches.
7. Explain the environmental impact and energy conservation aspects of hybrid vehicles.

Level-3: Applying

1. Select a suitable motor for a city electric bus and justify your choice.
2. Illustrate the energy flow in a plug-in hybrid electric vehicle (PHEV).
3. Apply the concept of regenerative braking in improving vehicle efficiency.
4. Compare the performance of BLDC and PMSM motors for HEV applications.
5. Determine the suitable energy storage system for a hybrid passenger car.
6. Compare series, parallel, and series–parallel hybrid configurations with suitable examples.
7. Explain different electric propulsion motors used in HEVs and justify their applications.
8. Discuss the selection criteria for traction motors used in hybrid vehicles.
9. Explain the working and applications of plug-in hybrid electric vehicles (PHEVs).

Level-4: Analyzing

1. Analyze the performance differences between series and parallel HEVs.
2. Examine the impact of hybrid vehicles on fuel consumption and emissions.
3. Analyze the advantages and limitations of fuel cells in HEVs.
4. Compare different battery technologies used in hybrid vehicles.

5. Analyze the efficiency characteristics of electric propulsion systems in HEVs.
6. Analyze the performance characteristics of different hybrid vehicle configurations.
7. Compare lead-acid, NiMH, and lithium-ion batteries used in hybrid vehicles.
8. Analyze the role of Battery Management Systems (BMS) in improving battery life and safety.
9. Evaluate the advantages and challenges of fuel-cell-based hybrid vehicles.
10. Analyze the energy management strategies used in hybrid electric vehicles.

Level-5: Evaluating

1. Evaluate the advantages of lithium-ion batteries in hybrid vehicles.
2. Justify the use of Battery Management Systems (BMS) in hybrid vehicles.
3. Evaluate the role of super capacitors in energy storage systems.
4. Compare fuel cells and conventional batteries for hybrid vehicle applications.
5. Justify the importance of energy management systems in hybrid vehicles.
6. Evaluate different battery technologies used in hybrid vehicles with respect to performance, efficiency, and applications.
7. Compare lead-acid, NiMH, and lithium-ion batteries used in hybrid vehicles.
8. Analyze and justify the role of Battery Management Systems (BMS) in improving battery safety and life.
9. Evaluate the advantages and limitations of fuel cells used in hybrid electric vehicles.

Chairperson

Board of Studies (ME)

R24MEOE04 FUNDAMENTALS OF THERMODYNAMICS 3 0 0 3
(Open Elective-IV)

Course Objectives:

1. **To introduce** the basic concepts and laws of thermodynamics.
2. **To understand** heat and work interactions in thermodynamic systems.
3. **To apply** the First and Second Laws of Thermodynamics to engineering systems.
4. **To study** properties of pure substances and vapor power cycles.
5. **To analyze** gas power cycles, refrigeration, and air-conditioning systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE 04.1	Explain the basic concepts of thermodynamics, thermodynamic systems, properties, processes, and heat–work interactions.	3	1	–	–	–	1	–	–	1	–	1	–	1	L1, L2
R24MEOE 04.2	Apply the First Law of Thermodynamics to closed and open systems and analyze engineering devices such as turbines, compressors, nozzles, and diffusers.	3	2	1	1	1	–	–	–	1	–	1	1	3	L2, L3
R24MEOE 04.3	Analyze the Second Law of Thermodynamics, entropy concepts, and the performance of heat engines, refrigerators, and heat pumps.	3	3	1	2	1	1	–	–	1	–	1	–	3	L2, L3
R24MEOE 04.4	Interpret the properties of pure substances and evaluate vapor power cycles such as Carnot and Rankine cycles.	3	2	2	2	1	–	–	–	1	–	1	1	3	L3, L4
R24MEOE 04.5	Compare gas power cycles and refrigeration systems used in engineering applications.	3	3	2	2	1	2	–	–	1	–	1	1	3	L4, L5

SYLLABUS

UNIT-I **14 Hours**

Introduction and Basic Concepts, Thermodynamic systems, surroundings, properties, state, process, cycle, thermodynamic equilibrium, reversible and irreversible processes, Zeroth Law of

Thermodynamics, temperature scales, heat and work interactions. **CO's: CO1**

Applications: The concepts of thermodynamics are applied in thermometers, piston-cylinder devices, IC engines, thermo flasks, and pressure cookers.

Self-Learning Topics: modern temperature measuring devices, energy conservation methods, applications of reversible and irreversible processes, and thermodynamic analysis of household appliances.

UNIT-II **14 Hours**

First Law of Thermodynamics First Law for closed and open systems, internal energy, enthalpy, specific heats, steady-flow energy equation, PMM-I, analysis of nozzles, turbines, compressors, and diffusers. **CO's: CO2**

Applications: team turbines, gas turbines, compressors, nozzles, diffusers, and power generation systems.

Self-Learning Topics: Energy analysis of engineering devices, modern turbine technologies, applications of steady-flow systems, industrial compressors and their uses, and practical limitations of PMM-I.

UNIT–III **12 Hours**

Second Law of Thermodynamics and Entropy Heat engines, refrigerators, heat pumps, Kelvin–Planck and Clausius statements, Carnot cycle, entropy, Clausius inequality, entropy generation, T–s diagrams.

Applications: refrigerators, heat pumps, air-conditioning systems, thermal power plants, and automobile engines **CO's:CO3**

Self-Learning Topics: applications of entropy, efficiency improvement of heat engines, advanced refrigeration systems, environmental impact of refrigeration, and entropy generation in practical systems.

UNIT–IV **12 Hours**

Properties of Pure Substances and Vapor Power Cycles Steam properties, p-v-T diagrams, dryness fraction, Mollier chart, Carnot vapor cycle, Rankine cycle. **CO's:CO4**

Applications: steam power plants, boilers, steam engines, thermal power stations, and industrial steam systems.

Self-Learning Topics: use of Mollier charts in industries, advanced steam cycles, superheated and wet steam applications, efficiency improvement in Rankine cycle, and modern vapor power plants.

UNIT–V **10 Hours**

Gas Power Cycles and Refrigeration Systems Otto, Diesel, Dual, Brayton cycles, refrigeration cycles, Bell-Coleman cycle, vapour compression refrigeration system, COP, air-conditioning systems. **CO's: CO5**

Applications: gas turbine power plants, refrigerators, air conditioners, and aircraft propulsion systems.

Self-Learning Topics: hybrid refrigeration systems, green refrigerants, modern gas turbine technologies, energy-efficient air-conditioning systems, and comparison of power cycles used in automobiles

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Engineering Thermodynamics by P.K. Nag – Tata McGraw Hill Education.
2. Engineering Thermodynamics by R.K. Rajput – Laxmi Publications.
3. Thermodynamics: An Engineering Approach by Yunus A. Çengel and Michael A. Boles – McGraw Hill Education.
4. Fundamentals of Engineering Thermodynamics by Moran and Shapiro – Wiley Publications.
5. Engineering Thermodynamics by K. Ramakrishna – Universities Press.

Reference Books:

1. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley.
3. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley.
4. .B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons.

Web References:

1. NPTEL – Thermodynamics Course – Online course covering fundamental concepts of thermodynamics, laws of thermodynamics, entropy, and engineering applications.
2. NPTEL – Basic Thermodynamics – Lecture materials and video content on basic thermodynamic concepts and applications.
3. NPTEL – Engineering Thermodynamics, IIT Kanpur – Comprehensive online lectures on engineering thermodynamics and power cycles.
4. SWAYAM Online Courses – Government online learning platform providing thermodynamics and thermal engineering courses.
5. NPTEL YouTube – Introduction and Fundamental Concepts of Thermodynamics – Video lectures explaining basic thermodynamic principles and applications.
6. NPTEL – Basic Engineering Thermodynamics – Course covering work and heat interactions, entropy, and thermodynamic cycles.
7. NPTEL – Elementary Thermodynamics for All – Introductory thermodynamics course discussing energy, entropy, and thermodynamic laws.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	30
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define thermodynamic system.
2. What is thermodynamic equilibrium?
3. State Zeroth Law of Thermodynamics.
4. Define heat and work.
5. What is a reversible process?
6. Explain the basic concepts of thermodynamics with examples.
7. Discuss thermodynamic systems, surroundings, boundaries, and properties.
8. Explain heat and work interactions in thermodynamic systems.

Level 2: Understanding

1. State the First Law of Thermodynamics.
2. Define enthalpy and internal energy.
3. What is PMM-I?
4. Explain the function of a nozzle.
5. Differentiate between nozzle and diffuser.
6. Explain the First Law of Thermodynamics for closed systems.
7. Derive the steady-flow energy equation for open systems.
8. Discuss the applications of the First Law in turbines and compressors.
9. Explain heat and work interactions in thermodynamic systems

Level-3: Applying

1. Define entropy.
2. State Kelvin–Planck statement.
3. What is a heat pump?
4. Define Rankine cycle.
5. Differentiate between wet steam and dry steam.
6. Explain the Second Law of Thermodynamics with Kelvin–Planck and Clausius statements.
7. Analyze the performance of heat engines, refrigerators, and heat pumps.
8. Explain entropy generation in reversible and irreversible processes.
9. Explain the properties of pure substances using p-v-T and T-s diagrams.
10. Discuss Carnot vapor cycle with neat sketch.
11. Analyze Rankine cycle with T-s diagram and applications

Level-4: Analyzing

1. Define Brayton cycle.
2. What is COP of refrigerator?
3. Define Bell-Coleman cycle.
4. Differentiate between Otto and Diesel cycles.
5. What is vapour compression refrigeration system?
6. Compare Otto, Diesel, and Dual cycles with neat diagrams.
7. Analyze Brayton cycle and its applications in gas turbines.
8. Compare different refrigeration systems and evaluate their performance.

Level-5: Evaluating

1. Evaluate the efficiency of Otto and Diesel cycles used in automobiles.
2. Justify the use of Brayton cycle in gas turbine power plants.

3. Evaluate the performance of vapour compression refrigeration systems.
4. Compare Bell-Coleman cycle and vapour compression refrigeration cycle.
5. Justify the use of green refrigerants in refrigeration systems.
6. Evaluate Otto, Diesel, and Dual cycles with respect to efficiency and applications.
7. Compare Brayton cycle and Rankine cycle used in power generation systems.
8. Evaluate the performance characteristics of vapour compression refrigeration systems.
9. Analyze and justify the use of Bell-Coleman cycle in aircraft refrigeration systems.
10. Evaluate the role of COP in refrigeration and air-conditioning systems.

Chairperson

Board of Studies (ME)

R24MEOE05 **ENGINEERING MATERIALS** **3 0 0 3**
(Open Elective-I)

Course Objectives:

1. **To understand** the fundamental concepts of engineering materials, their classification, and structure–property relationships.
2. **To Gain knowledge** of metallic materials, phase diagrams, and heat treatment processes to improve material properties.
3. **To learn** the behavior, properties, and applications of non-metallic materials such as polymers, ceramics, and composites.
4. **To understand** mechanical behavior of materials including deformation, fracture, fatigue, and creep, along with testing methods.
5. **To develop** the ability to select suitable materials for engineering applications based on performance, environment, and cost considerations.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE05.1	Explain the classification, crystal structures, and basic properties of engineering materials.	3	2	1	-	1	1	1	-	1	-	1	2	2	L1 L2
R24MEOE05.2	Describe metallic materials, phase diagrams, and heat treatment processes for improving material properties.	3	3	2	2	2	1	1	1	1	-	1	2	3	L3 L4
R24MEOE05.3	Analyze the properties, behavior, and applications of polymers, ceramics, and composite materials.	2	3	2	1	2	2	1	1	1	-	1	2	3	L3 L5
R24MEOE05.4	Apply knowledge of mechanical behavior and testing methods to evaluate material performance under different conditions.	2	3	3	3	3	2	1	2	2	1	2	3	3	L4 L3

R24MEOE05.5	Evaluate and select suitable engineering materials for specific applications considering mechanical, thermal, and environmental factors.	3	3	3	2	2	3	1	2	2	2	2	3	3	L5 L4

SYLLABUS

UNIT-I **14 Hours**

Introduction to Engineering Materials:

Classification of engineering materials: metals, ceramics, polymers, composites Structure of materials: atomic structure, crystal systems (BCC, FCC, and HCP) Crystal defects: point, line, and surface defects Mechanical properties: strength, hardness, toughness, ductility Stress–strain curve and elastic constants Selection of materials based on applications. **CO's: CO1**

Self-Learning Topics: Advanced understanding of crystal structures (BCC, FCC, HCP), crystal defects and their influence on material properties

UNIT-II **14 Hours**

Metallic Materials:

Types of metals and alloys Iron–carbon equilibrium diagram Properties of steel and cast-iron Heat treatment processes: annealing, normalizing, hardening, tempering Surface hardening methods: carburizing, nitriding, induction hardening Alloy steels and their applications. **CO's: CO2**

Self-Learning Topics: Iron–carbon equilibrium diagram interpretation, properties of steel and cast iron

UNIT–III **12 Hours**

Non-Metallic Materials:

Polymers: types, properties, and applications (thermoplastics, thermosets, and elastomers) Ceramics properties, classification, and industrial applications Glasses types and uses Composites classification, properties, and applications advanced materials smart materials, biomaterials. **CO's:CO3**

Self-Learning Topics: Types and properties of polymers (thermoplastics, thermosets, elastomers), ceramics classification and application

UNIT–IV **12 Hours**

Mechanical Behavior and Testing of Materials:

Elastic and plastic deformation Fracture: brittle and ductile fracture Creep and fatigue behaviour Hardness tests: Brinell, Rockwell, Vickers Tensile, compression, and impact testing Non-destructive testing (NDT) ultrasonic, radiography, magnetic particle inspection. **CO's:CO4**

Self-Learning Topics: Elastic and plastic deformation behavior, fracture mechanics (ductile and brittle fracture), creep and fatigue analysis, hardness testing methods

UNIT–V **10 Hours**

Advanced Engineering Materials:

Nanomaterials: classification, properties, synthesis methods, and characteristics Dielectricmaterials: Properties and types Refractory materials: properties and classification Biomaterials: metallic, ceramic, polymeric biomaterials Shape memory alloys and smart materials Eco-friendly and biodegradable materials Recycling of engineering materials**.** **CO's: CO5**

Self-Learning Topics: Recent developments in nanomaterials, Comparison of smart materials and conventional materials, Sustainable materials for future industries

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Engineering Materials & Metallurgy O. P. Khanna
2. Material Science & Engineering V. Raghavan
3. Manufacturing Processes for Engineering Materials by Serope Kalpakjian.

Reference Books:

1. **P.N.Rao** Manufacturing Technology (Vol 1 & 2) Manufacturing Technology
2. **Donald R. Askeland** Materials Science and Engineering.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remember

1. Define engineering materials.
2. Define stress and strain.
3. What is annealing?
4. What are polymers?
5. Name any two hardness tests.
6. What is composite material?
7. What is tensile strength?
8. List types of crystal structures in metals.
9. Define heat treatment.
10. What are ceramics?

L2 – Understand

1. Explain crystal structure.
2. What is the purpose of heat treatment?
3. Differentiate between thermoplastics and thermosets.
4. Explain fatigue in materials.
5. What is corrosion?

6. Explain ductility and toughness.
7. Explain phase diagram and its importance.
8. Describe properties of ceramics.
9. Explain composite materials with examples.
10. Describe normalizing process.

L3 – Apply

1. Suggest a suitable material for automobile body and justify.
2. Identify a suitable heat treatment process for hardening steel.
3. Choose a polymer for electrical insulation applications.
4. Select a testing method to determine material hardness.
5. Analyze failure modes in materials under load.
6. Explain impact of grain size on material strength.
7. Compare tensile and hardness test results.
8. Analyze applications of composites in aerospace.
9. Explain selection of materials for automotive parts.
10. Discuss deformation behavior of metals under stress.

L4 – Analyze

1. Compare FCC and BCC crystal structures.
2. Differentiate between creep and fatigue failure.
3. Compare ceramics and metals based on properties.
4. Analyze different types of corrosion.
5. Evaluate different heat treatment methods for tool steel.
6. Propose suitable material for marine applications with justification.
7. Investigate fatigue failure in machine components.
8. Evaluate ceramic materials for cutting tool applications.
9. Design a testing method to analyze material strength.
10. Recommend materials for high-temperature turbine blades.

L5 – Evaluate

1. Justify the use of composites in aerospace applications.
2. Evaluate the importance of heat treatment in improving material properties.
3. Which material is best for high-temperature applications? Justify.
4. Evaluate the need for NDT methods in industry.
5. Evaluate the role of engineering materials in aerospace and automotive industries.
6. Justify the importance of heat treatment in manufacturing industries.
7. Critically evaluate failure mechanisms in materials and prevention methods.
8. Assess the importance of material selection in engineering design.
9. Design eco-friendly heat treatment process with low energy use.
10. Develop advanced ceramic materials for extreme environments.

Chairperson

Board of Studies (ME)

R24MEPC16 **THERMAL ENGINEERING LAB** **0 0 3 1.5**

(Mechanical Engineering)

Course Objectives:

1. **To provide** practical knowledge on the construction, working, and testing of I.C. engines, boilers, and compressors.
2. **To familiarize** students with fuel testing methods and measurement of engine performance parameters such as brake power, friction power, heat balance, and exhaust emissions.
3. **To develop** experimental and analytical skills through performance testing of thermal engineering systems and interpretation of test results.
4. **To impart** hands-on experience in assembly, disassembly, maintenance, and operation of automobile and thermal engineering equipment.
5. **To enhance** the understanding of modern testing methods, safety practices, and engineering tools used in thermal and automobile engineering laboratories.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC16 .1	Conduct experiments on IC engines, fuels, boilers, and compressors to understand their construction, working principles, and operating characteristics.	3	2	-	2	2	-	-	1	1	1	-	2	3	L2
R24MEPC16 .2	Evaluate and analyze engine performance, fuel properties, friction power, heat balance, and exhaust emissions using standard experimental methods and engineering tools.	3	3	2	3	2	2	-	1	2	1	-	2	3	L3
R24MEPC16 .3	Demonstrate practical skills in testing, maintenance, assembly/disassembly, and interpretation of experimental results related to automobile and thermal engineering systems.	2	2	2	3	3	1	-	2	2	2	-	3	3	L3

List of Experiments:

WEEK 1

1. I.C. Engines valve / port timing diagrams. **CO's: CO1**

WEEK 2

2. Performance test on reciprocating air compressor unit. **CO's: CO1**

WEEK 3

3. Study of boilers, mountings and accessories **CO's: CO1**

WEEK 4

4. Testing of Fuels – Viscosity, flash point/fire point, carbon residue, calorific value. **CO's: CO2**

WEEK 5

5. Performance test and Exhaust emission measurements (4 -stroke CI) **CO's: CO2**

WEEK 6

6. Performance test and Exhaust emission measurements (2-stroke SI) **CO's: CO2**

WEEK 7

7. Determination of FP by retardation and motoring test on IC engine. **CO's: CO2**

WEEK 8

8. Morse Test on Multi-Cylinder SI Engine **CO's: CO3**

WEEK 9

9. I.C. Engines heat balance at different loads and show the heat distribution curve. **CO's: CO3**

WEEK 10

10. Economical speed test of an IC engine. **CO's: CO3**

WEEK 11

11. Performance test on variable compression ratio engines. **CO's: CO3**

WEEK 12

12. Assembly & Disassembly of Automobile Engines **CO's: CO3**

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Internal Combustion Engines by V. Ganesan, Tata McGraw-Hill Education.
2. A Course in Thermal Engineering by R. S. Khurmi and J. K. Gupta, S. Chand Publications.
3. Thermal Engineering by R. K. Rajput, Laxmi Publications.
4. Internal Combustion Engines by M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications.

Reference Books:

1. Fundamentals of Internal Combustion Engines by H. N. Gupta, PHI Learning.
2. Thermal Engineering by P. L. Ballaney, Khanna Publishers.
3. Engineering Thermodynamics and Thermal Engineering by J. B. Gupta, S.K. Kataria & Sons.
4. Internal Combustion Engines by V. Ganesan, McGraw-Hill Education.
5. Heat Engines by V. P. Vasandani and D. S. Kumar, Metropolitan Book Company.

Online Learning Resources:

1. Virtual Labs – Ministry of Education, Government of India
2. NPTEL Online Courses – Thermal Engineering
3. IIT Kharagpur Virtual Lab – IC Engines Lab
4. IIT Virtual Labs – Mechanical Engineering Experiments

Chairperson

Board of Studies (ME)

R24MESC03 **PYTHON PROGRAMMING LAB** **0 1 2 2**

(Mechanical Engineering)

Course Objectives:

1. **To understand** and implement numerical methods for solving algebraic and matrix equations using Python programming.
2. **To apply** Python programming for numerical integration, curve fitting, and eigen value problems.
3. **To develop** numerical solutions for ordinary and partial differential equations using computational techniques in Python.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs								Dok
		PO1	PO2	PO3	PO4	PO5	PO9	PSO1	PSO2	
R24MESC03.1	Develop Python programs to solve non-linear equations, systems of linear equations, and matrix problems using numerical methods.	3	3	2	2	3	2	3	2	L1 L2
R24MESC03.2	Apply numerical techniques for curve fitting, interpolation, numerical integration, and eigen value problems using Python programming.	3	2	2	2	3	-	3	2	L2 L3
R24MESC03.3	Develop numerical solutions for ordinary and partial differential equations using computational methods in Python.	3	3	2	3	3	-	3	3	L3

Write Programs in PYTHON Programming for the following:

WEEK 01

1. To find the roots of non-linear equation using Newton Raphson's method. **CO's: CO1**

WEEK 02

2. To solve the system of linear equations using Gauss - elimination method **CO's: CO1**

WEEK 03

3. To solve the system of linear equations using Gauss - Siedal method **CO's: CO1**

WEEK 04

4. To solve the system of linear equations using Gauss - Jordan method **CO's: CO1**

WEEK 05

5. Curve fitting by least – square approximations **CO's: CO2**

WEEK 06

6. To integrate numerically using Trapezoidal rule **CO's: CO2**

WEEK 07

7. To integrate numerically using Simpsons rule **CO's: CO2**

WEEK 08

8. To find the largest eigen value of a matrix by Power – method **CO's: CO2**

WEEK 09

9. To find numerical solution of ordinary differential equations by Euler's method **CO's: CO3**

WEEK 10

10. To find numerical solution of ordinary differential equations by Runge-Kutta method **CO's: CO3**

WEEK 11

11. To find the numerical solution of Laplace equation **CO's: CO3**

WEEK 12

12. To find the numerical solution of Wave equation **CO's: CO3**

WEEK 13

13. To find the solution of a tri-diagonal matrix using Thomas algorithm **CO's: CO3**

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Online Resources:

1. https://www.udemy.com/course/python-the-complete-python-developer-course/?matchtype=e&msclkid=0584dfb54dc715f39c0bb9aaf74033be&utm_campaign=BG-Python_v.PROF_la.EN_cc.INDIA_ti.7380&utm_content=deal4584&utm_medium=udemyads&utm_source=bing&utm_term=_._ag_1220458320107116_._ad__._kw_Python+language_._de_c_._dm__._pl__._ti_kwd-76278984197882%3Aloc-90_._li_116074_._pd__._&couponCode=IND21PM
2. https://www.w3schools.com/python/python_intro.asp
3. https://www.youtube.com/watch?v=eWRfhZUzrAc
4. https://onlinecourses.nptel.ac.in/noc20_cs83/preview
5. https://www.edx.org/learn/python
6. Virtual Labs - https://python-iitk.vlabs.ac.in/
7. Virtual Labs - https://virtual-labs.github.io/exp-arithmetic-operations-iitk/
8. Virtual Labs - https://cse02-iiith.vlabs.ac.in/
9. https://mlritm.ac.in/assets/cse/cse_lab_manuals/R20_cse_manuals/Python%20Lab%20Manual.pdf

Chairperson

Board of Studies (ME)

R24MEPC17 MACHINE TOOLS &METROLOGY LAB 0 0 3 1.5

(Mechanical Engineering)

Course Objectives:

1. **To interpret** the working principles of various machines viz lathe, Drilling, milling, shaping.
2. **To illustrate** the usage of CNC in Lathe and Milling machines.
3. **To learn** about basic measuring instruments vernier callipers, screw gauge, vernier height gauge.
4. **To learn** the measurement of the angle and taper by Bevel protractor, Sine bar, etc.
5. **To learn** about Mechanical parameter measuring systems and different alignment techniques.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC17.1	Perform machining operations such as turning, threading, drilling, milling, shaping, grinding, and CNC machining using general-purpose machines.	3	2	-	2	2	-	-	1	1	1	-	2	3	L1 L2
R24MEPC17.2	Apply machining techniques to manufacture components like gears, splines, tapers, and threaded parts with required accuracy.	3	3	2	3	2	2	-	1	2	1	-	2	3	L2 L3
R24MEPC17.3	Use precision measuring instruments such as vernier calipers, micrometers, bevel protractors, sine bars, and surface roughness testers for dimensional inspection and quality control.	2	2	2	3	3	1	-	2	2	2	-	3	3	L3 L4

List of Experiments

WEEK 1

1. Introduction of general-purpose machines -Lathe, drilling machine, Milling machine, Shaper **CO's: CO1**

WEEK 2

2. To perform Step turning and taper turning on lathe machine **CO's: CO1**

WEEK 3

3. To perform Thread cutting and knurling on lathe machine. **CO's: CO1**

WEEK 4

4. To perform Thread cutting and knurling on lathe machine **CO's: CO1**

WEEK 5

5. To perform flat surface operation on a block using shaper. **CO's: CO1**

WEEK 6

6. To perform Drilling & Tapping operations **CO's: CO2**

WEEK 7

7. To perform precise surface grinding operations. . **CO's: CO2**

WEEK 8

8. To perform precision cylindrical grinding operations. **CO's: CO2**

WEEK 9

9. To perform splines on a block using slotting machine **CO's: CO2**

WEEK 10

10. Measurement of lengths, heights, diameters by vernier calliper's, micrometres etc. **CO's: CO2**

WEEK 11

11. Measurement of bores by internal micrometre and dial bore indicators **CO's: CO2**

WEEK 12

12. To Study the Angle and taper measurements by Bevel protractor, Sine bars, etc. **CO's: CO2**

WEEK 13

13. Measurements by Gear Tooth Vernier Callipers **CO's: CO3**

WEEK 14

14. To study about the Tool makers microscope and its application **CO's: CO3**

WEEK 15

15. Surface Roughness Measurement **CO's: CO3**

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Online Learning Resources:

1. **Mechanical Engineering Labs**: https://www.vlab.co.in/broad-area-mechanical-engineering vlab.co.in+2vlab.co.in+2Wikipedia+2
2. **Dynamics of Machines Lab**: https://dom-nitk.vlabs.ac.in/iitb.vlabs.co.in+4dom-nitk.vlabs.ac.in+4mm-nitk.vlabs.ac.in+4
3. **Mechanics of Machines I Lab**: https://mm-nitk.vlabs.ac.in/mm-nitk.vlabs.ac.in

Chairperson
Board of Studies (ME)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech Mechanical Engineering **Regulation: R24**

Course Structure: III Year II Semester (or) Semester-VI

S.No	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	PC	R24MEPC18	Heat Transfer	3	0	0	3
2	PC	R24MEPC19	Introduction to Artificial Intelligence and Machine Learning	3	0	0	3
3	PC	R24MEPC20	Drone Technology	3	0	0	3
4	PE-II	R24MEPE06 R24MEPE07 R24MEPE08 R24MEPE09 R24MEPE10	1. Industrial Robotics 2. Mechatronics 3. Supply chain management 4. Total Quality Management 5. 12 Week MOOCS Swayam/NPTEL Course recommended by the BoS	3	0	0	3
5	OE-II	R24MEOE06 R24MEOE07 R24MEOE08 R24MEOE09 R24MEOE10	1. Computer Aided Design (CAD) 2. Introduction to Automobile Engineering 3. Green Manufacturing Technology 4. Industrial Engineering 5. Automation In Manufacturing	3	0	0	3
6	PC	R24MEPC21	Heat Transfer Lab	0	0	3	1.5
7	PC	R24MEPC22	Introduction to Artificial Intelligence and Machine Learning Lab	0	0	3	1.5
8	SC	R24MESC04	Simulation & I and CS Lab	0	1	2	2
9	HS	R24HS09	High Level Reasoning and Employability Skills	0	0	2	1
10	AC-I	R24AC01	Technical Paper Writing and Intellectual Property Rights	2	0	0	0
			Total	**17**	**01**	**10**	**21**
Mandatory Internship of 08 weeks duration during summer vacation							

Category	Courses	Credits
PC- Professional Core Courses	5	12
PE- Professional Elective Courses	1	03
OE- Open Elective Courses	1	03
HS- Humanity Science and Management Courses	1	01
SC- Skill Oriented Courses	1	2
AC-Audit Course	1	0
Total	10	21

R24MEPC18 **HEAT TRANSFER** **3 0 0 3**

(Heat transfer data book allowed)

(Mechanical Engineering)

Course Objectives:

1. **To understand** and apply the knowledge of conduction mode of heat transfer in steady and unsteady conditions To design the fin at desired locations for a specified heat transfer rate
2. **To understand** the knowledge of free and forced mode of heat transfer
3. **To understand** the boiling and condensation, and to design the heat exchanger
4. **To understand** and apply the knowledge of radiation mode of heat transfer
5. **To understand** the basics of radiation and analogy

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC 18.1	Explain modes of heat transfer and analyze conduction in simple and composite systems.	3	2	-	-	2	-	-	-	-	-	1	2	2	L1 L2
R24MEPC 18.2	Evaluate heat transfer in fins and transient conduction systems.	3	3	-	2	2	-	-	-	-	-	1	3	2	L2 L3
R24MEPC 18.3	Analyze natural and forced convection using relevant dimensionless parameters.	3	3	-	2	2	-	-	-	-	-	1	2	3	L3 L4
R24MEPC 18.4	Assess boiling, condensation, and heat exchanger performance.	3	3	2	2	2	-	-	-	-	-	1	2	3	L4 L5
R24MEPC 18.5	Apply radiation laws to solve heat transfer problems.	3	2	-	-	2	-	-	-	-	-	1	2	2	L6

SYLLABUS

UNIT-I **12 Hours**

Modes of Heat Transfer: Conduction, Convection, and Radiation.

Conduction-I: Fourier law of heat conduction - General heat conduction equation in Cartesian and cylindrical coordinates, Steady state heat Conduction through plane and cylindrical walls - Composite systems, Critical radius of insulation **CO's:CO1**

Self-learning Topics – Advanced insulation materials and composite systems.

UNIT-II **14 Hours**

Conduction-II: Heat Transfer through Fins - Infinite long fin, insulated at tip and convection heat transfer from tip, Fin equation for Heat transfer Efficiency and Effectiveness.

Transient Heat Conduction: Lumped System analysis, Use of Heisler's Charts.

Self-learning Topics – CFD analysis of fins and transient heat transfer. **CO's: CO2**

UNIT-III **14 Hours**

Natural Convection: Introduction to velocity and thermal boundary layers. - Nusselt number, Grashof Number, Prandtl Number and Reynolds Number, Flow over Horizontal and vertical plates. **Forced Convection:** External Forced convection - Laminar and Turbulent flow over plates, Internal Forced convection - Laminar and Turbulent flow through pipes, Heat transfer coefficients.

Self-learning Topics – Boundary layer theory and turbulence modeling. **CO's:CO3**

UNIT-IV **14 Hours**

Boiling and Condensation: Introduction to Boiling, Types of Boiling, Boiling curve. Introduction to condensation, types of condensation.

Heat Exchangers: Classification - Nature of heat exchange, direction of flow, mechanical design, physical state of fluid, Overall heat transfer coefficient, Heat Exchanger analysis - LMTD & Effectiveness NTU, Problems using LMTD and NTU methods.

Self-learning Topics – compact heat exchangers and phase change heat transfer. **CO's:CO4**

UNIT-V **12 Hours**

Radiation: Classification of Radiative bodies, Radiation Laws: Wein‟s law, Stefan-Boltzman law, Kirchhoff‟s law - Black body radiation, Shape factor - Radiation heat exchange between Gray bodies - Electrical analogy for radiation networks.

Self-learning Topics – Radiation exchange analysis and space heat transfer. **CO's:CO5**

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Heat and Mass Transfer, Fundamentals and applications, Yunus A.Cengel and A.J.Ghajar, McGraw Hill Education
2. Fundamentals of Engineering Heat and Mass Transfer, R.C.Sachdeva, New Age Pub.
3. Heat Transfer Databook, C.P.Kothandaraman, New Age Pub**.(Permitted for Exams)**

Reference Books:

1. Fundamentals of Heat Transfer by Incropera& Dewitt, John wiley
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, NewAge.
3. Heat& Mass Transfer by Amit Pal – Pearson Publishers
4. Heat Transfer by Ghosh dastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, DhanpatRai Pub

Web References:

1. **https://onlinecourses.nptel.ac.in/noc26_ch10/preview**
2. **https://onlinecourses.nptel.ac.in/noc25_ch26/preview**
3. **https://onlinecourses.nptel.ac.in/noc26_me53/preview**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	

L3	30	40
L4	--	40
L5	--	10
L6	--	10
Total (%)	**100**	**100**

Sample Questions of Various Cognitive Levels

L1: Remember

1. Define conduction, convection, and radiation.
2. State Fourier's law of heat conduction.
3. What is thermal conductivity?
4. Define fin efficiency.
5. Explain black body radiation.
6. What is critical radius of insulation?
7. Define Nusselt number.
8. What is LMTD in heat exchangers?
9. Explain boiling and condensation.
10. Calculate heat flux through a wall for given thermal conductivity and temperature difference.

L2: Understand

1. Explain transient heat conduction using lumped system analysis.
2. Discuss heat transfer through fins.
3. Explain parallel and counter flow heat exchangers.
4. Describe natural and forced convection.
5. Explain radiation exchange between gray bodies.
6. Calculate heat loss through a cylindrical pipe.
7. Determine effectiveness of a heat exchanger.
8. Calculate convection heat transfer coefficient for given data.
9. Solve a fin heat transfer problem.
10. Determine Biot number and comment on lumped system applicability.

L3: Apply

1. Compare natural and forced convection.
2. Analyze heat transfer through composite walls.
3. Compare parallel and counter flow heat exchangers.
4. Analyze factors affecting boiling heat transfer.
5. Compare film-wise and drop-wise condensation.
6. Analyze transient cooling of a metal sphere.
7. Evaluate fin performance under varying conditions.
8. Determine radiation heat transfer between two surfaces.
9. Analyze effectiveness of insulation in pipelines.
10. Compare laminar and turbulent convection heat transfer.

L4: Analyze

1. Design a heat exchanger for industrial application.
2. Propose methods to enhance heat transfer in condensers.
3. Design a thermal insulation system for pipelines.
4. Develop a cooling system for electronic equipment.

5. Analyze industrial applications of compact heat exchangers.
6. Calculate insulation thickness for minimum heat loss.
7. Design fin dimensions for maximum heat dissipation.
8. Analyze heat recovery systems for energy conservation.
9. Design a condenser for refrigeration systems.
10. Evaluate thermal management methods in power plants.

L4: Evaluating

1. Discuss advanced heat transfer enhancement techniques.
2. Analyze applications of nano-fluids in heat transfer.
3. Develop a smart thermal management system using IoT.
4. Investigate CFD applications in heat transfer analysis.
5. Propose sustainable thermal energy systems.
6. Evaluate performance improvement using nano-fluids.
7. Design an energy-efficient heat exchanger system.
8. Investigate advanced thermal storage technologies.
9. Analyze optimization techniques for industrial heat exchangers.
10. Develop renewable energy-based thermal systems for industrial use.

L5: Evaluate

1. Evaluate the performance of different types of fins used in heat transfer applications.
2. Assess the effectiveness of parallel flow and counter flow heat exchangers.
3. Evaluate the importance of insulation in reducing heat loss in thermal systems.
4. Compare and evaluate natural and forced convection heat transfer systems.
5. Assess the suitability of various boiling heat transfer methods in industrial applications.
6. Evaluate the efficiency of radiation shields in thermal engineering systems.
7. Compare film-wise and drop-wise condensation with respect to heat transfer rate.
8. Assess the impact of thermal conductivity on heat transfer through composite walls.
9. Evaluate industrial applications of compact heat exchangers.
10. Assess energy conservation techniques using heat recovery systems.

L6: Create

1. Design a heat exchanger for industrial cooling applications.
2. Develop a thermal insulation system for steam pipelines.
3. Design a fin arrangement for maximum heat dissipation.
4. Develop a cooling system for electronic equipment using convection techniques.
5. Design a radiation shielding system for high-temperature applications.
6. Propose a heat recovery system for industrial waste heat utilization.
7. Design an energy-efficient condenser for refrigeration applications.
8. Develop a thermal management system using nano-fluid technology.
9. Propose innovative methods to enhance boiling heat transfer.
10. Design a sustainable heat transfer system using renewable energy sources.

Chairperson
Board of Studies (ME)

R24MEPC19 Introduction to Artificial Intelligence and Machine Learning 3 0 0 3
(Mechanical Engineering)

Course Objectives:

1. **To train** the students to understand different types of AI & Applications of AI.
2. **To understand** various AI search algorithms.
3. **To Understand** different types of Machine learning & to know about data Preparation
4. **To introduce** the basic concepts and techniques of machine learning and the need for Machine learning techniques for real world problem
5. **To provide** understanding of various Machine learning algorithms and the way to evaluate the performance of ML algorithms

Course Outcomes:

At the end of the course, students will be able to:

Mapping with POs and PSOs															
Course Code	**Course Outcomes (COs)**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**Dok**
R24MEPC19.1	Understand different types of AI & Applications of AI	3	2	-	-	3	-	-	-	-	-	-	2	2	L1, L2
R24MEPC19.2	Understand the informed and uninformed problem types and apply search strategies to solve them.	3	3	2	2	3	-	-	-	-	-	-	3	2	L2, L4
R24MEPC19.3	Apply machine learning techniques in the design of computer systems	3	3	3	2	3	-	2	-	-	-	-	3	3	L4
R24MEPC19.4	To differentiate between various categories of ML algorithms	3	3	3	3	3	-	2	-	-	-	-	3	3	L3, L4
R24MEPC19.5	Design and make modifications to existing machine learning algorithms	3	2	2	2	3	2	2	-	-	1	-	2	3	L4, L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Artificial Intelligence Definition, History, Present state of Artificial Intelligence (AI), AI problems, Agents and Environments, Structure of Agents, Approaches to AI - Hard or Strong AI, Soft or Weak AI and Applications domains focused on mechanical engineering.

CO's: CO1

Self-Learning Topics: AI applications in smart manufacturing and Industry 4.0.

UNIT-II **14 Hours**

Problem Solving Methods 1.Uninformed search includes Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS) and bidirectional search. 2. Informed Search (heuristic search) includes greedy best first search, A* search.

CO's: CO2

Self-Learning Topics: Data visualization techniques using engineering datasets

UNIT–III **14 Hours**

Machine-Learning: Introduction. Machine Learning Systems, Forms of Learning: Supervised and Unsupervised Learning, reinforcement – theory of learning – feasibility of learning – Data Preparation– training versus testing and split. **CO's: CO3**

Self-Learning Topics: AI-based condition monitoring and fault diagnosis systems

UNIT–IV **12 Hours**

Supervised Learning - Definition, basic concepts, applications, Linear Regression, Multiple Linear Regression, Logistic Regression, Naive Bayes Classifiers, Support Vector Machines (SVM), Simple Examples. **CO's: CO4**

Self-Learning Topics: Applications of clustering in production systems

UNIT–V **10 Hours**

Unsupervised learning- Definition, basic concepts, applications, Nearest neighbor models-Kmeans Clustering, hierarchical Clustering– k-d trees, Simple Examples

Reinforcement Learning (RL) - Framework, Component of RL Framework, Simple Examples.

CO's: CO5

Self-Learning Topics: Emerging AI technologies for sustainable manufacturing and Industry 5.0

Board of Studies : Mechanical Engineering

Approved in BoS No : 03
Approved in ACM No: 03

Text Books:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall,.
2. M. Tim Jones, "Artificial Intelligence: A Systems Approach (Computer Science)",Jones and Bartlett Publishers, Inc.; 1st Edition, 2008.
3. Foundations of Artificial Intelligence and Expert Systems, V S Janakiraman, K Sarukesi, P Gopalakrishan, Macmillan India Ltd.

"**Reference Books:**

1. Nils J. Nilsson, "The Quest for Artificial Intelligence", Cambridge University Press,2009.

2. Python GUI programming Cookbook -Burkahard A Meier, PacktPublication, 2 nd Edition.
3. Barry, P. (2016). Head first Python: A brain-friendly guide. " O'Reilly Media, Inc.". Lutz, M. (2013). Learning python: Powerful object-oriented programming. "O'Reilly Media, Inc.

Web References:

1. http://greenteapress.com/wp/think-python/
2. https://books.google.co.in/books?id=uSvYmki2yg0C&printsec=frontcover&dq=Supervised+Learning&hl=en&sa=X&ved=0ahUKEwigkNa1xN3oAhWawjgGHe8hAzoQ6AEIKDAA#v=onepage&q=Supervised%2 0Learning&f=false
3. http://digimat.in/nptel/courses/video/106106202/L01.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	50
L4 (Analyzing)	-	40
L5 (Evaluating)	-	10
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remember

1. Define Artificial Intelligence (AI) and list its applications in Mechanical Engineering.
2. Define Intelligent Agent and mention its components.
3. List the types of AI and explain Strong AI and Weak AI.
4. Define uninformed search and informed search techniques.
5. Define Machine Learning and state its forms of learning.
6. List the steps involved in data preparation for machine learning.
7. Define Supervised Learning with examples.
8. Define Linear Regression and Logistic Regression.
9. Define K-Means Clustering and Hierarchical Clustering.
10. Define Reinforcement Learning and list its main components.

L2 – Understand

1. Explain the structure and working of an intelligent agent.
2. Describe the role of AI in smart manufacturing and Industry 4.0.
3. Explain the working of Breadth First Search (BFS) and Depth First Search (DFS).
4. Discuss the differences between informed and uninformed search methods.
5. Explain the concepts of training data, testing data, and validation data.
6. Describe the workflow of a machine learning system.
7. Explain the working principle of Linear Regression.
8. Explain the working of Logistic Regression with a suitable example.

9. Describe the process of K-Means Clustering.
10. Explain the Reinforcement Learning framework with a simple example.

L3 – Apply

1. Apply BFS to solve a given state-space search problem.
2. Apply DFS to traverse a given search tree.
3. Demonstrate the use of A* search in finding the shortest path.
4. Apply data preprocessing techniques to a given dataset.
5. Use Linear Regression to predict the output of an engineering dataset.
6. Apply Logistic Regression for a simple classification problem.
7. Implement Naïve Bayes classification for a sample dataset.
8. Apply Support Vector Machine (SVM) to classify engineering data.
9. Use K-Means Clustering to group similar manufacturing data.
10. Apply Reinforcement Learning concepts to a simple decision-making problem.

L4 – Analyze

1. Compare Strong AI and Weak AI with suitable examples.
2. Analyze the performance of BFS and DFS algorithms.
3. Compare Uniform Cost Search and A* Search.
4. Analyze the differences between supervised and unsupervised learning.
5. Compare Linear Regression and Logistic Regression.
6. Analyze the strengths and limitations of Naïve Bayes classifiers.
7. Compare SVM and Logistic Regression for classification tasks.
8. Analyze the impact of data preparation on machine learning performance.
9. Compare K-Means and Hierarchical Clustering techniques.
10. Analyze the challenges of applying AI in mechanical engineering systems.

L5 – Evaluate

1. Evaluate the role of AI in Industry 4.0 and smart manufacturing.
2. Assess the effectiveness of heuristic search techniques over uninformed search methods.
3. Evaluate different machine learning approaches for predictive maintenance.
4. Assess the suitability of Linear Regression for engineering prediction problems.
5. Evaluate the performance of SVM and Naïve Bayes classifiers.
6. Assess the importance of data preprocessing in machine learning.
7. Evaluate clustering techniques for production system analysis.
8. Assess the advantages and limitations of Reinforcement Learning.
9. Evaluate AI-based fault diagnosis systems in mechanical engineering.
10. Assess the impact of AI and ML on future manufacturing systems.

Chairperson

Board of Studies (ME)

R24MEPC20 **DRONE TECHNOLOGY** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. **To introduce** the fundamentals of drones, types, components, and regulatory aspects.
2. **To develop** skills in designing and assembling drone systems with appropriate components.
3. **To understand** the working and selection of drone motors, ESCs, and propulsion systems.
4. **To explain** flight mechanics and factors affecting drone performance and control.
5. **To explore** various commercial, industrial, and emerging applications of drones.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC 20.1	Explain fundamentals of drones, components, types, and regulatory guidelines.	3	2	-	-	2	2	-	-	-	-	-	2	2	L1 L2
R24MEPC 20.2	Design and assemble drone systems by selecting appropriate components and basic control coding.	3	3	2	2	3	-	-	2	2	-	-	3	2	L2 L3
R24MEPC 20.3	Analyze drone motors and ESC performance based on thrust, KV rating, and configuration.	3	3	-	2	2	-	-	-	-	-	-	3	2	L3 L4
R24MEPC 20.4	Apply flight mechanics principles to evaluate drone performance and select suitable controllers.	3	3	2	2	3	-	-	-	-	-	-	3	3	L4 L5
R24MEPC 20.5	Assess various drone applications including GPS navigation, camera systems, and industrial uses.	3	2	2	-	2	2	2	-	-	1	-	2	3	L5

SYLLABUS

UNIT-I **12 Hours**

Basics of Drones: Definition and history of drones, Types of drones and their applications, Drone components and terminology, Regulations and Guidelines for drone usage. **CO's:CO1**

Self learning Topics: Drone regulations and advanced drone applications.

UNIT-II **14 Hours**

Drone Design and Assembly: Design considerations for drone airframe and propulsion systems, Selecting and assembling drone components such as motors, batteries, flight controllers, and

cameras, Basic wiring and soldering techniques. **CO's: CO2**

Self learning Topics: Flight controller coding and drone frame design.

UNIT-III **14 Hours**

Drone Motors and ESC: Working, Types: Brush and Brushless Motors, motor sizing and identification, mounting patterns and thread size, Thrust to Weight ratio, KV ratings, advanced motor selection, Electronic Speed Controller (ESC) **CO's:CO3**

Self learning Topics: Advanced motor selection and drone propulsion systems.

UNIT-IV **14 Hours**

Flight Mechanics and Dynamics: Basic principles of flight mechanics, flight controller board, Selection of drone controller with example, Factors affecting drone flight performance and efficiency **CO's:CO4**

Self learning Topics: Autonomous flight control and drone stability systems.

UNIT-V **12 Hours**

Applications of Drone: Overview of commercial and industrial drone applications, Case studies and examples of successful drone deployments, GPS based navigation system, Drone Camera Systems, Agro application, Drone Delivery, Future trends and developments in the drone industry. **CO's:CO5**

Self learning Topics: GPS navigation, AI-based drones, and smart drone applications.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. M. LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. D. Levy, Drone Programming: A Guide to Code Your Own Drones, Packt Publishing, n.d.
4. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
5. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.
6. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.

Reference books:

1. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, CengageLearning, 2018.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, Apress, 2019.
3. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
4. G. C. Camara Leal, Flying Robots: An Introduction to Autonomous Aerospace Systems, Springer,2017

Web References:

1.https://www.youtube.com/watch?v=yC_hFm0BX28&list=PLxApjaSnQGi6Jm7LLSxvmNQjS_rt9swsu

2.https://www.youtube.com/watch?v=nzZkKoREEGo&list=PL9ooVrP1hQOGPQVeapGsJCktzIO4DtI4_

3.https://www.youtube.com/watch?v=6wi5DI6du4&list=PL_uaeekrhGzJlB8XQBxU3z_-hDwT95xlk

4. https://www.youtube.com/watch?v=KqSqyKwVuA8

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	
L3	30	50
L4	--	40
L5		10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define drone technology.
2. List different types of drones.
3. What is a flight controller?
4. Define thrust-to-weight ratio.
5. What is an ESC?
6. List components of a drone.
7. Define KV rating of a motor.
8. What is GPS navigation in drones?
9. Explain brushless motor.
10. Calculate thrust required for a drone carrying a given payload.

L2: Understand

1. Explain working of drone propulsion systems.
2. Discuss design considerations for drone airframes.
3. Explain drone assembly procedure.
4. Describe working of ESC in drones.
5. Explain flight mechanics of drones.
6. Calculate thrust-to-weight ratio for a quadcopter.
7. Determine suitable battery for a drone application.
8. Explain GPS-based drone navigation system.
9. Discuss drone camera systems and applications.
10. Analyze basic wiring and soldering techniques in drones.

L3: Apply

1. Compare brush and brushless motors used in drones.
2. Analyze factors affecting drone stability and performance.
3. Evaluate suitable drone type for agricultural applications.
4. Compare quadcopter and hexacopter configurations.
5. Analyze drone controller selection for industrial applications.
6. Determine motor and ESC combination for a given drone load.
7. Analyze energy consumption of drone systems.
8. Evaluate safety aspects in drone operations.
9. Analyze advantages of drones in delivery systems.
10. Compare manual and autonomous drone navigation systems.

L4: Apply

1. Design a drone system for surveillance applications.
2. Develop a drone-based agricultural spraying system.
3. Propose a drone delivery system for smart cities.
4. Design a flight controller setup for stable operation.
5. Analyze industrial applications of drones in disaster management.
6. Design a drone frame for maximum payload capacity.
7. Develop a GPS-enabled autonomous drone model.
8. Analyze thermal management in drone electronics.
9. Design a drone communication system using IoT.
10. Evaluate performance improvement techniques for drones.

L5: Apply

1. Evaluate the performance of brushless motors in drones.
2. Assess suitability of drones for agricultural applications.
3. Evaluate advantages and limitations of GPS-based navigation systems.
4. Judge effectiveness of different drone configurations for payload carrying.
5. Evaluate safety measures required for drone operations.
6. Assess efficiency of various drone propulsion systems.
7. Evaluate drone applications in disaster management.
8. Compare and evaluate battery technologies used in drones.
9. Assess impact of drones in industrial automation.
10. Evaluate future scope of drone technology in smart cities.

Chairperson

Board of Studies (ME)

R24MEPE06 **INDUSTRIAL ROBOTICS** **3 0 0 3**

(Professional Elective-II)

Course Objectives:

1. **To illustrate** various applications of robotics and classification of coordinate system and control systems
2. **To build** the concepts of components of industrial robotics.
3. **To determine** kinematic analysis with D-H notation, forward and inverse kinematics and Solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
4. **To model** trajectory planning for a manipulator by avoiding obstacles
5. **To analyze** different types of actuators and applications of robots in manufacturing

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 06.1	Illustrate various applications of robotics and classification of coordinate system and control systems	3	2	-	-	2	-	-	-	-	-	-	2	2	L1 L2
R24MEPE 06.2	Build the concepts of components of industrial robotics.	3	3	2	2	3	-	-	-	-	-	-	3	2	L2 L3
R24MEPE 06.3	Determine kinematic analysis with D-H notation, forward and inverse kinematics and Solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations	3	3	2	3	3	-	-	-	-	-	-	3	3	L3 L4
R24MEPE 06.4	Model trajectory planning for a manipulator by avoiding obstacles	3	3	3	2	3	-	-	-	-	-	-	3	3	L4 L5
R24MEPE 06.5	Analyze different types of actuators and applications of robots in manufacturing	3	2	2	2	3	2	2	-	-	1	-	2	3	L6

SYLLABUS

UNIT-I **14 Hours**

Introduction: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system.

CO's: CO1

Self-Learning Topics: Industrial robot classifications, modern robotic applications, and Industry

4.0 concepts.

UNIT-II **14 Hours**

Components Of The Industrial Robotics: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices. **CO's: CO2**

Self-Learning Topics: Advanced robot end effectors and robotic locomotion systems.

UNIT–III **14 Hours**

Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems.

Manipulator Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems. Differential transformation and manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems. **CO's: CO3**

Self-Learning Topics: Robot kinematics simulation using MATLAB/RobotStudio and Jacobian analysis.

UNIT–IV **12 Hours**

General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming, languages and software packages-description of paths with a robot programming language. **CO's: CO4**

Self-Learning Topics: Robot programming languages, trajectory optimization, and obstacle avoidance techniques.

UNIT–V **10 Hours**

Robot actuators and feed back components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

Robot Applications In Manufacturing: Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

CO's: CO5

Self-Learning Topics: AI-based robotic systems, smart sensors, and robotic applications in automated manufacturing.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John J. Craig/ Pearson

Reference Books:

1. Theory of Applied Robotics /Jazar/Springer.
2. Robotics / Ghosal / Oxford

Web References:

1. http://archive.nptel.ac.in/courses/112/108/112108093/
2. http://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-me39/
3. https://onlinecourses.nptel.ac.in/noc26_me01/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	20
L6 (Creating)	-	10
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level-1: Remembering

1. Define Robotics and Automation.
2. List different types of robots.
3. What is CAD/CAM?
4. Define degree of freedom in robots.
5. List types of robot actuators.
6. What is an end effector?
7. Define homogeneous transformation.
8. What is robot programming?
9. Define Jacobian matrix.
10. List applications of robots in manufacturing.

Level-2: Understanding

1. Explain classification of robots based on coordinate system.
2. Describe components of an industrial robot.
3. Explain electric, hydraulic, and pneumatic actuators.
4. Discuss requirements of end effectors.
5. Explain D-H notation used in robotics.
6. Describe robot trajectory planning.
7. Explain forward kinematics of robots.
8. Discuss feedback sensors used in robots.
9. Explain obstacle avoidance techniques.
10. Describe robotic welding applications.

Level-3: Applying

1. Apply homogeneous transformations for rotation and translation problems.
2. Calculate forward kinematics of a manipulator.
3. Solve inverse kinematics problems.
4. Determine Jacobian matrix for robotic arm motion.
5. Apply trajectory planning for straight line motion.

6. Select suitable actuator for robotic applications.
7. Apply robot programming for pick-and-place operation.
8. Calculate degrees of freedom for a robot manipulator.
9. Use D-H parameters for manipulator modeling.
10. Apply robotic systems in material handling operations.

Level-4: Analyzing

1. Analyze different robot coordinate systems.
2. Compare hydraulic and pneumatic actuators.
3. Analyze robot path planning techniques.
4. Compare forward and inverse kinematics.
5. Analyze trajectory generation methods.
6. Compare different robotic sensors.
7. Analyze robotic applications in manufacturing industries.
8. Compare spot welding and arc welding robots.
9. Analyze robot dynamics using Newton–Euler formulation.
10. Compare various robot programming methods.

Level-5: Evaluating

1. Evaluate performance of industrial robots in manufacturing.
2. Assess advantages of robotic automation in industries.
3. Evaluate suitability of different actuators for robotic systems.
4. Compare and evaluate robot programming languages.
5. Assess effectiveness of robotic welding systems.
6. Evaluate robotic trajectory planning methods.
7. Assess applications of AI in robotics.
8. Evaluate performance of robotic sensors.
9. Assess economic benefits of robotic automation.
10. Evaluate safety measures in robotic systems.

Level -6: Create

1. Design a robotic arm for material handling applications.
2. Develop a robotic system for automated welding.
3. Design a trajectory planning system for industrial robots.
4. Develop a robot programming algorithm for obstacle avoidance.
5. Design a pick-and-place robotic manipulator.
6. Develop a smart robotic system using sensors and AI.
7. Design an automated robotic assembly line.
8. Propose a robotic solution for industrial inspection.
9. Develop an autonomous mobile robot for manufacturing.
10. Design a robotic control system using feedback components.

Chairperson

Board of Studies (ME)

R24MEOE07 **MECHATRONICS** **3 0 0 3**

(Professional Elective-II)

Course Objectives (COs)

The student will be able to:

1. **To understand** the fundamentals of mechatronics systems, industrial automation, and control methods used in modern engineering applications.
2. **To develop** knowledge of mechanical actuation systems, electronic interfacing, sensors, and signal conditioning techniques.
3. **To analyze** the working principles and applications of electromechanical drives, microcontrollers, and embedded systems in automation.
4. **To apply** PLC programming, motion control concepts, and industrial control strategies in manufacturing and robotic systems.
5. **To understand** feedback devices, PID controllers, and multi-axis control systems used in smart manufacturing and industrial automation.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PSO2	
R24MEOE 04.1	Explain the fundamentals of mechatronics systems, signal conditioning techniques, and automation systems used in modern industries.	3	2	-	-	2	-	-	-	-	-	-	2	1	L1, L2
R24MEOE 04.2	Analyze pneumatic, hydraulic, electro-hydraulic, and electronic interface systems used in industrial automation applications.	3	2	1	-	2	-	-	-	-	-	-	2	2	L3, L4
R24MEOE 04.3	Apply the concepts of electrical drives, motor control, and microcontroller interfacing for embedded and automation applications.	3	3	2	1	2	-	-	-	-	-	-	3	2	L3, L4

R24MEOE 04.4	Examine PLC programming, ladder logic, timers, counters, and motion control systems used in industrial automation.	3	3	3	2	3	-	-	-	1	1	-	3	3	L3, L4
R24MEOE 04.5	Evaluate sensors, PID controllers, multi-axis control systems, and smart automation technologies in mechatronic systems.	3	2	2	1	3	-	-	-	1	1	-	3	3	L4, L5

SYLLABUS

UNIT – I: Introduction to Mechatronics **12 Hours**

Definition and trends in Mechatronics – Basic control methods – Standalone and PC based systems – Introduction to CNC, Robots and automation systems.

Signal Conditioning: Introduction – Analog and digital signals – Basic input/output systems – ADC basics – Noise filtering using resistors and capacitors – Introduction to operational amplifiers (OP-Amps), Digital Twin Technology in Automation. **CO's: CO1**

Self-Learning Topics: Basics of Mechatronics applications in daily life, Working of ADC and basic signal conditioning circuits.

UNIT – II: Mechanical and Electronic Systems **12 Hours**

Introduction to Pneumatic and Hydraulic systems – Electro-pneumatic and Electro-hydraulic systems – Timing belts – Ball screw and nut – Bearings and linear motion systems – Basics of motor selection.

Electronic Interface Systems: Basics of sensors and actuators – Interfacing of motors and solenoids – Power supply basics – Introduction to transistors and MOSFETs.Energy-efficient Electro-Hydraulic Systems. **CO's: CO2**

Self-Learning Topics: Basics of bearings and linear motion mechanisms, Sensor and actuator applications in automation.

UNIT – III: Electrical Drives and Microcontrollers **14 Hours**

Introduction to Relays and Solenoids – Stepper motors – DC motors – Servo motors – Basics of PWM and motor speed control.

Microcontrollers: Introduction to 8051 microcontroller – Basic digital and analog interfacing – ADC and DAC basics – Simple applications such as LED blinking and voltage measurement.Brushless DC (BLDC) Motors in Electric Vehicles. **CO's: CO3**

Self-Learning Topics: Comparison of stepper motors and DC motors, Basics of servo motor applications.

UNIT – IV: Programmable Logic Controllers (PLC) **12 Hours**

PLC Basics: Structure and working of PLC – Ladder diagram programming – Timers, counters and relays – Analog input/output basics – PLC selection and simple industrial applications.

Introduction to Motion Controllers – Basics of transfer function and Laplace transform.Industrial Internet of Things (IIoT) with PLC. **CO's: CO4**

Self-Learning Topics: Basics of PLC programming using ladder diagrams, Applications of timers and counters in industries.

UNIT – V: Sensors and Control Systems **12 Hours**

Position and velocity sensors – Optical encoders – Proximity sensors: Inductive, capacitive and infrared sensors.

Control Systems: Basics of P, PI and PID controllers – Position, velocity and torque control – Introduction to velocity profiles and multi-axis control.Autonomous Mobile Robots (AMRs) and Smart Sensors. **CO's: CO5**

Self-Learning Topics: Working principles of proximity sensors, Applications of encoders in automation systems

Text Books

1. W. Bolton, Mechatronics, Pearson Education India 3rd Edition, 2006.
2. Lawrence J. Kamm, Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics, IEEE Press,2nd Edition, 2000.

References Books

1. Sabri Cetinkunt, Mechatronics with Experiments, John Wiley & Sons, Illustrated Reprint, 2015
2. HMT, Mechatronics, Tata McGraw-Hill Education, 1st Edition, 2000.
3. Mahalik, Mechatronics, TMH, 1st Edition, 2003.
4. David and Alcaire Michael B. Histand, Introduction Mechatronics, TMH, 4th Edition, 2006.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_me91
2. https://archive.nptel.ac.in/content/syllabus_pdf/112103174.pdf?utm_source

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	20	
L2 (Understanding)	40	
L3 (Applying)	30	50
L4 (Analyzing)	-	40
L5 (Evaluating)	-	10
Total	**100**	**100**

Sample Long Answer Questions of Various Cognitive Levels

L1 – Remembering

1. Define Mechatronics.
2. What is signal conditioning?
3. Expand CNC and PLC.
4. Define pneumatic system and hydraulic system.
5. What is the function of a sensor?

6. Define stepper motor and servo motor.
7. What is PWM in motor control?
8. Define ladder diagram in PLC programming.
9. What is a PID controller?
10. List any two types of proximity sensors.

L2 – Understanding

1. Differentiate between analog and digital signals.
2. Explain the working principle of ADC.
3. Compare pneumatic and hydraulic systems.
4. Explain the importance of bearings in linear motion systems.
5. Describe the working of a DC motor.
6. Explain the role of PWM in motor speed control.
7. Describe the structure and working of a PLC.
8. Explain the function of timers and counters in PLCs.
9. Differentiate between inductive and capacitive sensors.
10. Explain the working of PID controllers in automation systems.

L3 – Applying

1. Suggest a suitable Mechatronics application used in daily life.
2. Apply ADC concepts for temperature measurement systems.
3. Select a suitable actuator for an automated material handling system.
4. Demonstrate the interfacing of a motor with a controller.
5. Apply PWM for controlling DC motor speed.
6. Interface an LED with an 8051 microcontroller.
7. Develop a simple ladder diagram for motor ON/OFF control.
8. Apply timers in conveyor belt automation systems.
9. Select a suitable proximity sensor for object detection.
10. Apply PID control for maintaining constant motor speed.

L4 – Analyzing

1. Analyze the advantages of Mechatronics in industrial automation.
2. Compare standalone systems and PC-based systems.
3. Differentiate between CNC machines and conventional machines.
4. Compare pneumatic and hydraulic systems based on performance.
5. Analyze the factors affecting motor selection.
6. Compare stepper motors and servo motors.
7. Analyze the advantages of BLDC motors in electric vehicles.
8. Compare PLC systems with conventional relay control systems.
9. Differentiate between P, PI, and PID controllers.
10. Analyze the role of smart sensors in automation systems.

L5 – Evaluating

1. Evaluate the importance of Mechatronics in modern industries.
2. Justify the use of robots in automated production systems.
3. Evaluate the effectiveness of signal conditioning in sensor systems.
4. Assess the suitability of hydraulic systems for heavy-load applications.
5. Evaluate the importance of sensors and actuators in industrial automation.

6. Justify the use of microcontrollers in embedded systems.
7. Evaluate the effectiveness of PWM techniques in motor control.
8. Assess the advantages of PLC-based automation systems.
9. Evaluate the effectiveness of PID controllers in industrial control.
10. Justify the role of Autonomous Mobile Robots (AMRs) in smart manufacturing.

Chairperson
Board of Studies (ME)

R24MEPE08 **SUPPLY CHAIN MANAGEMENT** **3 0 0 3**

(Professional Elective-II)

Course Objectives:

1. **To explain** the importance of Supply chain management frame work in business management.
2. **To interpret** basic concepts of Supply Chain Drivers and Metrics
3. **To interpret** the Design of Supply Chain Network and factors influencing distribution network design
4. **To analyze** role of forecasting in a supply chain
5. **To analyze** aggregate Planning and inventories in supply chain

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24ME PE08.1	Explain the importance of Supply chain management frame work in business management	3	2	-	-	2	-	-	-	-	-	-	2	2	L1 L2
R24ME PE08.2	Interpret basic concepts of Supply Chain Drivers and Metrics	3	3	2	2	2	-	-	-	-	-	-	2	3	L2 L3
R24ME PE08.3	Interpret the Design of Supply Chain Network and factors influencing distribution network design	3	3	3	2	2	-	-	-	-	-	-	3	3	L3 L4
R24ME PE08.4	Analyze role of forecasting in a supply chain	3	3	2	3	2	-	-	-	-	-	-	2	3	L4 L5
R24ME PE08.5	Analyze aggregate Planning and inventories in supply chain	3	3	2	2	3	2	2	-	-	1	-	2	3	L5

SYLLABUS

UNIT-I **14 Hours**

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope. CO's**: CO1**

Self-Learning Topics: Digital supply chains and Industry 4.0 in SCM

UNIT-II **14 Hours**

Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit. **CO's: CO2**

Self-Learning Topics: Supply chain analytics and performance measurement systems.

UNIT–III **12 Hours**

Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation. **CO's: CO3**

Self-Learning Topics: E-commerce logistics and smart warehouse management.

UNIT–IV **12 Hours**

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting. **CO's: CO4**

Self-Learning Topics: AI-based forecasting and risk management in supply chains.

UNIT–V **10 Hours**

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect. **CO's: CO5**

Self-Learning Topics: Green logistics, smart transportation, and blockchain in SCM.

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text books:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

References:

1. Sarika Kulkarni, Ashok Sharma Supply Chain Management – Creating Linkages for Faster Business Turnaround, Tata McGraw-Hill Publishing Company Ltd, Latest Edition
2. James B. Ayers, Supply Chain Project Management – A Structured Collaborative and Measurable Approach, CRC Press, Latest Edition

Web References:

1. http://www.sdcexec.com/web/online/Demand-Management-Trends/Forecast-Fit-vs-Forecast-Error-- Clarifying-the-Concepts--Understanding-the-Value/22$9933)

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Supply Chain Management.
2. What is strategic fit in supply chain?
3. Define push and pull views in supply chain.
4. What are supply chain drivers?
5. Define inventory management.
6. What is forecasting in supply chain?
7. Define distribution network.
8. What is aggregate planning?
9. Define bullwhip effect.
10. List modes of transportation in supply chain.

L2: Understand

1. Explain decision phases in supply chain management.
2. Describe drivers of supply chain performance.
3. Explain supply chain metrics.
4. Discuss distribution network design.
5. Explain forecasting methods in supply chain.
6. Describe role of inventory in supply chain.
7. Explain aggregate planning strategies.
8. Discuss supply chain coordination.
9. Explain transportation systems in SCM.
10. Describe e-business applications in supply chain.

L3: Apply

1. Apply supply chain drivers for improving performance.
2. Analyze distribution network design for industries.
3. Apply forecasting methods for demand prediction.
4. Demonstrate aggregate planning in supply chain.
5. Apply inventory management techniques in SCM.
6. Analyze transportation modes for logistics systems.
7. Apply supply chain coordination techniques.
8. Analyze risk management in forecasting.
9. Apply facility location models in SCM.
10. Analyze IT applications in supply chain management.

L4: Analyze

1. Compare push and pull supply chain strategies.
2. Analyze factors affecting supply chain performance.
3. Compare different forecasting techniques.
4. Analyze distribution network models.
5. Compare centralized and decentralized inventory systems.
6. Analyze aggregate planning methods.
7. Compare transportation systems in logistics.
8. Analyze causes and effects of bullwhip effect.
9. Compare traditional and digital supply chains.

10. Analyze role of e-business in SCM.

L5: Evaluate

1. Evaluate effectiveness of supply chain management in industries.
2. Assess importance of forecasting in supply chain performance.
3. Evaluate aggregate planning strategies in SCM.
4. Assess effectiveness of inventory management techniques.
5. Evaluate transportation systems in logistics management.
6. Assess role of IT in modern supply chains.
7. Evaluate supply chain coordination strategies.
8. Assess impact of bullwhip effect on industries.
9. Evaluate distribution network design for business efficiency.
10. Assess future trends in digital supply chain management

Chairperson

Board of Studies (ME)

R24MEPE09 TOTAL QUALITY MANAGEMENT 3 0 0 3

(Professional Elective-II)

Course Objectives:

1. **To understand** the fundamental concepts, evolution, and tools of quality in engineering and service systems.
2. **To Gain knowledge** of Total Quality Management (TQM) principles and contributions of quality pioneers.
3. **To Apply** TQM principles such as leadership, continuous improvement, and employee involvement in organizations.
4. **To Understand** quality improvement techniques including quality circles, TPM, and cost of quality.
5. **To Learn advanced** qualitysystems such as Six Sigma, ISO standards, and environmental management systems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE09.1	Explain the concepts, dimensions, tools, and techniques used in quality management and process capability analysis.	3	2	1	-	1	-	-	-	-	-	1	-	-	L1 L2
R24MEPE09.2	Analyze TQM principles, customer-oriented practices, and quality philosophies proposed by Deming, Juran, and Crosby.	3	3	2	-	1	1	-	-	-	1	1	-	-	L3 L4
R24MEPE09.3	Apply and evaluate continuous improvement techniques such as PDCA, Kaizen, 5S, and supplier partnership in TQM implementation.	3	3	3	1	1	-	-	2	1	1	1	1	1	L3 L4
R24MEPE09.4	Assess quality circles, TPM, QFD, Taguchi methods, and performance measures for organizational quality enhancement.	3	3	2	2	1	-	-	2	1	1	1	1	1	L4 L5
R24MEPE09.5	Design and evaluate Six Sigma methodologies, ISO standards, benchmarking, and environmental management systems for sustainable quality practices.	3	3	3	2	2	2	-	1	1	1	2	1	2	L5 L6

SYLLABUS

UNIT-I **12 Hours**

Introduction to Quality: Need for quality - Evolution of quality - Definitions of quality - Dimensions ofproduct and service quality - Seven tools of quality - Control charts - Process capability. Digital Quality Management Systems (QMS). **CO's: CO1**

Self-Learning Topics: Application of Seven Quality Tools in real industries, Use of control charts in manufacturing and service sectors

UNIT-II **12 Hours**

Introduction to TQM: Definition - Basic concepts of TQM - TQM Framework - Features of TQM - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention. Quality Management in E-Commerce and Service Industries**.** **CO's: CO2**

Self-Learning Topics: Comparative study of Deming, Juran, and Crosby philosophies, Customer satisfaction measurement techniques.

UNIT-III **12 Hours**

TQM Principles: Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation,Empowerment, Team and Teamwork - Continuous process improvement – Plan Do Check Act (PDCA) cycle, 5S, Kaizen - Supplier partnership - Supplier selection. Sustainable Quality Management Practices**.** **CO's: CO3**

Self-Learning Topics: Practical implementation of Kaizen and 5S in industries, Role of leadership in quality improvement initiatives.

UNIT-IV **12 Hours**

Quality Circles, TPM: Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality lossfunction – Total productive maintenance (TPM) - Concepts, improvement needs – Performancemeasures.Predictive Maintenance using IoT Sensors. **CO's: CO4**

Self-Learning Topics: Quality circles success stories in Indian industries, TPM implementation in manufacturing organizations.

UNIT-V **14 Hours**

TQM Tools, SIX Sigma: New management tools - Six sigma Concepts, Methodology, Applications to manufacturing,Benchmarking -Benchmarking process.

Quality Management System: Introduction - Benefits of ISO Registration - ISO9000 Series of Standards - ISO 9001Requirements - Implementation - Internal Audits.

Environmental Management System: Introduction - ISO14000 Series Standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS. Green Quality Management and Sustainable Manufacturing. **CO's: CO5**

Self-Learning Topics: six Sigma DMAIC methodologies with real examples, ISO 9001 certification process and documentation.

Board of Studies: Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text books:

1. 1.Total Quality Management, Dale H. Besterfield et.al., 3rded, Pearson Education Pub.
2. 2.Total Quality Management‖, Pearson Education Asia, Revised Third Edition, Indian Reprint,
3. Sixth Impression, 2013.

Reference books:

1. 1.James R.Evans& William M.Lidsay, The Management and Control of Quality, (5thEdition,South-Western (Thomson Learning, 2002 (ISBN0-324-06680-5).
2. Total Quality Management, A.V.Feigenbaum, McGraw HillPub.
3. Total Quality Management, J.S.Oakland,ButterworthHeinemannPub.

Web References:

1. http://archive.nptel.ac.in/courses/110/106/110106036/
2. http://www.youtube.com/watch?v=0o1X7X6kH6E
3. http://onlinecourses.nptel.ac.in/noc24_mg40/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	10	-
L2 (Understanding)	20	10
L3 (Applying)	30	20
L4 (Analyzing)	25	30
L5 (Evaluating)	15	25
L6 (Create)	-	15
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remembering

1. Define quality.
2. List seven tools of quality.
3. What is TQM?
4. Define Six Sigma.
5. Explain evolution of quality.
6. Describe seven tools of quality.
7. Define TQM and its features.
8. Explain ISO standards.
9. Define quality control.
10. Explain dimensions of product quality.

L2: Understanding

1. Explain dimensions of quality.
2. Describe TQM framework.
3. Explain customer satisfaction.
4. Describe PDCA cycle.
5. Explain contributions of Deming, Juran and Crosby.
6. Describe customer focus in TQM.
7. Explain continuous improvement techniques.

8. Discuss Six Sigma concepts.
9. Explain Kaizen methodology.
10. Discuss the need for benchmarking.

L3: Applying

1. Apply control charts in process monitoring.
2. Use PDCA cycle for process improvement.
3. Apply Six Sigma methodology.
4. Demonstrate benchmarking process.
5. Apply control charts for quality control.
6. Apply PDCA cycle in manufacturing.
7. Use Six Sigma DMAIC methodology.
8. Apply benchmarking in industry.
9. Apply TPM concepts for quality improvement in industries.
10. Apply customer satisfaction techniques.

L4: Analyzing

1. Analyze causes of poor quality.
2. Compare different quality tools.
3. Analyze Six Sigma stages.
4. Compare ISO 9001 and ISO 14001.
5. Analyze implementation of TQM.
6. Compare quality tools and techniques.
7. Analyze ISO 9001 requirements.
8. Compare different improvement strategies.
9. Analyze Taguchi quality loss function and its applications.
10. Analyze supplier partnership strategies.

L5: Evaluating

1. Evaluate effectiveness of TQM implementation.
2. Justify importance of customer focus.
3. Evaluate benchmarking practices.
4. Assess benefits of ISO certification.
5. Evaluate role of TQM in industry.
6. Assess effectiveness of Six Sigma.
7. Evaluate ISO certification benefits.
8. Justify need for quality systems.
9. Justify sustainable manufacturing approaches.
10. Assess Six Sigma implementation in industrial organizations.

L6: Create

1. Design a quality improvement strategy for reducing defects in an automobile manufacturing industry using Six Sigma concepts.
2. Develop a framework for implementing green quality management practices in a manufacturing organization.
3. Formulate a customer satisfaction enhancement model for service industries using TQM principles.
4. Propose an integrated TPM and Kaizen approach for improving industrial productivity.

5. Construct a benchmarking model for evaluating organizational quality performance.
6. Design a comprehensive Total Quality Management framework for a manufacturing organization by integrating Six Sigma, Kaizen, TPM, and ISO 9001 standards.
7. Develop a sustainable quality management system for an industry considering environmental management standards (ISO 14001) and green manufacturing practices.
8. Create a strategic quality improvement plan for reducing process variation and improving customer satisfaction in service industries.
9. Formulate a complete implementation procedure for Six Sigma in a production industry with suitable case examples.
10. Design an integrated quality assurance and continuous improvement model using TQM tools, benchmarking, and supplier partnership concepts.

Chairperson
Board of Studies (ME)

R24MEOE06 **COMPUTER AIDED DESIGN (CAD)** **3 0 0 3**

(Open Elective-II)

Course Objectives:

1. **To interpret** the basic fundamentals of computer aided design and manufacturing.
2. **To analyze** 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. **To Apply** solid, surface, and feature-based modeling techniques to visualize engineering components before manufacturing.
4. **To interpret** the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. **To illustrate** the overall configuration and elements of computer integrated manufacturing systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE 06.1	Interpret the basic fundamentals of Computer Aided Design and Manufacturing	2	2	1	1	2	-	-	-	-	-	1	2	1	L1 L2
R24MEOE 06.2	Analyze 2D and 3D transformations of basic geometric entities	3	3	2	2	3	-	-	-	-	-	1	3	1	L2 L4
R24MEOE 06.3	Interpret geometric modeling techniques such as solid, surface, and feature-based modeling	3	3	2	2	3	-	-	-	-	-	1	3	2	L4
R24MEOE 06.4	Apply part programming, Group Technology, CAPP, and computer aided quality control concepts	3	3	3	2	3	1	-	-	-	-	1	3	3	L3 L4
R24MEOE 06.5	Illustrate the configuration and elements of Computer Integrated Manufacturing systems	3	3	3	3	3	1	-	-	-	1	1	3	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction: Computers in industrial manufacturing, product cycle, CAD / CAM Hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, storage devices.

CO's: CO1

Self-Learning Topics: Study the applications of CAD/CAM in modern industries, types of manufacturing systems, latest trends in CAD/CAM hardware, and concepts of industrial automation.

UNIT-II **14 Hours**

Computer Graphics: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal. **CO's: CO2**

Self-Learning Topics: Learn the concepts of animation in computer graphics, windowing and viewing techniques, graphics standards and packages, and applications of 3D visualization.

UNIT–III **14 Hours**

Geometric Modeling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

Drafting and Modeling Systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modelling.

CO's: CO3

Self-Learning Topics: Understand wireframe modeling techniques, feature-based modeling, parametric modeling concepts, and industrial applications of solid modeling.

UNIT–IV **12 Hours**

Introduction to Drafting System- Basic facilities in Autocad, Basic Geometric Commands, Layers, Display Control commands, Editing a drawing, Dimensioning **CO's: CO4**

Self-Learning Topics: Practice advanced AutoCAD commands, plotting and printing methods, use of blocks and attributes, and basics of 3D drafting in AutoCAD.

UNIT–V **10 Hours**

NC and CNC Machine Fundamentals: Manual Part Programming, G-Codes and M-Codes, Coordinate Systems, Tooling and Tool Offsets. **CO's: CO5**

Self-Learning Topics: Study CNC machine applications, CNC tool materials and tool life, introduction to CAM software, and CNC program verification techniques.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Mikell P. Groover and Emory W. Zimmers Jr., CAD/CAM: Computer-Aided Design and Manufacturing, Prentice Hall of India, 2006.
2. P. N. Rao, CAD/CAM: Principles and Applications, Third Edition, Tata McGraw-Hill Education, 2010.

Reference Books:

1. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM Theory and Practice, Tata McGraw-Hill Education, 2009.
2. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Education, 2008.

Web References:

1. https://nptel.ac.in/courses/112/102/112102103/
2. https://nptel.ac.in/courses/112/105/112105053/
3. https://www.cadcamlab.org/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	50
L4 (Analyzing)	-	40
L5 (Evaluating)	-	10
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remembering

1. Define CAD.
2. What is a transformation in computer graphics?
3. Define geometric modelling.
4. What is AutoCAD used for?
5. Define G-code in CNC programming.
6. Explain the product cycle in manufacturing and describe the role of CAD/CAM systems in each stage.
7. Describe the basic structure of a CAD/CAM system and explain the functions of hardware components such as CPU, memory, input devices, display devices, and storage devices.
8. Explain geometric modeling techniques and describe wireframe, surface, and solid modeling methods with suitable examples.
9. Describe the basic facilities and commands used in AutoCAD for drafting, editing, layering, and dimensioning.
10. Explain NC and CNC machine fundamentals, coordinate systems, G-codes, M-codes, and tooling concepts used in CNC programming.

Level-2: Understanding

1. Explain the basic structure of a CAD/CAM system.
2. Describe 3D transformation in computer graphics.
3. Explain curve representation methods in geometric modeling.
4. Explain the use of layers in AutoCAD.
5. Explain coordinate systems used in CNC machines.
6. Explain the product cycle in manufacturing and describe the role of CAD/CAM in each stage.
7. Explain curve representation methods and surface representation methods used in geometric modeling.
8. Explain G-codes and M-codes used in CNC programming with suitable examples.
9. Explain raster scan graphics coordinate system with neat sketches.
10. Discuss the database structure used for graphics modeling.

Level-3: Applying

1. Apply robot classification to select a suitable robot for an application.
2. Apply CAD/CAM concepts in a product development cycle.
3. Apply transformation matrices for simple geometric operations.
4. Apply solid modeling techniques to represent a mechanical part.
5. Draw a simple object using basic AutoCAD commands.
6. Apply 2D transformation techniques such as translation, rotation, and scaling on a geometric object with examples.
7. Demonstrate the use of AutoCAD commands to draw and edit a simple engineering drawing.
8. Write and explain a simple CNC part program for a turning or milling operation using G-codes and M-codes.
9. Explain the requirements and types of geometric models.
10. Discuss different curve representation methods used in geometric modeling.

Level-4: Analyzing

1. Differentiate between CAD and CAM systems with examples.
2. Analyze the effect of 2D and 3D transformations on geometric objects.
3. Compare surface and solid modeling techniques.
4. Analyze the advantages of layers and editing tools in AutoCAD.
5. Analyze the role of tool offsets in CNC machining accuracy.
6. Compare CAD and CAM systems and analyze their integration in modern manufacturing industries.
7. Analyze 3D transformations and explain their mathematical representation in computer graphics.
8. Compare wireframe, surface, and solid modeling techniques and analyze their advantages and limitations.
9. Explain the basic facilities available in AutoCAD.
10. Discuss basic geometric commands used in AutoCAD drafting.

Level-5: Evaluating

1. Evaluate the impact of CAD/CAM systems on modern manufacturing industries.
2. Evaluate different projection methods used in computer graphics.
3. Justify the selection of solid modeling over wireframe modeling.
4. Evaluate AutoCAD as a drafting tool compared to manual drawing.
5. Evaluate the efficiency of CNC programming over manual machining methods.
6. Evaluate the impact of CAD/CAM systems on productivity and product quality in manufacturing industries.
7. Evaluate different projection methods used in computer graphics and justify the most suitable method for engineering applications.
8. Evaluate AutoCAD as a drafting tool compared to manual drafting and justify its industrial importance.
9. Explain the functions of G-codes and M-codes in CNC programming.
10. Discuss manual part programming with suitable examples.

Chairperson

Board of Studies (ME)

R24MEOE07 INTRODUCTION OF AUTOMOBILE ENGINEERING 3 0 0 3

(Professional Elective-II)

Course Objectives:

1. **To introduce** fundamentals and components of automobile engineering.
2. **To understand** working principles of automobile engines and transmission systems.
3. **To study** steering, braking, suspension, and electrical systems in automobiles.
4. **To understand** cooling, lubrication, and automobile auxiliary systems.
5. **To analyze** automobile emissions, safety systems, and modern automotive technologies

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE 07.1	Explain fundamentals, classifications, and components of automobiles.	3	2	-	-	2	-	-	-	-	-	-	3	2	L1 L2
R24MEOE 07.2	Describe working principles of SI and CI engines and transmission systems.	3	3	2	2	2	-	-	-	-	-	-	3	3	L1 L2
R24MEOE 07.3	Analyze steering, braking, suspension, and automobile electrical systems.	3	3	2	2	3	-	-	-	-	-	-	3	3	L2 L3
R24MEOE 07.4	Apply concepts of cooling, lubrication, and auxiliary automobile systems.	3	2	2	2	2	-	-	-	-	-	-	3	2	L3 L4
R24MEOE 07.5	Evaluate automobile emissions, safety systems, and modern automotive technologies.	3	3	2	2	3	2	3	-	-	1	-	3	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Automobiles: History and development of automobiles, classification of automobiles, major components of an automobile, chassis and body types, layout of automobile systems. **CO's: CO1**

Self-Learning Topics: Latest trends in automobile industry and electric vehicles.

UNIT-II **14 Hours**

Automobile Engines: Classification of IC engines, two-stroke and four-stroke engines, SI and CI engines, engine components and working principles, fuel supply systems. **CO's: CO2**

Self-Learning Topics: Advanced engine technologies and hybrid engine systems.

UNIT–III **12 Hours**

Transmission and Steering Systems: Clutch, gearbox, propeller shaft, differential, steering system, braking system, suspension systems and wheel alignment. **CO's:CO3**

Self-Learning Topics: Automatic transmission and ABS braking systems.

UNIT–IV **12 Hours**

Automobile Electrical and Cooling Systems: Battery, ignition system, lighting system, starting system, cooling system, lubrication system and air conditioning basics. **CO's:CO4**

Self-Learning Topics: Electric vehicle batteries and smart automotive electronics.

UNIT–V **10 Hours**

Automobile Emissions and Modern Trends: Automobile emissions, pollution control techniques, safety systems, hybrid and electric vehicles, future trends in automobile engineering. **CO's: CO5**

Self-Learning Topics: Autonomous vehicles and green automobile technologies.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.
2. Automobile engineering by R B Gupta, Satya Prakashan publications (P) Ltd.
3. Richard Stone, Jeffrey K. Ball, Automotive Engineering Fundamentals" SAE International.
4. Automobile engineering by R K Rajput- Laxmi publications (P) Ltd.

Reference Books:

1. William. H. Crouse, AutomotiveMechanics,10/e Edition, McGraw-Hill.
2. David A. Corolla, Automotive Engineering: Power train, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd.
3. Bosch , Automotive Hand Book, 6/e SAE Publications year.
4. K. Newton and W. Steeds, The motor vehicle, 13/e Butterworth- Heinemann Publishing Ltd.

Web References:

1. SAE International | Advancing mobility knowledge and solutions
2. nptel.ac.in/?utm_source=chatgpt.com
3. Automotive Research Association of India (ARAI)
4. Virtual Labs – Ministry of Education, Government of India
5. International Energy Agency – Transport Sector

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	
L2 (Understanding)	40	30
L3 (Applying)	30	40
L4 (Analyzing)		30
L5 (Evaluating)		
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define automobile engineering.
2. List classifications of automobiles.
3. What is a chassis?
4. Define SI and CI engines.
5. List major components of an automobile.
6. What is a clutch?
7. Define braking system.
8. What is wheel alignment?
9. Define lubrication system.
10. List types of automobile fuels.

Level 2: Understanding

1. Explain working of a four-stroke engine.
2. Describe functions of transmission system.
3. Explain steering system in automobiles.
4. Discuss suspension system and its importance.
5. Explain automobile cooling system.
6. Describe working of braking system.
7. Explain functions of differential gear.
8. Discuss automobile electrical systems.
9. Explain lubrication methods used in engines.
10. Describe hybrid vehicle technology.

Level-3: Applying

1. Apply engine classification for different vehicle applications.
2. Analyze working of clutch and gearbox systems.
3. Select suitable braking system for heavy vehicles.
4. Apply wheel alignment concepts in automobiles.
5. Analyze suspension systems for passenger comfort.
6. Determine suitable cooling system for an engine.
7. Apply lubrication techniques in automobile engines.
8. Analyze fuel supply systems in SI and CI engines.
9. Apply steering geometry concepts in vehicles.
10. Analyze working of automobile electrical systems.

Level-4: Analyzing

1. Compare SI and CI engines.
2. Analyze manual and automatic transmission systems.
3. Compare different braking systems used in automobiles.
4. Analyze effects of poor wheel alignment.
5. Compare conventional and electric vehicles.
6. Analyze functions of suspension systems.
7. Compare air cooling and water-cooling systems.
8. Analyze automobile emission control methods.

9. Compare hybrid and fuel cell vehicles.
10. Analyze safety systems used in automobiles.

Level-5: Evaluating

1. Evaluate performance of SI and CI engines.
2. Assess effectiveness of different braking systems.
3. Evaluate advantages of electric vehicles over conventional vehicles.
4. Assess environmental impact of automobile emissions.
5. Evaluate automobile safety systems.
6. Assess performance of hybrid vehicles.
7. Evaluate energy efficiency of modern automobiles.
8. Assess suitability of automatic transmission systems.
9. Evaluate role of lubrication in engine performance.
10. Assess future scope of green automobile technologies.

Chairperson

Board of Studies (ME)

R24MEOE08 GREEN MANUFACTURING TECHNOLOGY 3 0 0 3

(Open Elective-II)

Course Objectives:

1. **To introduce** principles and importance of green manufacturing and sustainable development.
2. **To understand** green materials, energy conservation, and waste minimization techniques.
3. **To study** sustainable manufacturing and eco-friendly machining processes.
4. **To analyze** industrial waste management and pollution control methods.
5. **To understand** green supply chain management and sustainable industrial applications

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPC 10.1	Explain concepts of green manufacturing and sustainable development.	3	2	-	-	2	-	3	-	-	-	-	2	2	L1 L2
R24MEPC 10.2	Analyze green materials, energy efficient systems, and waste reduction techniques.	3	3	2	2	2	-	3	-	-	-	-	2	3	L2 L3
R24MEPC 10.3	Apply sustainable manufacturing and eco-friendly machining processes.	3	3	3	2	3	-	2	-	-	-	-	3	3	L3 L2
R24MEPC 10.4	Evaluate waste management, recycling, and pollution control methods.	3	3	2	3	2	2	3	-	-	-	-	2	3	L4 L3
R24MEPC 10.5	Assess green manufacturing applications, standards, and sustainable industrial practices.	3	2	2	2	2	2	3	-	-	1	-	2	3	L5 L4

SYLLABUS

UNIT-I **12 Hours**

Introduction to Green Manufacturing: Concepts of green manufacturing, sustainable development, environmental impact of manufacturing, green engineering principles, need and benefits of green manufacturing.

Self-Learning Topics: Sustainable industrial practices and eco-friendly manufacturing concepts.

CO's:CO1

UNIT-II **12 Hours**

Green Materials and Energy Management: Eco-friendly and recyclable materials, material selection, energy conservation techniques, energy efficient systems in industries, waste minimization methods. **CO's: CO2**

Self-Learning Topics: Advanced recyclable materials and industrial energy auditing.

UNIT–III **12 Hours**

Sustainable Manufacturing Processes: Green machining, dry machining, minimum quantity lubrication, sustainable casting, forming, welding and joining processes. **CO's: CO3**

Self-Learning Topics: Nano-lubrication and smart manufacturing techniques.

UNIT–IV **12 Hours**

Waste Management and Pollution Control: Industrial waste management, recycling and reuse techniques, pollution prevention methods, cleaner production technologies, life cycle assessment. **CO's: CO4**

Self-Learning Topics: Zero waste manufacturing and carbon footprint reduction.

UNIT–V **10 Hours**

Green Manufacturing Applications: Green supply chain management, sustainable product design, environmental standards, green factories, case studies in green manufacturing. **CO's: CO5**

Self-Learning Topics: Industry 4.0 applications in sustainable manufacturing.

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text books:

1. Dornfield David, Green Manufacturing, Springer, 2012
2. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013

References:

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.

Web References:

1. **https://www.youtube.com/watch?v=WnYVK1KLTME**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	-
L2	30	-
L3	40	30
L4	-	50
L5	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remember

1. Define green manufacturing.
2. What is sustainable development?
3. Define recyclable materials.
4. What is dry machining?
5. Define life cycle assessment.
6. List types of industrial waste.
7. What is energy conservation?
8. Define cleaner production.
9. What is green supply chain management?
10. List applications of green manufacturing.

L2 – Understand

1. Explain principles of green manufacturing.
2. Discuss energy conservation methods in industries.
3. Explain waste minimization techniques.
4. Describe eco-friendly machining processes.
5. Explain pollution prevention methods.
6. Discuss green materials and their applications.
7. Explain minimum quantity lubrication.
8. Describe sustainable manufacturing systems.
9. Explain recycling and reuse techniques.
10. Discuss environmental impacts of manufacturing industries.

L3 – Apply

1. Apply green manufacturing principles in industries.
2. Select suitable recyclable materials for products.
3. Apply energy auditing methods in manufacturing plants.
4. Analyze sustainable machining processes.
5. Apply waste reduction methods in industries.
6. Demonstrate cleaner production techniques.
7. Apply pollution control methods in manufacturing systems.
8. Analyze energy efficient industrial systems.
9. Apply eco-friendly joining and welding methods.
10. Develop sustainable manufacturing practices for industries.

L4 – Analyze

1. Compare green and conventional manufacturing systems.
2. Analyze effects of industrial waste on environment.
3. Compare dry machining and conventional machining.
4. Analyze energy efficient manufacturing systems.
5. Compare recyclable and non-recyclable materials.
6. Analyze industrial pollution control techniques.
7. Compare sustainable and traditional manufacturing methods.
8. Analyze green supply chain systems.
9. Compare waste management techniques in industries.

10. Analyze role of energy conservation in industries.

L5 – Evaluate

1. Evaluate benefits of green manufacturing systems.
2. Assess effectiveness of recycling techniques.
3. Evaluate sustainable manufacturing practices in industries.
4. Assess environmental benefits of green industries.
5. Evaluate energy conservation techniques.
6. Assess economic feasibility of green manufacturing.
7. Evaluate eco-friendly machining processes.
8. Assess role of Industry 4.0 in sustainable manufacturing.
9. Evaluate green supply chain management systems.
10. Assess future scope of green manufacturing technologies.

Chairperson

Board of Studies (ME)

R24MEOE09 **INDUSTRIAL ENGINEERING** **3 0 0 3**

(Open Elective-II)

Course Objectives:

1. **Understand** the fundamental principles of management, organizational structures, and personnel management practices.
2. **Gain knowledge** of industrial relations, labour laws, and dispute resolution mechanisms in industries.
3. **Learn** production planning & control, plant layout design, and maintenance strategies.
4. **Understand** materials handling and materials management including inventory control techniques.
5. **Apply work study**, work measurement, and quality control techniques to improve productivity.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE09.1	Explain management principles, organizational structures, and personnel management practices followed in industries.	3	2	1	-	-	1	-	1	1	1	1	-	-	L1, L2
R24MEOE09.2	Analyze industrial relations, labour laws, trade unions, and dispute settlement mechanisms in industrial organizations.	3	3	2	-	-	2	-	2	2	1	1	-	-	L3, L4
R24MEOE09.3	Apply and evaluate production planning, plant layout, and maintenance techniques for improving industrial productivity.	3	3	3	1	1	-	-	2	2	1	2	2	1	L3, L4
R24MEOE09.4	Assess material handling, purchasing, inventory control, and logistics management systems used in industries.	3	3	2	2	1	-	-	2	2		2	2	1	L3, L4
R24MEOE09.5	Design and evaluate work study, work measurement, and quality control techniques for productivity and quality improvement.	3	3	2	2	1	-	-	1	1	1	2	2	1	L4, L5

SYLLABUS

UNIT-I: **12 Hours**

Concepts of Industrial Management: Principles of management - Functions of management, Principles of organization, Types of organization.

Personnel management: Functions, Hawthorne studies, Discipline in industry, Promotion, Transfer, lay off and discharge.Digital Human Resource Management (HR Analytics & e-HRM)

CO's: CO1

Self-Learning Topics: Modern organizational structures (matrix, flat organizations), Human resource practices in industries (recruitment, training, performance appraisal)

UNIT-II: **12 Hours**

Industrial relations - Trade unions, Industrial disputes, Strikes, Lock-out, Settlement of industrial disputes, Collective bargaining, Industrial dispute act 1947 and factories act 1948.Labour Codes of India and Digital Compliance Systems. **CO's: CO2**

Self-Learning Topics: Role of trade unions in modern industries, Case studies on industrial disputes and their resolution.

UNIT-III: **12 Hours**

Production Planning and Control: Types of productions, Production cycle, Process planning, Forecasting, Loading, Scheduling, Dispatching, Routing, Progress Control.

Plant Layout: Economics of plant location, Types of layouts, Travel chart technique, Assembly line balancing simple problems.

Plant Maintenance: Objectives and types.IoT-based Predictive Maintenance Systems.

CO's: CO3

Self-Learning Topics: Assembly line balancing using real industrial examples, Preventive vs predictive maintenance techniques.

UNIT-IV: **14 Hours**

Materials Handling - Principles, Concept of unit load, Selection of material handling equipment, Applications of belt conveyors, Cranes, Forklift trucks in industry.

Materials Management: Introduction, Purchasing, Objectives of purchasing department, Buying techniques, Purchase procedure, Stores and material control, Receipt and issue of materials, Store records. Inventory Control, EOQ model.Warehouse Automation and Smart Logistics. **CO's: CO4**

Self-Learning Topics: Automation in material handling systems, Digital inventory management systems in industries

UNIT-V: **14 Hours**

Work Study: Concept of productivity, Method Study - Basic steps in method study, Process charts, Diagrams, Principles of motion economy, Therbligs, SIMO chart.

Work Measurement - Stop watch procedure of time study, Performance rating, allowances, Work sampling.

Quality Control - Control charts of variables and attributes. single and double sampling plans.Lean Manufacturing and Six Sigma Concepts. **CO's: CO5**

Self-Learning Topics: Application of motion study in improving workplace efficiency**,** Work sampling vs time study.

Board of Studies: Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Book:

1. O. P. Khanna Industrial Engineering Management, Dhanpat Rai Publications, 2018

References:

1. Heinz Weihrich, Mark V Cannice , Harold Koontz Management: 'A Global, Innovative andEntrepreneurial Perspective' (15th Edition) Mc Graw Hill Education, New Delhi 2019.
2. K.Aswathappa: ―Organizational Behaviour-Text, Cases and Games‖ HimalayaPublishing House, New Delhi, 2008
3. R. Panneerselvam: "Production and Operations Management ", PHI LearningPrivate Limited, New Delhi, 2009.
4. L.M.Prasad: ―Principles and Practice of Management‖, Sultan Chand & Sons,New Delhi, Ninth Edition 2015 (Reprint 2016,2017, 2018) Check & MRManagement: A South Asian Perspective with course material.
5. SN Chary: "Production and Operations Management", Tata McGraw Hill, NewDelhi, 2008.
6. B.S.Goel:" Production and Operations Management", A Pragati Edition, Meeru.

Web References:

1. http://archive.nptel.ac.in/courses/112/105/112105124/
2. http://www.youtube.com/watch?v=7bF0kZ9G6Hg
3. http://onlinecourses.nptel.ac.in/noc24_me45/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	20	-
L2 (Understanding)	30	10
L3 (Applying)	30	30
L4 (Analyzing)	20	40
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define production planning and control.
2. What is plant layout?
3. Define inventory control.
4. What is work study?
5. Explain principles of management.
6. Describe production planning and control.
7. Explain plant layout.
8. Describe work study.
9. Define management.
10. Explain functions of management.

L2: Understanding

1. Explain functions of management.
2. Describe production cycle.
3. Explain EOQ model.
4. Describe material handling principles.
5. Explain production cycle and process planning.

6. Describe material handling systems.
7. Explain inventory control techniques.
8. Discuss quality control basics.
9. Discuss objectives of purchasing department.
10. Explain process planning and scheduling techniques.

L3: Applying

1. Apply EOQ model to determine order quantity.
2. Demonstrate method study steps.
3. Apply routing and scheduling.
4. Use work measurement techniques.
5. Apply EOQ model in inventory management.
6. Apply assembly line balancing.
7. Demonstrate method study analysis.
8. Apply scheduling techniques.
9. Compare preventive and predictive maintenance.
10. Apply work measurement techniques in manufacturing industries.

L4: Analyzing

1. Analyze plant layout types.
2. Compare production systems.
3. Analyze material handling equipment.
4. Compare work study techniques.
5. Analyze plant layout selection.
6. Compare production planning methods.
7. Analyze work measurement techniques.
8. Compare material handling systems.
9. Analyze quality control techniques using control charts.
10. Analyze the impact of labour laws on industries.

L5: Evaluating

1. Evaluate effectiveness of PPC.
2. Justify selection of plant layout.
3. Evaluate inventory control methods.
4. Assess productivity improvement techniques.
5. Evaluate PPC effectiveness in industry.
6. Assess productivity improvement methods.
7. Evaluate inventory management systems.
8. Justify industrial engineering techniques in manufacturing.
9. Evaluate industrial productivity improvement techniques.
10. Justify automation in warehouse management.

Chairperson
Board of Studies (ME)

R24MEOE10 AUTOMATION IN MANUFACTURING 3 0 0 3

(Open Elective -II)

Course Objectives:

1. **To understands** the types and strategies and various components in Automated Systems
2. **To classify** the types of automated flow lines and analyze automated flow lines
3. **To solve** the line balancing problems in the various flow line systems with and without buffer storage
4. **To interpret** different automated material handling systems, storage and retrieval systems and automated inspection systems
5. **To understand** the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE10.1	Understands the types and strategies and various components in Automated Systems.	3	2	1	-	2	-	-	-	-	-	1	2	3	L1 L2
R24MEOE10.2	Classify the types of automated flow lines and analyze automated flow lines	3	3	2	2	2	-	-	-	-	-	1	3	3	L2 L3
R24MEOE10.3	Solves the line balancing problems in the various flow line systems with and without buffer storage	2	3	3	2	2	-	-	-	-	-	2	3	3	L3 L4
R24MEOE10.4	Interpret different automated material handling systems, storage and retrieval systems and automated inspection systems.	3	2	2	2	3	1	1	-	-	-	1	2	3	L4 L5
R24MEOE10.5	Understand the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications	3	2	2	2	3	1	1	-	-	-	1	2	3	L5

SYLLABUS

UNIT-I **14 Hours**

Introduction: Types and strategies of automation, pneumatic and hydraulic components, circuits,

automation in machine tools, power transmission in CNC machines, optical encoders, other sensors, mechanical feeding and tool changing and machine tool control. IoT, PLC, SCADA concepts. **CO's: CO1**

Self-Learning Topics: Basics of PLC programming (Ladder Logic), Introduction to SCADA systems, IoT in manufacturing (Industry 4.0 concepts)

UNIT-II **14 Hours**

Automated Flow Lines: Methods of part transport transfer mechanism, buffer storage, control function, design and fabrication considerations, Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, and implementation of automated flow lines. RMS, performance metrics. **CO's: CO2**

Self-Learning Topics: Simulation of flow lines using Arena/Simulink, Study of Flexible Manufacturing Systems (FMS), Line efficiency and productivity analysis.

UNIT–III **12 Hours**

Assembly System and Line Balancing: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines. AUTOMATED **Inspection:** Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision AI-based inspection, modern balancing. **CO's: CO3**

Self-Learning Topics: Basics of Machine Vision (OpenCV), Study of AI in quality inspection, Line balancing using software tools, Case study: Automated inspection in aerospace industry, Introduction to Six Sigma quality control.

UNIT–IV **12 Hours**

Automated Material Handling and Storage Systems: Types of equipment, functions, analysis and design of material handling systems, conveyor systems,and automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing. Robotics + Industry 4.0 integration. **CO's: CO4**

Self-Learning Topics: Study of Warehouse Management Systems (WMS), Basics of Industrial Robotics (pick & place robots), Design of conveyor systems, Case study: Smart warehouses (Industry 4.0), Introduction to RFID-based tracking systems.

UNIT–V **10 Hours**

Adaptive Control Systems: Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force,temperatures, vibration and acoustic emission in the adaptive controls systems. AI/ML, smart machining. **CO's: CO5**

Self-Learning Topics: Basics of Machine Learning in manufacturing, Study of sensor data analysis (MATLAB/Python), Adaptive control algorithms, Case study: Smart machining systems. Introduction to Digital Manufacturing & Smart Factories.

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text book:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover/ PE/PHI.
2. Automation by W. Buekinsham**.**

References:

1. Computer Control of Manufacturing Systems by Yoram Coren.
2. CAD / CAM/ CIM by Radhakrishnan.Internal Assessment Pattern

Web References:

1. Siemens–IndustrialAutomation&SmartManufacturing https://new.siemens.com/global/en/products/automation.html
2. RockwellAutomation–PLC,SCADA&IndustrialControlSystems https://www.rockwellautomation.com/
3. IBM–Industry4.0&SmartFactoryConcepts https://www.ibm.com/topics/industry-4-0
4. OpenCV–MachineVision&AIApplications https://opencv.org/
5. ABBRobotics–Robotics&IndustrialAutomation https://new.abb.com/products/robotics

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define automation and list its types.
2. What is PLC? Mention its applications.
3. Define automated flow line.
4. What is buffer storage in manufacturing systems?
5. Define assembly line balancing.
6. What is Coordinate Measuring Machine (CMM)?
7. Define Automated Guided Vehicle (AGV).
8. What is Automated Storage and Retrieval System (AS/RS)?
9. Define adaptive control system.
10. List the parameters monitored in adaptive control systems.

L2: Understand

1. Explain the working principle of pneumatic and hydraulic systems.
2. Explain the role of PLC and SCADA systems in industrial automation.
3. Describe the methods of part transport used in automated flow lines.
4. Explain the functions of buffer storage in transfer lines.

5. Explain different line balancing methods used in assembly systems.
6. Describe the working principle of machine vision systems.
7. Explain the working of conveyor systems used in industries.
8. Explain the applications of robotics in material handling systems.
9. Describe adaptive control with optimization in machining operations.
10. Explain the importance of IoT and Industry 4.0 in smart factories.

L3: Apply

1. Develop a simple PLC ladder logic program for motor control.
2. Apply pneumatic systems for industrial automation applications.
3. Design a conveyor-based automated flow line system.
4. Demonstrate the use of buffer storage in assembly lines.
5. Apply line balancing techniques for improving production efficiency.
6. Use CMM for dimensional inspection of components.
7. Apply machine vision systems for defect detection.
8. Implement RFID systems in warehouse management.
9. Apply AGV systems in automated material handling.
10. Use adaptive control systems in CNC machining operations.

L4: Analyze

1. Compare fixed automation and flexible automation systems.
2. Analyze the advantages of CNC machine automation over conventional systems.
3. Compare automated flow lines with and without buffer storage.
4. Analyze the performance of conveyor-based production systems.
5. Compare flexible assembly systems and traditional assembly systems.
6. Analyze the role of AI in automated inspection systems.
7. Compare AGV systems with conveyor systems used in industries.
8. Analyze the integration of robotics with Industry 4.0 systems.
9. Compare traditional machining systems with smart machining systems.
10. Analyze sensor-based monitoring systems used in adaptive control.

L5: Evaluate

1. Evaluate the effectiveness of automation in manufacturing industries.
2. Assess the importance of PLC and SCADA systems in industrial control.
3. Evaluate automated flow line systems used in automobile industries.
4. Assess the effectiveness of buffer storage in production systems.
5. Evaluate line balancing techniques in assembly industries.
6. Judge the effectiveness of machine vision systems in quality inspection.
7. Evaluate automated warehouse systems used in logistics industries.
8. Assess the role of robotics in automated material handling systems.
9. Evaluate AI and Machine Learning applications in smart machining.
10. Justify the importance of adaptive control systems in modern manufacturing industries.

`Chairperson

Board of Studies (ME)

R24MEPC13 **HEAT TRANSFER LAB** **0 0 3 1.5**
(Mechanical Engineering)

Course Objectives:

1. **To provide** hands-on experience in measuring heat transfer parameters such as thermal conductivity, heat transfer coefficient, and emissivity.
2. **To understand** and verify different modes of heat transfer—conduction, convection, and radiation through experiments.
3. **To analyze** the performance of heat transfer equipment like fins, heat exchangers, and condensation systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs								Dok
		PO1	PO2	PO3	PO4	PO5	PO9	PSO1	PSO2	
R24MEPC13.1	Conduct experiments to determine thermal properties such as thermal conductivity, heat transfer coefficients, and emissivity.	3	3		2	3	2	3	2	L1 L2
R24MEPC13.2	Analyze heat transfer mechanisms including conduction, convection, and radiation using experimental data.	3		3	2	2	--	3	2	L2 L3
R24MEPC13.3	Evaluate performance of heat transfer systems such as fins, heat exchangers, and phase change processes.	3	2		3	2	--	3	3	L3

List of Experiments:

WEEK 01

1. Determination of overall heat transfer co-efficient of a composite slab **CO's: CO1**

WEEK 02

2. Determination of heat transfer rate through a lagged pipe. **CO's: CO1**

WEEK 03

3. Determination of heat transfer rate through a concentric sphere **CO's: CO1**

WEEK 04

4. Determination of thermal conductivity of a metal rod. **CO's: CO1**

WEEK 05

5. Determination of efficiency of a pin-fin **CO's: CO3**

WEEK 06

6. Determination of heat transfer coefficient in natural and forced convection **CO's: CO2**

WEEK 07

7. Determination of effectiveness of parallel and counter flow heat exchangers. **CO's: CO3**

WEEK 08

8. Determination of emissivity of a given surface. **CO's: CO1**

WEEK 09

9. Determination of Stefan Boltzman constant. **CO's: CO2**

WEEK 10

10. Determination of heat transfer rate in drop and film wise condensation. **CO's: CO3**

WEEK 11

11. Determination of critical heat flux. **CO's: CO2**

WEEK 12

12. Determination of Thermal conductivity of liquids and gases. **CO's: CO1**

WEEK 13

13. Investigation of Lambert's cosine law. **CO's: CO2**

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

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Text Books:

1. "Theory of Machines" by S.S. Rattan
2. "Theory of Machines and Mechanisms" by Joseph E. Shigley and John U. Ood
3. "Applied Mechanism and Machine Theory" by C.M. Gupta and P.K. Khurmi

Reference Books:

1. "Theory of Machines and Mechanisms" by Jagdish Lal
2. "Theory of Machines" by R.S. Khurmi and J.K. Gupta
3. "Machine Design: An Integrated Approach" by Robert L. Norton

Online Resources:

Virtual labs (https://mfts-iitg.vlabs.ac.in/) on

1. Conduction Analysis of a Single Material Slab
2. Conduction Analysis of a Single Material Sphere
3. Conduction Analysis of a Single Material Cylinder
4. Conduction Analysis of a Double Material Slab
5. Conduction Analysis of a Double Material Sphere
6. Conduction Analysis of Double Material Cylinder
7. To determine the overall heat transfer coefficient (U) in the (i) parallel flow heat exchanger and (ii) Counter flow heat exchanger
8. To investigate the Lambert's distance law.
9. To investigate the Lambert's direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination.

Chairperson

Board of Studies (ME)

R24MEPC22 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB 0 0 3 1.5
(Mechanical Engineering)

Course Objectives:

1. **To Familiarity** with the Python programming environment.
2. **To introduce** students to the basic concepts and techniques of Machine Learning.
3. **To implement** classification and clustering methods.
4. **To become** familiar with Dimensionality reduction Techniques.
5. **To Learning** basic concepts of Python through illustrative examples and small exercises &Understanding list data structure in Python.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs								Dok
		PO1	PO2	PO3	PO4	PO5	PO9	PSO1	PSO2	
R24MEPC22.1	Develop Python programs to solve AI search problems using BFS, DFS, Best First Search, Hill Climbing, and related algorithms.	3	3	2	2	3	2	3	2	L1 L2
R24MEPC22.2	Apply data extraction, data preprocessing, visualization, and regression techniques using Python for machine learning applications.	3	2	2	2	3	-	3	2	L2 L3
R24MEPC22.3	Implement supervised and unsupervised machine learning algorithms such as KNN, K-Means, and Hierarchical Clustering using Python.	3	3	2	3	3	-	3	3	L3

STUDY OF PROLOG; WRITE THE FOLLOWING PROGRAMS USING PROLOG/PYTHON

WEEK 01

1. Write a program to implement all set operations(Union, Intersection, Complement etc) **CO's: CO1**

WEEK 02

2. Implementation of DFS for water jug problem using PYTHON **CO's: CO1**

WEEK 03

3. Implementation of BFS for tic-tac-toe problem using PYTHON **CO's: CO1**

WEEK 04

4. Solve 8-puzzle problem using best first search **CO's: CO1**

WEEK 05

5. Write a program to solve 8 queens problem **CO's: CO2**

WEEK 06

6. Implementation of Hill-climbing to solve 8- Puzzle Problem **CO's: CO2**

MACHINE LEARNING

WEEK 07

7. **Data Extraction, Wrangling:** 1. Loading different types of dataset in Python 2. Arranging the data **CO's: CO2**

WEEK 08

8. **Data Visualization:** 1. Handling missing values 2. Plotting the graphs **CO's: CO2**

WEEK 09

9. **Supervised Learning**: Implementation of Linear Regression **CO's: CO3**

WEEK 10

10. Implementation of K-nearest Neighbor **CO's: CO3**

WEEK 11

11. Implementing K-means Clustering **CO's: CO3**

WEEK 12

12. Unsupervised Learning Implementing Hierarchical Clustering **CO's: CO3**

Board of Studies : Mechanical Engineering
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Board of Studies (ME)

R24MESC04 **SIMULATION LAB and I&CS LAB** **0 1 2 2**
(Mechanical Engineering)

Course Objectives:

1. **To understand** the fundamentals of CAD/CAE tools (ANSYS, FLUENT, etc.) for engineering simulation.
2. **To develop** 3D models and assemblies using feature-based and surface modeling techniques.
3. **To apply** simulation techniques to analyze stresses, deformation, vibration, and heat transfer problems.
4. **To generate** CNC part programs for turning and milling operations using CAM concepts.
5. **To perform** calibration and analysis of industrial measuring instruments such as pressure gauges, LVDT, strain gauges, and temperature sensors.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MESC04.1	Develop 3D models and perform engineering simulations to analyze mechanical components.	3	2	1	-	2	-	-	-	-	-	1	2	3	L1 L2
R24MESC04.2	Apply CNC programming and CAM tools to generate machining codes for manufacturing processes.	3	3	2	2	2	-	-	-	-	-	1	3	3	L2 L3
R24MESC04.3	Analyze and calibrate industrial instruments for measuring physical parameters such as pressure, temperature, displacement, and flow.	2	3	3	2	2	-	-	-	-	-	2	3	3	L3 L4

SYLLABUS

PART-A

1. PART MODELING: Generation of various 3D models through protrusion, revolve, shell sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modelling surface and assembly modelling. Study of various standard translators. Design

simple components.

2. ANALYSIS:

WEEK 1

a) Determination of deflection and stresses in 2D and 3D trusses and beams**.** - **CO's:CO1**

WEEK 2

b) Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and axis symmetric components. - **CO's:CO1**

WEEK 3

c) Determination of stresses in 3D and shell structures (at least one example in each case) - **CO's:CO1**

WEEK 4

d) Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam. – **CO's: CO1**

WEEK 5

e) Steady state heat transfer Analysis of plane and axis symmetric components. - **CO's: CO1**

WEEK 6

f) Study and prepare the Manual Part program for CNC Turn machine - **CO's: CO2**

WEEK 7

g) Study and prepare the Manual Part program for CNC Mill machine - **CO's: CO2**

WEEK 8

h) Study of various post processors used in NC Machines- **CO's: CO2**

PART-B

List of Experiments:

WEEK 9

a) Calibration of pressure gauge**.-** **CO's:CO3**

WEEK 10

b) Calibration of transducer for temperature measurement. **.-** **CO's:CO3**

WEEK 11

c) Study and calibration of LVDT transducer for displacement measurement. **.-** **CO's:CO3**

WEEK 12

d) Calibration of strain gauge. **. -** **CO's:CO3**

WEEK 13

e) Calibration of capacitive transducer. **. -** **CO's:CO3**

WEEK 14

f) Study and calibration of a rotameter. - **CO's:CO3**

WEEK 15

g) Study and calibration of Mcleod gauge for low pressure. **.-** **CO's:CO3**

Packages to be provided to cater to drafting, modelling & analysis from the following: CATIA, Pro-E, I-DEAS, ANSYS, NISA, etc

Board of Studies: Mechanical Engineering

Approved in BOS No: 03

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Board of Studies (ME)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech Mechanical Engineering **Regulation: R24**

Course Structure: IV Year I Semester (or) Semester-VII

S.No	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	PC	R24MEPC23	Finite Element Methods	3	0	0	3
2	HS	R24HS12	Operations Research	2	0	0	2
3	PE-III	R24MEPE11 R24MEPE12 R24MEPE13 R24MEPE14 R24MEPE15	1. Automobile Engineering 2. Computer Integrated Manufacturing 3. Computational Fluid Dynamics 4. Hydrogen fuel cells Technologies 5. 12 Week MOOCS Swayam/NPTEL Course recommended by the BoS	3	0	0	3
4	PE-IV	R24MEPE16 R24MEPE17 R24MEPE18 R24MEPE19 R24MEPE20	1. Power Plant Engineering 2. Production Planning and Control 3. Jet Propulsion & Rockets 4. Refrigeration and Air Conditioning 5. 12 Week MOOCS Swayam/NPTEL Course recommended by the BoS	3	0	0	3
5	OE-III	R24MEOE11 R24MEOE12 R24MEOE13 R24MEOE14 R24MEOE15	1. 3D Printing Technologies 2. Green Engineering 3. Industrial Automation 4. Fundamentals of Drone Technology 5. Non-Destructive Testing (NDT)	3	0	0	3
6	SC	R24MESC05	Mechatronics Lab	0	1	2	2
7	SI	R24MESI01	Evaluation of Industry Internship	0	0	0	2
8	PJ	R24MEPJ01	Project Work: Project topic, Problem Statement, Literature Survey.	0	0	6	0
9	AC-II	R24AC02	Constitution of India	2	0	0	0
			Total	**14**	**01**	**08**	**18**

Category	Courses	Credits
PC- Professional Core Courses	1	03
PE- Professional Elective Courses	2	06
OE- Open Elective Courses	1	03
SC- Skill Oriented Course	1	02
HS- Humanity Science and Management Course	1	02
PJ- Project Work Phase-I	1	00
AC-Audit Course	1	00
SI-Summer Internship	1	02
Total	10	18

R24MEPC23 **FINITE ELEMENT METHODS** **3 0 0 3**

(Mechanical Engineering)

Course Objectives:

1. **To understand** the fundamentals of finite element methods and their application to engineering problems.
2. **To develop** skills in finite element modeling, including discretization, stiffness matrix formulation, and boundary condition application.
3. **To analyze** structural problems using advanced FEM techniques for 2D elements and numerical integration methods.
4. **To apply** FEM to dynamic analysis and learn the theoretical concepts and processes involved in FEA software for modeling, solving, and interpreting results.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	pO7	pO8	pO9	PO10	PO11	PSO1	PSO2	
R24MEPC 23.1	Develop and apply the fundamental principles of stress-strain relationships and Rayleigh-Ritz methods to solve structural analysis problems.	3	2	1	1	1	–	–	–	–	–	1	3	1	L2 L3
R24MEPC 23.2	Solve 1D finite element problems for bar and beam elements, incorporating temperature effects, boundary conditions, and load analysis.	3	3	2	2	2	1	–	–	–	–	1	3	2	L3 L4
R24MEPC 23.3	Analyze plane trusses and beams using finite element modeling techniques to compute nodal displacements, stresses, and reactions	3	3	2	2	2	1	–	–	–	–	1	3	1	L3 L4
R24MEPC 23.4	Formulate and solve two-dimensional problems using constant strain triangles, including numerical integration for higher accuracy	3	3	2	3	2	–	–	–	–	–	2	3	1	L3 L4

R24MEPC 23.5	Evaluate dynamic behavior of 1D bar and 2D beam structures through eigenvalue analysis and utilize FEA software for modeling, simulation, and result interpretation.	3	3	2	3	3	1	–	1	1	1	3	3	2	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction: Introduction to finite element methods, stress equilibrium equations for 3D body, strain – displacement relations for 3D body, stress – strain relations for 3D body, material matrix, plane stress and plane strain conditions for 2D body, Problems on stress-strain relations and strain displacement relations. Basic Steps in FEM formulation - concept of potential energy, Rayleigh Ritz method, problems on Rayleigh-Ritz method.

Self-Learning Topics: Applications of Rayleigh–Ritz Method in Structural Engineering Problems

CO's: CO1

UNIT-II **14 Hours**

Finite Element Modeling: Discretization of domain, element shapes, node numbering, coordinates and shape functions, derivation of element stiffness matrix, assembly of stiffness matrices and load vector, half band width, Potential energy approach, Finite Element Equations, Imposition of boundary conditions, Solution of the FE equations using elimination and penalty approaches, calculation of nodal displacements, stress, strain and support reactions, Applications to 1-D bar elements and temperature effects.

Self-Learning Topics: Finite Element Analysis of Composite Bar Elements with Thermal Loading. **CO's: CO2**

UNIT–III **12 Hours**

Plane Trusses: Finite element modeling - Discretization of domain of truss structures, local and global numbering scheme, Element stiffness matrix, Assembly of stiffness matrices and Load vector, Finite element equations and solution to calculate nodal displacements, strains, stresses and reactions of plane truss structures.

Analysis of Beams: Introduction, Finite element formulation using 2D Hermite beam element, derivation of Hermite shape functions, derivation of stiffness matrices, derivation of load vector for concentrated and UDL, Boundary considerations, Shear force and bending moment calculations

Self-Learning Topics: Finite Element Modeling and Analysis of Frame Structures Using Beam Elements **CO's: CO3**

UNIT–IV **12 Hours**

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, constant strain triangle, problem modeling and boundary conditions.

Numerical Integration: Introduction to Higher order and iso-parametric elements – Importance of Numerical integration & Gaussian Quadrature, Problems on 1×1 and 2×2 rules.

Self-LearningTopics: Iso-parametric Elements and Their Applications in Two-Dimensional FEM Problems**.** **CO's:CO4**

UNIT–V **10 Hours**

Dynamic Considerations: Introduction, formulation, element consistent & lumped mass matrices, evaluation of Eigen values and Eigen vectors, Mode shapes, Free vibration problems of 1D stepped bar and 2D beam with reduced matrix of order 2×2.

Introduction FEA software: FE modeling in software, Preprocessor, Processor& Post Processor modules, Theory of imposing boundary conditions and applying loads in software, extracting FE simulation results in package.

Self-Learning Topics: Introduction to Modal Analysis and Vibration Analysis Using ANSYS/ABAQUS Software. **CO's: CO5**

Board of Studies : Mechanical Engineering
Approved in BoS No: 03
Approved in ACM No: 03

Text Books:

1. Introduction to Finite Elements in Engineering, Second Edition/ Tirupati Reddy m Chandrupatla/Prentice Hall.
2. The Finite Element Methods in Engineering /S.S.Rao /Pergamon.

Reference Books:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method /JN Reddy/McGraw-Hill
3. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education.
4. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. By rom/John Wiley & sons (ASIA) Pvt Ltd.
5. Finite Element Analysis: for students & Practicing Engineers / G. Lakshmi Narasaiah

Web References: Finite Element Analysis

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remembering

1. Define Finite Element Method (FEM).
2. What is discretization in FEM?
3. Define stress and strain.
4. What is a stiffness matrix?
5. Define plane stress condition.
6. Explain the basic concepts and steps involved in FEM.
7. List and explain applications of FEM in engineering.
8. Define stress, strain, and their types.
9. Explain plane stress and plane strain conditions.
10. Define stiffness matrix, mesh, and nodes.

L2 – Understanding

1. Explain the basic concept of FEM.
2. Differentiate between plane stress and plane strain.
3. Explain interpolation (shape) functions.
4. Describe local and global coordinate systems.
5. Explain the concept of mass matrix.
6. Explain discretization, mesh generation, and node numbering.
7. Describe strain–displacement and stress–strain relations.
8. Explain local and global coordinate systems with examples.
9. Describe interpolation functions and their properties.
10. Explain consistent and lumped mass matrices.

L3 – Applying

1. Calculate stress using Hooke's law for given strain.
2. Determine strain from a given displacement function.
3. Apply FEM steps to a simple bar problem.
4. Compute nodal displacement in a simple truss.
5. Apply boundary conditions to a simple system.
6. Derive stiffness matrix for a one-dimensional bar element.
7. Solve a simple truss problem using FEM.
8. Analyze a beam subjected to UDL using FEM.
9. Solve a steady-state heat transfer problem in a fin.
10. Determine natural frequencies using FEM for a simple system.

L4 – Analyzing

1. Analyze the steps involved in FEM procedure.
2. Compare FEM with analytical methods.
3. Analyze the effect of mesh size on accuracy.
4. Examine the role of boundary conditions.
5. Differentiate between CST and higher-order elements.
6. Analyze assembly of global stiffness matrix in FEM.
7. Compare FEM with analytical and experimental methods.
8. Analyze effect of mesh refinement on solution accuracy.
9. Examine CST and higher-order elements in detail.

10. Analyze treatment of boundary conditions in FEM.

L5 – Evaluating

1. Evaluate the advantages of FEM over other methods.
2. Justify the need for discretization.
3. Evaluate the use of isoperimetric elements.
4. Assess importance of convergence criteria.
5. Evaluate FEM applicability in engineering problems.
6. Evaluate FEM for solving complex engineering problems.
7. Critically analyze advantages and limitations of FEM.
8. Justify use of isoparametric elements in FEM.
9. Evaluate convergence requirements in FEM solutions.
10. Assess FEM applications in dynamic and heat transfer analysis

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Board of Studies (ME)

R24MEPE11 **AUTOMOBILE ENGINEERING** **3 0 0 3**

(Professional Elective-III)

Course Objectives:

1. **To understand** the layout, construction, and working principles of automobile engines and vehicle systems.
2. **To study** the functioning of lubrication, cooling, and valve mechanisms used in automobile engines.
3. **To analyze** the operation and performance of transmission and steering systems in automobiles.
4. **To understand** the principles and working of suspension, braking, and automobile electrical systems.
5. **To study** automobile safety features, emission control methods, and pollution standards for sustainable transportation.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24ME PE11.1	Explain the construction, components, lubrication, cooling systems, and working principles of automobile engines and vehicle layouts.	3	2	-	1	2	-	_	_	1	_	1	1	2	L1 L2
R24ME PE11.2	Analyze the working and performance of automobile transmission systems including clutches, gearboxes, differentials, and drive systems.	3	3	2	2	2	1	_	_	1	_	1	1	2	L1 L2
R24ME PE11.3	Illustrate the construction and operation of steering mechanisms and steering geometry used in automobile vehicles.	2	2	2	1	2	1	_	_	1	_	2	1	3	L2 L3
R24ME PE11.4	Explain the working principles of	3	2	2	2	3	1	_	_	1	_	2	1	3	L3 L4

	suspension, braking, and automobile electrical systems used in modern vehicles.														
R24ME PE11.5	Analyze automobile safety systems, emission control techniques, and pollution standards for sustainable vehicle operation.	2	3	2	2	2	3	_	_	1	_	2	2	2	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction To Automobile and Engine Construction: Layout of four-wheeler automobile - Chassis and body - –Power unit – power transmission – rear wheel drive, front wheel drive, 4-wheel drive – types of automobile engines, engine construction details, turbo charging and super charging- valve mechanisms-types– engine lubrication, splash and pressure lubrication systems, oil filters– crank case ventilation –cooling system –types **CO's: CO1**

Self-Learning Topics: Hybrid and electric vehicle engines, turbochargers and superchargers, advanced cooling systems, synthetic lubricants, modern chassis materials.

UNIT-II **14 Hours**

Transmission system: Clutches-Function-Types-Single plate, Multiple plate, Cone clutch and Diaphragm Clutch – Fluid coupling - Gearbox - Sliding - Constant - Synchromesh - Overdrive– Torque converter-Continuously variable transmission-Universal joint- Propeller shaft- Drive types-Differential - rear axles– types – wheels and tyres. **CO's: CO2**

Self-Learning Topics: Automatic transmission systems, dual clutch transmission (DCT), continuously variable transmission (CVT), advanced differential systems, smart tyres and TPMS.

UNIT–III **12 Hours**

Steering System: Steering geometry – camber, castor, king pin rake, combined angle toe in, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages. **CO's:CO3**

Self-Learning Topics: Electronic power steering, four-wheel steering, steering stability, autonomous vehicle steering, modern steering controls.

UNIT–IV **12 Hours**

Suspension System: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

Braking System: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder, pneumatic and vacuum brakes.

Electrical System: Wiring diagram of 4-wheeler and 2-wheeler, battery construction- ignition types– current regulator - voltage regulator - current - voltage regulator – Bendix drive, solenoid switch, Charging circuit, horn circuit, wiper circuit. **CO's:CO4**

Self-Learning Topics: Electronic suspension systems, regenerative braking systems, automotive battery technologies, intelligent lighting systems, vehicle electronic control systems.

UNIT–V **10 Hours**

Automobile safety and Emission control: Safety and security - Seat belts - Air bags - Electronic Control Unit (ECU) - Anti lock brake system (ABS) - Active Suspension System(ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP)- Traction Control System (TCS) - Global Positioning System (GPS) - Types of pollutants, mechanism of formation, exhaust gas treatment-thermal and catalytic converters use of alternative fuels for emission control – National and International pollution standards **CO's: CO5**

Self-Learning Topics: BS-VI emission norms, electric and hydrogen vehicles, ADAS technology, smart vehicle safety systems, and sustainable transportation technologies.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.
2. Automobile engineering by R B Gupta, Satya Prakashan publications (P) Ltd.
3. Richard Stone, Jeffrey K.Ball, Automotive Engineering Fundamentals" SAE International.
4. Automobile engineering by R K Rajput- Laxmi publications (P) Ltd.

Reference Books:

1. William.H. Crouse, AutomotiveMechanics,10/e Edition, McGraw-Hill.
2. David A. Corolla, Automotive Engineering: Power train, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd.
3. Bosch, Automotive Hand Book, 6/e SAE Publications year.
4. K. Newton and W. Steeds, The motor vehicle, 13/e Butterworth- Heinemann Publishing Ltd.

Web References:

1. SAE International | Advancing mobility knowledge and solutions
2. nptel.ac.in/?utm_source=chatgpt.com
3. Automotive Research Association of India (ARAI)
4. Virtual Labs – Ministry of Education, Government of India
5. International Energy Agency – Transport Sector

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	
L2 (Understanding)	40	30
L3 (Applying)	30	40
L4 (Analyzing)		30
L5 (Evaluating)		
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define chassis in an automobile.
2. List the types of automobile engines.
3. What is meant by turbocharging?

4. Define clutch and state its function.
5. Name the types of steering gears.
6. Explain the layout of a four-wheeler automobile with neat sketch.
7. Describe the construction and working of a single plate clutch.
8. Explain the lubrication systems used in automobile engines.
9. Describe the types of braking systems used in automobiles.
10. Explain the construction of automobile battery and its functions.

Level 2: Understanding

1. Differentiate between front wheel drive and rear wheel drive.
2. Explain the function of a differential.
3. Compare Ackerman and Davis steering mechanisms.
4. What is the purpose of shock absorbers?
5. Explain the need for cooling systems in engines.
6. Explain the working of synchromesh gearbox with neat sketch.
7. Discuss the working principle of hydraulic braking system.
8. Explain the steering geometry terms camber, castor, and toe-in.
9. Describe the working of suspension systems used in automobiles.
10. Explain the charging circuit and horn circuit in automobiles.

Level-3: Applying

1. Identify suitable lubrication systems for heavy-duty engines.
2. Select an appropriate clutch for high torque transmission.
3. Suggest a suitable suspension system for rough road conditions.
4. How does ABS improve vehicle safety?
5. Choose suitable tyres for heavy load vehicles.
6. Analyze the working of torque converter in automatic transmission systems.
7. Explain the application of pneumatic brakes in heavy vehicles.
8. Discuss the working and applications of continuously variable transmission (CVT).
9. Explain the operation of electronic ignition system in automobiles.
10. Describe the applications of turbocharging and supercharging in automobiles.

Level-4: Analyzing

1. Analyze the causes of engine overheating.
2. Compare mechanical and hydraulic brake systems.
3. Differentiate between rigid axle and independent suspension systems.
4. Analyze the role of ECU in modern vehicles.
5. Compare SI and CI engine emissions.
6. Analyze the working and advantages of electronic stability program (ESP).
7. Compare catalytic and thermal converters used for emission control.
8. Analyze the performance of different transmission systems used in automobiles.
9. Explain the effects of improper steering geometry on vehicle performance.
10. Analyze various emission control methods used in automobiles.

Level-5: Evaluating

1. Evaluate the effectiveness of ABS in preventing wheel locking and improving vehicle safety.
2. Justify the use of airbags in modern automobiles.
3. Evaluate the importance of traction control systems in vehicle stability.
4. Justify the use of central locking and electric window systems in automobiles.

5. Evaluate the role of suspension sensors in modern vehicle safety systems.
6. Evaluate the performance and effectiveness of automobile safety systems such as seat belts, airbags, and ABS.
7. Justify the importance of traction control and speed control systems in modern vehicles.
8. Evaluate different smart safety systems used in automobiles with suitable examples.
9. Analyze and justify the role of advanced driver assistance and intelligent safety technologies in automobiles.
10. Evaluate modern automobile safety systems with respect to passenger safety, comfort, and vehicle control.

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R24MEPE12 **Computer Integrated Manufacturing** **3 0 0 3**

(Professional Elective-III)

Course Objectives:

1. **To apply** manufacturing concepts and management principles.
2. **To classify** and compare different manufacturing processes and systems.
3. **To develop** part program for manufacturing of different machine components.
4. **To analyze** the behavior of manufacturing system using simulation.
5. **To understand** automation, robotics, and advanced manufacturing systems in CIM.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	CourseOutcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 12.1	Apply manufacturing concepts and management principles	3	2	1	3	1	-	-	-	-	-	-	2	2	L3
R24MEPE 12.2	Classify and compare different manufacturing processes and systems. Develop part programs for manufacturing of machine components	3	3	2	3	2	-	-	-	-	-	-	2	3	L4
R24MEPE 12.3	Develop part programs for manufacturing of machine components	2	2	3	3	3	1	-	-	-	-	-	3	3	L4
R24MEPE 12.4	Analyze the behavior of manufacturing systems using simulation techniques	3	3	3	2	2	-	-	-	-	-	-	3	2	L5
R24MEPE 12.5	Understand automation, robotics, and advanced CIM systems	3	2	2	3	2	-	-	-	-	-	1	3	2	L2

SYLLABUS

UNIT-I **14 Hours**

Introduction: Introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In Time Production. **CO's:CO1**

Self-Learning Topics: Study the concepts of lean production and Just-In-Time (JIT)

manufacturing, levels of automation in production systems, basic elements of automated systems, and mathematical models used for production performance analysis.

UNIT-II **14 Hours**

Production Planning and Control and Computerized Process Planning: Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems. **CO's: CO2**

Self-Learning Topics: Learn the concepts of Manufacturing Resource Planning-II (MRP-II) and Enterprise Resource Planning (ERP), shop floor control systems, inventory control techniques, and material requirement planning with simple problem-solving approaches.

UNIT–III **14 Hours**

Cellular Manufacturing: Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell **CO's: CO3**

Self-Learning Topics: Study parts classification and coding systems in Group Technology, including the Opitz coding system, machine cell design and layout techniques, and quantitative methods such as Rank Order Clustering for cellular manufacturing.

UNIT–IV **12 Hours**

Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety. **CO's: CO4**

Self-Learning Topics: Learn about types of flexibility in manufacturing systems, FMS planning and control strategies, quantitative analysis in FMS, and vehicle guidance, management, and safety aspects of Automated Guided Vehicle Systems.

UNIT–V **10 Hours**

Industrial Robotics: Robot Anatomy and Related Attributes – Classification of Robots - Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems. **CO's: CO5**

Self-Learning Topics: Study robot control systems, sensors used in robotics, end effectors and their applications, robot programming methods, and concepts of robot accuracy and repeatability in industrial applications.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Mikell P. Groover, *Automation, Production Systems and Computer Integrated*

Manufacturing, Pearson Education, 2008.
2. Andrew Kusiak, *Intelligent Manufacturing Systems*, Prentice Hall, 1990.

Reference Books:

1. T. O. Boucher, *Computer Automation in Manufacturing*, Chapman and Hall, 1996.
2. Mikell P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, Wiley, 2010.
3. J. T. Black, *The Design of the Factory with a Future*, McGraw-Hill, 1991.
4. Yoram Koren, *Computer Control of Manufacturing Systems*, McGraw-Hill, 1983.
5. P. N. Rao, *CAD/CAM Principles and Applications*, Tata McGraw-Hill, 2010.

Web References:

1. https://nptel.ac.in/courses/112/101/112101099/
2. https://nptel.ac.in/courses/112/104/112104189/
3. https://ocw.mit.edu/courses/mechanical-engineering/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	30
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remembering

1. Define CIM (Computer Integrated Manufacturing).
2. Define Group Technology.
3. Define FMS (Flexible Manufacturing System).
4. Define ERP system.
5. Define industrial robot.
6. Define CIM and list its applications.
7. Explain the basic elements of an automated system.
8. Define Group Technology and list its advantages.
9. Define AGVS and explain its applications.
10. Define FMS and list its components.

L2: Understanding

1. Explain manufacturing planning and control in CIM.
2. Explain Computer Aided Process Planning (CAPP).
3. Explain parts classification and coding in Group Technology
4. Explain types of flexibility in FMS.
5. Explain robot anatomy.
6. Explain manufacturing planning and control in CIM.

7. Describe Computer Aided Process Planning (CAPP) in detail.
8. Explain ERP and MRP-II systems.
9. Explain the process planning procedure and Computer Aided Process Planning (CAPP).
10. Discuss aggregate production planning and master production scheduling with suitable examples.

L3: Applying

1. Apply MRP concept to a simple production planning problem.
2. Apply Opitz coding system for part classification.
3. Prepare a simple machine cell layout for cellular manufacturing.
4. Solve a basic FMS production problem.
5. Write basic robot programming steps for a pick-and-place operation.
6. Solve a simple MRP problem for material requirement planning.
7. Apply Rank Order Clustering method in cellular manufacturing.
8. Develop a simple robot part program for industrial application.
9. Explain Group Technology (GT) and parts classification systems in cellular manufacturing.
10. Discuss the Opitz part coding system with suitable examples.

L4: Analyzing

1. Analyze differences between MRP and ERP systems.
2. Analyze advantages of cellular manufacturing over traditional manufacturing.
3. Analyze components and working of FMS.
4. Analyze AGVS applications in industries.
5. Analyze robot control systems in automation.
6. Compare traditional manufacturing and CIM systems.
7. Analyze design and working of Flexible Manufacturing Systems.
8. Examine AGVS structure and safety systems in detail.
9. Explain the concepts, components, and applications of Flexible Manufacturing Systems (FMS).
10. Evaluate vehicle management and safety aspects in AGVS for industrial applications.

L5: Evaluating

1. Evaluate the role of CIM in modern manufacturing industries.
2. Evaluate advantages of FMS compared to conventional systems.
3. Evaluate effectiveness of Group Technology in production efficiency.
4. Evaluate industrial robotics in automation systems.
5. Evaluate lean production and JIT systems in CIM environment.
6. Evaluate the importance of CIM in Industry 4.0 environment.
7. Critically analyze the effectiveness of robotics in automation.
8. Evaluate lean manufacturing and JIT in modern industries.
9. Explain robot anatomy, classification, and related attributes of industrial robots.
10. Discuss robot control systems, end effectors, and sensors used in robotics.

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R24MEPE14 **HYDROGEN FUEL CELLS TECHNOLOGY** **3 0 0 3**

(Professional Elective-III)

Course Objectives:

1. **To introduce** hydrogen as an alternative energy source and its properties, advantages, and safety aspects.
2. **To understand** various methods of hydrogen production and their technological significance.
3. **To study** hydrogen storage techniques and their practical applications.
4. **To explain** the working principles, types, and performance of fuel cells.
5. **To analyze** fuel cell applications, economic feasibility, and environmental impact.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs										DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO10	PSO1	PSO2	
R24MEPE14.1	Explain fundamentals of hydrogen energy, properties, and associated safety concerns.	3	2	-	-	2	2	2	-	2	2	**L1**
R24MEPE14.2	Describe various hydrogen production methods and evaluate their effectiveness.	3	3	-	2	2	-	2	-	2	3	**L2**
R24MEPE14.3	Analyze hydrogen storage techniques and applications in energy systems.	3	3	2	2	2	-	2	-	3	3	**L2 L3**
R24MEPE14.4	Explain working principles, types, and performance of different fuel cells.	3	3	-	2	2	-	-	-	3	2	**L3**
R24MEPE14.5	Assess fuel cell applications, economic feasibility, and environmental impact.	3	2	2	-	2	2	2	1	2	3	**L4 L5**

SYLLABUS

UNIT-I **12 Hours**

Hydrogen Fundamentals: Hydrogen as a source of energy, physical and chemical properties, salient characteristics, issues and safety concerns.

Self-learning Topics – Hydrogen economy and safety standards. **CO's:CO1**

UNIT-II **14 Hours**

Hydrogen Production Methods: Steam reforming, water electrolysis, gasification and biomass conversion, biological hydrogen production, photo dissociation, thermal and catalytic water splitting. **CO's: CO2**

Self-learning Topics – Green hydrogen technologies

UNIT-III **14 Hours**

Hydrogen Storage & Applications: Hydrogen storage methods (compressed gas, liquid hydrogen, hydrides, chemical storage), safety and handling, applications of hydrogen.

Self-learning Topics – Advanced storage materials and safety. **CO's:CO3**

UNIT-IV **14 Hours**

Fuel Cells – Types & Working: History, principle, thermodynamics and kinetics, types of fuel cells (AFC, PAFC, SOFC, MCFC, DMFC, PEMFC), performance evaluation, comparison with batteries.

Self-learning Topics – Fuel cell efficiency and materials **CO's:CO4**

UNIT-V **12 Hours**

Fuel Cells – Applications & Economics: Fuel cell applications in domestic, industrial, automobile and space sectors, economic and environmental analysis, future trends.

Self-learning Topics – Cost analysis and future fuel cell trends. **CO's:CO5**

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation,Oklahoma
3. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.
4. Karl Kordesch & Gunter R. Simader., Fuel Cells and Their Applications, 1st ed., VCH Publishers, NY, 2001.

Reference Books:

1. Bent Sorensen (Sorensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK
2. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany
3. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London
4. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA

Web References:

1. **https://www.youtube.com/watch?v=Eb7pv0oOf_k**
2. **https://www.youtube.com/@npteliitguwahati8283/search?query=hydrogen**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	
L3	30	50
L4	--	40
L5		10
Total (%)	**100**	**100**

Sample Questions of Various Cognitive Levels

L1: Remember

1. Define hydrogen energy.
2. What are fuel cells?
3. List methods of hydrogen production.
4. Define steam reforming.
5. What is water electrolysis?
6. List types of fuel cells.
7. Define hydrogen storage.
8. What is PEM fuel cell?
9. Define calorific value of hydrogen.
10. List applications of fuel cells.

L2: Understand

1. Explain steam reforming process for hydrogen production.
2. Describe water electrolysis method.
3. Explain compressed gas hydrogen storage.
4. Discuss working principle of PEM fuel cell.
5. Explain thermodynamics of fuel cells.
6. Describe hydrogen safety measures.
7. Explain working of SOFC fuel cell.
8. Discuss advantages of hydrogen as fuel.
9. Explain comparison between battery and fuel cell.
10. Describe applications of hydrogen energy systems.

L3: Apply

1. Compare different hydrogen production methods.
2. Analyze performance of fuel cell systems.
3. Compare PEMFC and SOFC fuel cells.
4. Evaluate hydrogen storage methods for automobiles.
5. Analyze environmental impact of hydrogen fuels.
6. Compare fuel cells with conventional power systems.
7. Analyze efficiency of water electrolysis systems.
8. Evaluate advantages of hydrogen-powered vehicles.
9. Compare gaseous and liquid hydrogen storage.
10. Analyze economic feasibility of fuel cell technology.

L4: Analyze

1. Design a hydrogen fuel storage system for automobiles.
2. Develop a fuel cell-based power generation model.
3. Propose a hydrogen energy system for industries.
4. Design a renewable hydrogen production system.
5. Analyze hydrogen fuel usage in smart cities.
6. Develop safety management methods for hydrogen handling.
7. Design a hybrid fuel cell-electric vehicle system.
8. Evaluate large-scale fuel cell applications in industries.
9. Propose methods to improve fuel cell efficiency.
10. Design an eco-friendly hydrogen transportation system.

L5: Evaluate

1. Evaluate performance of hydrogen fuel cells in automobiles.
2. Assess suitability of hydrogen as future energy source.
3. Evaluate advantages and limitations of fuel cell systems.
4. Judge effectiveness of hydrogen storage methods.
5. Evaluate environmental benefits of hydrogen energy systems.
6. Assess economic feasibility of fuel cell technology.
7. Evaluate role of hydrogen in sustainable development.
8. Compare and evaluate different fuel cell types.
9. Assess industrial applications of hydrogen energy.
10. Evaluate future scope of hydrogen and fuel cell technology.

Chairperson
Board of Studies (ME)

R24MEPE13 **COMPUTATIONAL FLUID DYNAMICS** **3 0 0 3**

(Professional Elective - III)

Course Objectives:

1. **To understand** the fundamentals of Computational Fluid Dynamics (CFD), governing equations, boundary conditions, and classification of partial differential equations used in fluid flow analysis.
2. **To learn** discretization techniques such as Finite Difference Method (FDM), Finite Volume Method (FVM), and Finite Element Method (FEM) for solving engineering problems numerically.
3. **To develop** the ability to apply numerical methods for one-dimensional and two-dimensional steady and transient heat conduction problems using FDM and FVM approaches.
4. To understand convection–diffusion equations and implement suitable numerical schemes such as central differencing and upwind differencing methods.
5. **To acquire** knowledge of turbulence modelling, pressure–velocity coupling techniques, SIMPLE algorithm, and stream function–vorticity formulation used in CFD simulations.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs											Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO8	PO9	PO11	PSO1	PSO2	
R24MEPE13.1	Explain the principles of conservation to develop governing equations of CFD and identify PDEs based on their physical behavior	3	3	1	2	2	1			2	2	3	L1 L2
R24MEPE13.2	Use FDM to discretized partial differential equations and solve one-dimensional steady state heat conduction equation using FDM	3	3	2	2	3				2	3	2	L2 L3
R24MEPE13.3	Solve transient one-dimensional and steady two-dimensional conduction equations using FDM and use FVM to discretized partial differential equations	3	3	2	3	3	1			2	3	3	L3 L4
R24MEPE13.4	Solve diffusion and convection-diffusion equations using FVM of	3	3	2	3	3	1			2	2	3	L3 L4

	discretization												
R24MEPE13.5	Apply different turbulence modelling techniques to solve pressure linked equations	3	3	2	3	3	1	1	1	3	3	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Computational Fluid Dynamics (CFD): Impact – Applications. Governing equations of CFD – Continuity equation – Momentum equation – Energy equation – Conservative and nonconservative form. Initial and boundary conditions – Dirichlet – Neumann – Mixed or Robin. Partial Differential Equations (PDE): Second-order PDEs – Equilibrium problem – Marching problem. First-order PDEs – parabolic – elliptic – hyperbolic – physical behavior**.**

Self-Learning Topics: Use of CFD in aerospace, automobile, thermal, and biomedical engineering for flow and heat transfer analysis. **CO's:CO1**

UNIT-II **14 Hours**

Discretization: Basic aspects – Finite Difference Method (FDM) – Finite Volume Method (FVM) – Finite Element Method (FEM) – Differences. Grid generation for 1D, 2D and 3D geometries. General properties of discretization. Taylor's series of expansion – Discretization error – Round off error.

Finite Difference Method: First and second order derivatives – Forward, Backward and Central difference schemes – Discretization errors. Implementation of FDM – 1D steady state heat conduction in a slab with uniform internal heat generation – Introduction to Thomas algorithm.

Self-Learning Topics: Study the basic differences, advantages, and engineering applications of numerical discretization Methods. **CO's: CO2**

UNIT–III **14 Hours**

FDM to Diffusion Equations: Transient 1D heat conduction in a slab – Explicit, implicit methods – Crank-Nicolson scheme. 2D steady state heat conduction in a slab – Alternating Direction Implicit method.

Finite Volume Method: Introduction – Discretization – General steps involved in FVM – Implementing boundary conditions using FVM.

Self-Learning Topics: Study Explicit, Implicit, and Crank–Nicolson schemes for solving transient 1D heat conduction problems. **CO's: CO3**

UNIT–IV **12 Hours**

FVM to diffusion equations: 1D steady state heat transfer in a simple slab – With heat source – Without heat source. 1D steady heat transfer from a rectangular fin. 2D state heat transfer in a rectangular slab.

FVM to convection-diffusion equations: Steady one-dimensional convection diffusion equation – Central differencing scheme – Upwind differencing scheme

Self-Learning Topics: Solving 1D and 2D steady-state heat conduction problems using Finite Volume Method. **CO's: CO4**

UNIT-V **10 Hours**

Turbulence Modelling: Introduction – Types of Turbulence modelling – Reynolds time averaging – Reynolds time averaged conservation equations – Boussinesq's approach – One equation k-ε model.

Pressure linked equations: Concept of staggered grid – SIMPLE algorithm. Stream function and vorticity formulation.

Self-Learning Topics: Study Reynolds averaging, Boussinesq approximation, and k-ε turbulence model used in practical CFD simulations. **CO's: CO5**

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. J.D. Anderson, Computational Fluid Dynamics – The Basics with Applications, McGraw-Hill Inc., Indian Edition, 2017. (for Units I, II and III).
2. H.K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method', 2nd Edition, Pearson Education Limited, 2007. (for Units III, IV, V)

Reference Books:

1. J.H. Ferziger, M. Peric, R.L. Street, Computational Methods for Fluid Dynamics, 4th Edition, Springer, 2019.
2. K. Muralidhar, T. Sundararajan, Computational Fluid Flow and Heat Transfer, 2 nd Edition, Narosa Publishing House, New Delhi, 2008.
3. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, 1st Edition, CRC Press, 2009.
4. C.A.J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques, 2nd Edition, Springer-Verlag. 1988

Web References:

1. **https://nptel.ac.in/courses/112105045?utm_source=chatgpt.com**
2. **https://ocw.mit.edu/courses/2-29-numerical-fluid-mechanics-spring-2015/pages/lecture-notes-and-references/**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level-1: Remembering

1. Define Computational Fluid Dynamics (CFD).
2. State the continuity equation.
3. Define Dirichlet boundary condition.
4. What is Finite Difference Method (FDM)?

5. Define Finite Volume Method (FVM).
6. Explain the fundamentals and applications of CFD.
7. Describe continuity, momentum, and energy equations.
8. Explain discretization techniques used in CFD.
9. Describe Finite Difference Method and Finite Volume Method.
10. 10.Explain turbulence modelling and SIMPLE algorithm

Level-2: Understanding

1. Explain the importance of governing equations in CFD.
2. Differentiate FDM, FVM, and FEM.
3. Explain conservative and non-conservative equations.
4. Explain explicit and implicit numerical schemes.
5. Describe turbulence modelling in CFD.
6. Explain the classification of PDEs based on physical behavior.
7. Discuss conservative and non-conservative forms of governing equations.
8. Explain grid generation and discretization errors.
9. Explain transient heat conduction methods.
10. Discuss Reynolds averaged equations and turbulence models

Level-3: Applying

1. Apply continuity equation for incompressible flow.
2. Solve first-order derivatives using central difference scheme.
3. Apply FDM for one-dimensional heat conduction problems.
4. Apply Crank–Nicolson method for transient heat conduction.
5. Use SIMPLE algorithm for pressure–velocity coupling.
6. Apply FDM to solve one-dimensional steady-state heat conduction problems.
7. Solve transient heat conduction problems using Crank–Nicolson method.
8. Apply FVM for diffusion and convection–diffusion equations.
9. Solve 2D heat transfer problems using ADI method.
10. Apply SIMPLE algorithm for pressure–velocity coupling problems.

Level-4: Analyzing

1. Compare elliptic, parabolic, and hyperbolic PDEs.
2. Analyze discretization errors in numerical methods.
3. Compare explicit and implicit methods.
4. Analyze central differencing and upwind differencing schemes.
5. Compare different turbulence modelling techniques.
6. Analyze governing equations used in CFD simulations.
7. Compare FDM, FVM, and FEM techniques.
8. Analyze stability and convergence of numerical methods.
9. Compare central differencing and upwind differencing schemes.
10. Analyze turbulence modelling methods used in CFD.

Level-5: Evaluating

1. Evaluate the importance of CFD in engineering applications.
2. Assess the suitability of FDM and FVM for heat transfer problems.
3. Evaluate the stability of numerical schemes in CFD.
4. Critically evaluate pressure-linked algorithms in fluid flow analysis.
5. Justify the use of turbulence models in industrial CFD applications.

6. Evaluate the role of CFD in modern engineering design.
7. Assess the effectiveness of various discretization methods.
8. Critically evaluate numerical methods for heat transfer analysis.
9. Evaluate the performance of pressure–velocity coupling algorithms.
10. Justify the application of turbulence models in industrial fluid flow problems.

Chairperson
Board of Studies (ME)

R24MEPE16 **POWER PLANT ENGINEERING** **3 0 0 3**

(Professional Elective-IV)

Course Objectives:

1. **To illustrate** the working of different circuits of the steam power plant.
2. **To analyze** the layout and auxiliaries of the diesel and gas power plants.
3. **To interpret** the different elements in the hydroelectric and nuclear power plants.
4. **To illustrate** the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5. **To analyze** the concepts of power plant economics and pollution standards to be observed in the power plants.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO02	
R24MEPE16.1	Explain the principles, operation, and applications of non-conventional energy sources and direct energy conversion systems.	3	2	1	–	1	3	1	–	1	–	2	2	2	L1 L2
R24MEPE16.2	Describe the layout, components, fuel handling systems, and combustion processes involved in steam power plants.	3	2	2	1	2	2	1	–	1	2	2	1	2	L2 L3
R24MEPE16.3	Analyze the construction, working principles, and performance of diesel power plants, gas turbine plants, and combined cycle power plants.	3	3	2	2	2	2	1	–	–	2	2	2	3	L3 L4
R24MEPE16.4	Illustrate the operation and applications of hydro-electric and nuclear power plants along with combined	2	2	2	1	1	3	1	–	1	1	2	2	3	L3 L4

	operation of different power stations.														
R24MEPE16.5	Evaluate power plant economics, load characteristics, combustion gas analysis, and environmental pollution control methods in power generation systems.	2	3	2	3	2	3	2	–	1	3	3	3	3	L4 L5

SYLLABUS

UNIT-I **12 Hours**

Non-Conventional Sources: Utilization of Solar- Collectors- Principle of Working, Wind Energy – types – HAWT, VAWT -Tidal Energy. Direct Energy Conversion: Solar energy, Fuel cells, Thermo electric and Thermo ionic, MHD generation. **CO's: CO1**

Self-Learning Topics: Ocean Thermal Energy Conversion (OTEC)

UNIT-II **12 Hours**

Steam Power Plant: Plant Layout, Working of different Circuits, Fuel and handling equipment's, types of coals, coal handling, choice of handling equipment, coal storage, and Ash handling systems.

Combustion Process: – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, Dust collectors. **CO's: CO2**

Self-Learning Topics: Fluidized Bed Combustion (FBC)

UNIT–III **12 Hours**

Diesel Power Plant: Introduction – IC Engines, types, construction– Plant layout with auxiliaries– fuel supply system, air starting equipment, lubrication and cooling system – super charging.

Gas Turbine Plant: Introduction – classification - construction – Layout with auxiliaries – Principle of working of closed and open cycle gas turbines. Combined cycle Power Plants.

CO's: CO3

Self-Learning Topics: Jet Propulsion Systems

UNIT–IV **12 Hours**

Hydro Electric Power Plant: Water power – Hydrographs – storage and Pondage – classification of dams and spill ways.

Combined operations of different power plants: Introduction, advantages of combined working power plant, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant.

Nuclear Power Station: Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. Types of Reactors, Pressurized water reactor, Boiling water reactor **CO's: CO4**

Self-Learning Topics: Fast Breeder Reactors

UNIT–V **12 Hours**

Power Plant Economics and Environmental Considerations: Definitions of connected load,

Maximum demand, demand factor, average load, load factor, diversity factor, load curves, load duration curve. – related exercises. Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Analysis of Combustion gases, Pollution; Types, Methods to Control. **CO's: CO5**

Self-Learning Topics: Carbon Capture and Storage (CCS)

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text books:

1. Power plant engineering, P. K. Nag, Tata McGraw-Hill Pub.
2. Power Plant Engineering, Manoj Kumar Gupta, PHI Pub.

References:

1. K.K. Ramalingam, Power Plant Engineering, Scitech Publications, 1st Edition, 2010.
2. Subhash C. Arora, S. Domkundwar, Power Plant Engineering, Dhanpat Rai, 8th Edition, 2016
3. M.M. EL-Wakil, Power Plant Technology, McGraw-Hill Science, 1st Edition, 2002.

Web References:

1. https://themechanicalengineering.com/power-plant-engineering/?utm_source=chatgpt.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level–1: Remembering

1. Define load factor and diversity factor in power plants.
2. List the types of wind turbines used in power generation.
3. What is the function of a condenser in a steam power plant?
4. Name the different types of nuclear reactors.
5. State the advantages of combined cycle power plants.
6. Explain the layout and working of a steam power plant with a neat sketch.
7. Describe the construction and working of a diesel power plant.
8. Explain the working principle of hydroelectric power plants.
9. Describe different non-conventional energy sources used for power generation.
10. Describe the construction and working of a Wind plant.

Level–2: Understanding

1. Explain the working principle of a fuel cell.
2. Differentiate between HAWT and VAWT.
3. Explain the necessity of ash handling systems in thermal power plants.

4. Describe the working of an open cycle gas turbine plant.
5. Explain the importance of hydrographs in hydroelectric power plants
6. Explain the working of solar collectors and fuel cells with applications.
7. Discuss the operation of open and closed cycle gas turbine power plants.
8. Explain the classification and operation of dams and spillways.
9. Describe the working of pressurized water reactors and boiling water reactors.
10. Explain load curves and load duration curves with suitable examples.

Level–3: Applying

1. Calculate the load factor for a power station with given maximum demand and average load.
2. Select a suitable coal handling system for a large thermal power plant and justify your choice.
3. Illustrate how supercharging improves diesel engine performance.
4. Apply the concept of pondage in regulating hydroelectric power generation.
5. Analyze combustion gas data to identify pollution levels in a power plant
6. Solve problems related to load factor, demand factor, and diversity factor.
7. Develop a suitable layout for a combined cycle power plant for industrial applications.
8. Apply combustion principles to improve boiler efficiency in steam power plants.
9. Design a simple arrangement for coal handling in a thermal power station.
10. Apply pollution control techniques to reduce emissions in thermal power plants.

Level–4: Analyzing

1. Compare steam power plants and nuclear power plants based on efficiency and environmental impact.
2. Analyze the performance differences between overfeed and underfeed stokers.
3. Compare closed cycle and open cycle gas turbine plants.
4. Analyze the advantages of combined operation of hydro and steam power plants.
5. Examine the causes and effects of pollution produced by thermal power plants.
6. Analyze the performance and applications of diesel and gas turbine power plants.
7. Compare hydroelectric, steam, and nuclear power plants based on operation and efficiency.
8. Analyze the economic considerations involved in power plant selection.
9. Compare various stokers used in combustion systems with their advantages and limitations.
10. Analyze the impact of environmental pollution caused by different power plants.

Level–5: Evaluating

1. Evaluate the suitability of renewable energy sources for future power generation needs.
2. Justify the use of combined cycle power plants for improved efficiency.
3. Evaluate different methods used for controlling emissions in thermal power plants.
4. Assess the economic factors affecting the selection of a power plant.
5. Critically evaluate the safety and environmental considerations of nuclear power plants.
6. Evaluate the role of renewable energy systems in sustainable power generation.
7. Critically evaluate combined operation of hydroelectric and steam power plants.
8. Assess the economic and environmental feasibility of nuclear power plants.
9. Evaluate modern pollution control methods used in thermal power plants.
10. Justify the selection of suitable power plants for varying load conditions and energy demands.

Chairperson
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R24MEPE17 **Production Planning and Control** **3 0 0 3**

(Professional Elective-IV)

Course Objectives:

1. **To illustrate** different types of production systems and explain the internal organization and functions of production planning and control (PPC).
2. **To Estimate** forecasts in manufacturing and service sectors using selected qualitative and quantitative techniques.
3. **To analyze** the importance and functions of inventory and apply basic inventory control and management methods.
4. **To apply** routing procedures, distinguish between scheduling and loading, and interpret scheduling policies and aggregate production planning.
5. **To explain** dispatching procedures, follow-up activities, and basic applications of computers in production planning and control.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE 17.1	Illustrate the types of production systems and explain the objectives, functions and internal organization of the PPC department.	2	1	0	0	0	1	1	1	0	1	1	2	2	L1
R24MEPE 17.2	Use elementary qualitative and quantitative forecasting methods to estimate demand for production planning.	2	3	2	2	1	0	0	0	0	1	2	2	3	L1 L2
R24MEPE 17.3	Apply basic inventory control techniques such as ABC analysis, EOQ and simple control systems and outline aggregate planning strategies.	2	3	3	2	1	0	0	0	1	2	2	3	3	L3
R24MEPE 17.4	Prepare route sheets, develop simple schedules, and explain line balancing and basic shop-floor control techniques.	2	3	2	2	1	0	0	0	0	1	3	2	3	L4 L5

R24MEPE 17.5	Explain dispatching and follow-up functions and identify basic applications of computers in PPC.	1	3	3	2	2	1	1	1	2	2	3	2	3	L4 L5

SYLLABUS

UNIT-I **10 Hours**

Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department. **CO's: CO1**

Self-Learning Topics: Historical evolution of PPC and its importance in modern manufacturing, Study of PPC organization chart in a local industry (collect and discuss)

UNIT-II **14 Hours**

Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods C**O's: CO2**

Self-Learning Topics: Use of spreadsheet (Excel) for performing moving average and exponential smoothing. Role of forecasting data as input to MRP and aggregate planning

UNIT–III **12 Hours**

Inventory Management: Functions of inventories, relevant costs, ABC and VED analysis, Basic EOQ model. **Inventory Control Systems:** Continuous and periodic review systems, MRP I, MRP II, ERP, JIT systems. **Aggregate Planning:** Definition, strategies, methods, and transportation model. **CO's: CO3**

Self-Learning Topics: Case example of ABC analysis in a manufacturing or service organization (hospital, auto-service, etc.). Short note on how JIT and ERP affect inventory levels and information flow.

UNIT–IV **12 Hours**

Techniques Of Scheduling And Control: Line Balancing: Terminology, methods (RPW, Largest Candidate, Heuristic).

Routing: Definition, procedure, factors affecting routing, and route sheets. C**O's: CO4**

Self- Learning Topics: Visit/virtual tour to observe scheduling and line balancing in an industry (video or case study). Preparing route sheets for a simple machined component using given process data

UNIT–V **10 Hours**

Dispatching: Definition, activities, procedures, and various forms used.

Follow-Up: Definition, types, expediting procedures**. Applications:** Use of computers in planning and control. **CO's: CO5**

Self- Learning Topics: Sample formats of dispatching and follow-up documents (students collect or prepare). Short case on how an ERP or simple software (e.g., Excel-based) helps in PPC activities.

Text Books:

1. Samuel Eilon, Elements of Production Planning and Control, Macmillan / Universal Book Corp.
2. K. C. Jain and L. N. Agarwal, Production Planning and Control, Khanna Publishers.
3. S. N. Chary, Production and Operations Management, Tata McGraw-Hill.

Reference Books:

1. E. S. Buffa and R. Sarin, Modern Production / Operations Management, Wiley.
2. John E. Biegel, Production Control: A Quantitative Approach, Prentice-Hall.jntufastupdates+1
3. Mukhopadhyay, Production Planning and Control, PHI

Web References:

1. https://mrcet.com/downloads/digital_notes/ME/IV%20year/PPC_3122018.pdf
2. https://mrcet.com/downloads/digital_notes/ME/IV%20year/PRODUCTION%20PLANNING%20AND%20CONTROL.pdf
3. https://ijaers.com/uploads/issue_files/40-IJAERS-AUG-2018-24-ReferenceModels.pdf
4. https://ijaers.com/uploads/issue_files/21-IJAERS-DEC-2018-8-ScientificLiterature.pdf

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remember

1. Define production planning and control (PPC).
2. List the main objectives of production planning and control.
3. Name the types of production systems used in manufacturing.
4. Define forecasting in the context of PPC.
5. State any four qualitative forecasting methods.
6. Define inventory and list its main types.
7. What is Economic Order Quantity (EOQ)?
8. Expand: MRP-I, MRP-II, ERP, JIT, LOB, KANBAN.
9. Define routing and scheduling.
10. What is meant by line balancing?

Level 2. Understand

1. Explain the functions of PPC in a manufacturing organization.
2. Distinguish between job, batch and mass production with suitable examples.
3. Explain why forecasting is important for production planning.
4. Describe the general principles of good forecasting.
5. Explain the functions of inventory in a production system.
6. Describe the concept of ABC analysis in inventory control.
7. Differentiate between P-system and Q-system of inventory control.
8. Explain the terms routing, scheduling, dispatching and follow-up as elements of PPC.
9. Describe the basic steps in routing procedure.
10. Explain the objectives of line balancing in an assembly line.

Level 3. Apply:

1. A small company manufactures a standard component. Explain how you would apply PPC functions (planning, routing, scheduling, dispatching, follow-up) to this situation.
2. Using a simple numerical example, apply the moving average method to forecast demand for the next period.
3. For given annual demand, ordering cost and holding cost, calculate EOQ and interpret its significance.
4. For a given list of items with annual consumption value, classify them into A, B and C categories using ABC analysis.
5. Prepare a simple route sheet for manufacturing a turned and drilled shaft (assume basic operations and machines).
6. Draw a Gantt chart for scheduling three jobs on one machine when basic processing times are given.
7. For a small assembly line with known task times and cycle time, do a simple line balancing and assign tasks to workstations.
8. Given a set of jobs and due dates, prepare a dispatching sequence using a simple rule such as FCFS or SPT.
9. Apply dispatching rules to prepare a daily dispatch list for a shop.
10. Use simple spreadsheet tools to record and track production and inventory data.

Level 4. Analyze

1. Analyze how the type of production system (job vs batch vs mass) influences the structure and functions of PPC.
2. Compare and analyze the advantages and limitations of qualitative and quantitative forecasting methods.
3. Analyze the effect of ordering cost and carrying cost on EOQ and the total inventory cost.
4. Given inventory and demand data, analyze the suitability of P-system vs Q-system for a particular item.
5. Analyze the bottlenecks and delays that may occur due to improper routing and scheduling in a machine shop.
6. For a given assembly line, analyze reasons for imbalance and suggest possible improvements.
7. Analyze how improper dispatching and poor follow-up can affect delivery performance and customer satisfaction.
8. Examine how the introduction of MRP/ERP systems changes the role of PPC staff on the shop floor.
9. Analyze the role of dispatching and follow-up in improving adherence to production schedules.
10. Examine how computer-based PPC systems change information flow and decision-making compared to manual systems.

Level 5. Evaluate

1. Evaluate the effectiveness of PPC in improving productivity, lead time and customer satisfaction in a manufacturing organization.
2. Justify the choice of a particular forecasting method for a given product and demand pattern.
3. Evaluate the strengths and limitations of ABC analysis as an inventory control tool.

4. Justify the selection of P-system or Q-system for managing inventories in a specific case (e.g., critical spares vs consumables).
5. Evaluate different aggregate planning strategies (level, chase, mixed) for a given demand pattern and resource constraints.
6. Assess the suitability of different scheduling rules for a job shop focused on due-date performance.
7. Evaluate the benefits and drawbacks of adopting JIT and KANBAN in an Indian manufacturing context.
8. Justify the need for computer-based PPC/ERP systems over manual systems in a growing organization.
9. Evaluate the overall impact of PPC decisions on cost, quality and delivery performance.
10. Justify investment in training and systems to strengthen PPC as a strategic function.

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Board of Studies (ME)

R24MEPE18 **JET PROPULSION & ROCKETS** **3 0 0 3**

(Professional Elective - IV)

Course Objectives:

1. **To understand** the fundamentals and performance analysis of jet propulsion systems and rotating machines.
2. **To study** the principles of orbital mechanics and motion of bodies in space.
3. **To analyze** rocket propulsion theory and performance parameters of rockets.
4. **To understand** rocket nozzle characteristics, thrust generation, and propulsion efficiencies.
5. **To apply** aerospace propulsion concepts for solving engineering problems related to aircraft and space vehicles.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE18.1	Explain the working principles of air-breathing and rocket propulsion systems.	3	2	1	1	2	–	–	–	1	–	1	2	3	L1 L2
R24MEPE18.2	Analyze performance parameters of jet engines and rockets.	3	3	1	2	2	1	–	–	1	–	1	2	3	L2 L3
R24MEPE18.3	Apply orbital mechanics principles to space vehicle motion.	3	3	2	2	2	1	–	–	1	–	1	2	3	L2 L3
R24MEPE18.4	Evaluate rocket nozzle performance and propulsion efficiencies.	3	3	2	2	2	1	–	–	1	–	1	3	3	L3 L4
R24MEPE18.5	Compare different propellant systems for aerospace applications.	3	3	3	2	3	2	1	1	2	1	2	3	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Jet Propulsion Cycles and their Analysis: Criteria of Performance, Simple Turbojet Engine, Simple Turbofan Engine, Simple Turboprop Engine, Turbo-shaft Engine, Thrust Augmentation Techniques.

Fundamentals of Rotating Machines: General Fluid Dynamic Analysis, Euler's Energy Equation, Components of Energy Transfer, Impulse and Reaction Machines **CO's:CO1**

Self-Learning Topics:

1. Recent developments in aircraft propulsion systems.
2. Applications of impulse and reaction turbines in aerospace engineering

UNIT-II **14 Hours**

Motion In Space: Requirement For Orbit: Motion of Bodies in space, Parameters describing motion of bodies, Newton's Laws of motion, Universal law of gravitational force, Gravitational field, Requirements of motion in space, Geosynchronous and geostationary orbits, Eccentricity and inclination of orbits, Energy and velocity requirements to reach a particular orbit, Escape velocity, Freely falling bodies, Methods of achieving required velocities **CO's: CO2**

Self-Learning Topics:

1. Applications of geostationary and polar satellites.
2. Recent advancements in satellite launch technologies.

UNIT–III **14 Hours**

Theory of Rocket Propulsion: Introduction to rocket propulsion principles Illustrative examples of momentum propulsion (sled and squid motion), Rocket principle and rocket equation, Mass ratio of rocket, Desirable parameters of rocket, Rocket having small propellant mass fraction, Propulsive efficiency of rocket, Performance parameters of rocket, Staging and clustering of rockets, Classification of rockets. **CO's: CO3**

Self-Learning Topics:

1. Reusable launch vehicle technology.
2. Modern rocket staging and clustering methods.

UNIT–IV **12 Hours**

Rocket Nozzle and Performance: Expansion of gas from a high-pressure chamber, Shape of the nozzle, Nozzle area ratio, Performance loss in conical nozzle, Flow separation in nozzles, Contour or bell nozzles, Unconventional nozzles, Mass flow rates and characteristics velocity, Thrust developed by a rocket; Thrust coefficient, Nozzle efficiencies, Specific impulse and correlation with characteristic velocity and thrust coefficient, General performance trends **CO's: CO4**

Self-Learning Topics:

1. Aero spike and plug nozzle technologies.
2. Advanced thermal protection and nozzle cooling methods.

UNIT–V **10 Hours**

Solid Propellants, Liquid Propellants, And Hybrid Rockets: Working principle, Choice of fuels and oxidizer, Mechanism of burning and burn rate. **CO's: CO5**

Self-Learning Topics:

1. Green propellants and eco-friendly rocket fuels.
2. Recent developments in hybrid rocket propulsion systems.

Board of Studies : Mechanical Engineering
Approved in BoS No: 03
Approved in ACM No: 03

Text Books:

1. Barrere, M., Rocket Propulsion, Elsevier Pub. Co., 1990.
2. Sutton, G. P., Rocket Propulsion Elements, John Wiley, New York, 1993.
3. Ramamurthi K., Rocket Propulsion, Macmillan Publishers India Ltd., 2010

Reference Books:

1. Feedesiev, V. I. and Siniarev, G. B., Introduction to Rocket Technology, Academic Press, New York, 2000.
2. 2. Saravanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, Pearson PrenticeHall, 6th Edition, 2008.

Web References:

1. **https://www.youtube.com/watch?v=YrkbOeF7wFw&utm_source=chatgpt.com**
2. **https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/guide-to-utm_source=chatgpt.com**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level–1: Remember

1. Define thrust augmentation techniques.
2. What is a turbojet engine?
3. State Euler's energy equation.
4. Define geostationary orbit.
5. What is escape velocity?
6. Explain the construction and working of turbojet, turbofan, and turboprop engines.
7. Describe Newton's laws of motion and their application to rocket propulsion.
8. Explain the basic principle of rocket propulsion and rocket classification.
9. Discuss the types and characteristics of rocket nozzles.
10. Characteristics of rocket nozzles.

Level–2: Understand

1. Explain the working principle of a turbofan engine.
2. Describe the importance of orbital inclination.
3. Explain the rocket principle using Newton's third law.
4. Discuss the significance of specific impulse in rocket performance.
5. Explain the concept of flow separation in rocket nozzles.
6. Explain the criteria of performance for jet propulsion systems.
7. Describe the requirements for achieving orbital motion in space.
8. Explain the significance of mass ratio and propulsive efficiency in rockets.
9. Discuss the operation and applications of impulse and reaction machines.
10. Explain thrust development in rocket engines with neat sketches.

Level–3: Apply

1. Calculate escape velocity for a satellite orbiting Earth.

2. Apply Euler's equation to determine energy transfer in a rotating machine.
3. Determine rocket mass ratio using the rocket equation.
4. Estimate thrust developed by a rocket nozzle for given inlet and exit conditions.
5. Analyze the performance of a turbofan engine under varying operating conditions.
6. Solve problems related to orbital velocity and escape velocity.
7. Determine rocket performance parameters using rocket equations.
8. Apply Euler's energy equation to rotating machinery performance analysis.
9. Calculate thrust coefficient and specific impulse for given rocket data.
10. Analyze nozzle performance using area ratio and pressure relations.

Level–4: Analyze

1. Analyze the performance differences between turbojet and turbofan engines.
2. Compare geosynchronous and geostationary orbits with suitable examples.
3. Analyze the effects of nozzle area ratio on rocket performance.
4. Compare impulse and reaction machines based on energy transfer mechanisms.
5. Compare different orbital paths based on eccentricity and inclination.
6. Analyze the influence of nozzle geometry on rocket engine efficiency.
7. Compare various rocket staging techniques and their advantages.
8. Analyze the role of thrust augmentation techniques in aircraft propulsion systems.
9. Analyze the causes of flow separation in rocket nozzles.
10. Examine the influence of thrust coefficient on nozzle performance.

Level–5: Evaluate

1. Evaluate the suitability of turboprop engines for low-speed aircraft applications.
2. Assess the effectiveness of multistage rockets in space missions.
3. Evaluate the performance advantages of bell nozzles over conical nozzles.
4. Justify the selection of geostationary orbit for communication satellites.
5. Evaluate the importance of specific impulse in rocket engine design.
6. Evaluate the suitability of different propulsion systems for aerospace applications.
7. Critically evaluate the performance of conventional and unconventional rocket nozzles.
8. Assess the importance of orbital mechanics in satellite launching missions.
9. Evaluate the impact of propellant characteristics on rocket efficiency and mission success.
10. Design considerations for high-performance rocket propulsion systems — discuss critically.

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R24MEPEOE11 **3D PRINTING TECHNOLOGIES** **3 0 0 3**

(Open Elective-III)

Course Objectives:

1. **To understand** basic ideas and terms used in 3D printing technologies.
2. **To Learn** how 3D printers work and what materials they use.
3. **To know** the simple steps to go from a 3D CAD model to a printed part.
4. **To get** familiar with different 3D printing processes and their simple applications.
5. **To understand** basic design rules and limitations for parts made by 3D printing.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO01	PSO02	
R24MEPEOE 11.1	Explain the need, fundamentals, process chain, and classification of Additive Manufacturing and compare it with conventional/CNC processes.	3	2	–	–	1	1	1	–	–	1	–	3	2	L1 L2
R24MEPEOE 11.2	Describe the principles, equipment, materials, and applications of SLA and SGC processes.	3	2	1	1	2	1	1	–	–	1	–	3	3	L3
R24MEPEOE 11.3	Demonstrate the basic workflow from CAD model to 3D printed part, including file formats, slicing, and safety practices.	2	2	1	1	3	1	1	–	1	2	1	2	3	L2
R24MEPEOE 11.4	Apply simple design rules to develop AM-friendly components and discuss current and future applications of 3D printing.	2	2	3	1	2	1	2	1	1	2	1	3	3	L4

R24MEPEOE 11.5	Summarize important industrial and medical applications of AM and outline how AM integrates with production planning and control activities.	2	2	1	1	2	2	2	1	1	2	2	2	3	L5

SYLLABUS

UNIT-I **10 Hours**

Introduction: Need for time compression in product development, Need for Additive Manufacturing (AM), Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Classification of AM process, Comparison of AM with CNC and other technologies. . **CO's: CO1**

Self-Learning Topics: Using AM for rapid prototyping and time compression in small workshops and product development.

UNIT-II **14 Hours**

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, Laser scanning, Applications, Advantages and Limitations, Case studies. Solid Ground Curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Limitations C**O's: CO2**

Self-Learning Topics: SLA/SGC principles, machine specs, resins and photo-polymerization

UNIT–III **12 Hours**

CAD Model to Printed Part (Workflow) : Simple introduction to 3D CAD models for printing (STL, OBJ), File formats, Slicing software (slicers), Step-by-step workflow, Basic safety and good practices while operating a 3D printer. **CO's: CO3**

Self learning Topics: CAD formats (STL/OBJ), slicing parameters, and basic printer safety.

UNIT–IV **12 Hours**

Design Basics and Applications: Simple design rules for 3D printing (at intuitive level)- common Applications-Introduction to limitations of 3D printing-Future directions in simple language.

C**O's: CO4**

Self- learning Topics: Initiative design rules (overhangs, supports, wall thickness) and common applications

UNIT–V **10 Hours**

Applications in Industry: Applications in Aerospace Industry, Automotive Industry, Jewellery Industry application. AM in Medical and |Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices

CO's: CO5

Self- learning Topics: Industrial and medical AM uses in aerospace, automotive sectors.

Board of Studies: Computer Science and Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. **"Additive Manufacturing"**, McGraw Hill, 1st edition, 2021. K. C. Jain and L. N. Agarwal, *Production Planning and Control*, Khanna Publishers.
2. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and• Applications", World Scientific, 2017.

Reference Books:

1. **"A Textbook on Additive Manufacturing Technologies"**, Mohit Hemanth Kumar et al.,
2. **"Additive Manufacturing: Design, Methods, and Processes"**, Steinar Killi, RC/CRC-like publishers.

Web References:

1. https://www.coursera.org 2. edX.
2. https://www.edx.org.
3. https://fab.cba.mit.edu/classes/863.21/
4. https://www.hubs.com/knowledge-base/
5. https://academy.autodesk.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level-1: Remembering

1. Define additive manufacturing and list any two advantages over conventional manufacturing.
2. Write any four steps in a typical AM process chain.
3. Classify AM processes based on the form of starting material and give one example for each class.
4. State the working principle of stereolithography (SLA) in one or two sentences.
5. List any three important specifications of an SLA machine.
6. What is an STL file? Mention any two other common 3D printing file formats.
7. List any three important slicing parameters that affect 3D print quality.
8. State any two simple design rules for overhangs or wall thickness in FDM printing.
9. List any three common applications of desktop 3D printers in education or laboratories.
10. Mention any two aerospace and any one automotive applications of additive manufacturing.

Level.2 – Understanding

1. Explain the term "time compression" in product development in the context of AM.

2. Distinguish between AM and CNC machining with respect to material removal/addition and tooling.
3. Explain the role of photopolymers and photo-polymerization in SLA.
4. Describe the basic sequence of operations in the Solid Ground Curing (SGC) process.
5. Explain why model orientation is important during slicing.
6. Describe the basic workflow from CAD model creation to printing on a 3D printer.
7. Explain the term "Design for Additive Manufacturing (DfAM)" in simple words.
8. Describe how support structures influence design decisions in AM.
9. Explain how AM is used in planning and simulation of complex surgery.
10. Describe how AM can support spare-parts management in an industrial plant.

Level.3 – Applying

1. A small workshop needs five customized fixtures. Suggest whether AM or CNC is more suitable and state two reasons.
2. For a job-type production environment, mention how AM can help in reducing lead time for new product development.
3. A dental clinic wants accurate tooth models. Suggest whether SLA or FDM is more appropriate and justify briefly.
4. For a component requiring smooth surface finish and fine details, explain why SLA may be preferred over FDM.
5. A part shows warping at the corners during printing. Suggest two changes in slicing or process parameters to reduce warping.
6. For a simple keychain model, specify suitable layer height and infill percentage for a quick prototype.
7. A machined L-bracket is to be redesigned for AM. Suggest two modifications to reduce support material.
8. For a hollow component, explain how you would modify the design to reduce weight while maintaining stiffness.
9. Suggest how a small automotive service centre can use AM for low-volume spare-parts production.
10. For a jewellery manufacturer, explain briefly how AM fits into the wax-pattern-based casting process.

Level.4 – Analyzing

1. Analyze the limitations of AM when compared to traditional manufacturing for large-volume production.
2. Compare any two AM process categories based on material form, energy source, and typical applications.
3. Analyze two key limitations of SLA parts for functional mechanical applications.
4. Compare SLA and SGC with respect to support generation, build speed, and typical part size.
5. Analyze how changing layer thickness and infill percentage will affect build time and mechanical strength of a part.
6. For a given overhanging feature, discuss how support settings and orientation will influence surface finish.
7. Analyze the effect of part orientation on anisotropy (directional dependence) of strength in FDM parts.

8. Compare design considerations for AM and traditional machining for a component with complex internal channels.
9. Analyze the advantages and challenges of using AM in the medical field with respect to customization and regulation.
10. Compare the role of AM in aerospace and jewellery industries with respect to accuracy and material selection.

Level.5 – Evaluating

1. Evaluate the suitability of AM for prototyping a new consumer product and mention one major benefit and one major limitation.
2. Propose a brief strategy for integrating an AM machine into an existing small CNC workshop.
3. Evaluate the suitability of SLA for producing master patterns for investment casting.
4. Propose simple selection criteria to decide between SLA and SGC for a new product prototype.
5. Develop a simple checklist for safe operation of an FDM 3D printer in a student lab.
6. Propose a standard operating procedure (SOP) for students to convert CAD models to printable files.
7. Propose a simple set of design guidelines for first-year students modeling parts for 3D printing.
8. Evaluate the potential of AM for future household or personal applications with one example.
9. Propose a simple AM-enabled workflow for managing spare parts in a small manufacturing unit.
10. Evaluate the impact of integrating AM with basic PPC and Excel-based systems in a small industry.

Chairperson

Board of Studies (ME)

R24MEOE12 **GREEN ENGINEERING** **3 0 0 3**

(Open Elective-III**)**

Course Objectives:

1. **To introduce** the principles and concepts of green engineering and sustainable development.
2. **To understand** energy conservation, renewable energy systems, and resource optimization techniques.
3. **To study** environmental impact assessment, pollution prevention, and waste management methods.
4. **To develop** knowledge on green manufacturing, green buildings, and eco-friendly technologies.
5. **To apply** life cycle assessment and sustainability tools for engineering decision-making

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE12.1	Explain the concepts of green engineering, sustainability, and environmental ethics.	3	2	-	-	1	3	2	-	-	-	2	1	2	L1 L2
R24MEOE12.2	Apply energy conservation techniques and evaluate renewable energy systems for sustainable development	3	3	2	2	2	3	-	-	-	1	2	2	3	L2 L3
R24MEOE12.3	Analyze pollution prevention methods and waste management techniques for environmental protection.	3	3	2	3	2	3	1	-	-	-	2	2	3	L2 L3
R24MEOE12.4	Examine green manufacturing practices and sustainable building technologies.	2	2	3	2	3	3	1	1	1	1	2	3	3	L3 L4
R24MEOE12.5	Evaluate life cycle assessment methods and sustainability tools for engineering applications.	2	3	3	3	2	3	1	-	1	1	3	2	3	L4 L5

SYLLABUS

UNIT-I **12 Hours**

Introduction to Green Engineering: Concept of Green Engineering, Principles of Sustainability, Environmental Ethics, Industrial Ecology, Need for Green Technologies, Sustainable Development Goals (SDGs), Environmental Impacts of Engineering Activities, Green Design Concepts. **CO's:CO1**

Self-Learning Topics: Case studies on sustainable engineering practices in industries.

UNIT-II **12 Hours**

Energy Resources and Conservation: Conventional and Non-Conventional Energy Sources, Renewable Energy Technologies (Solar, Wind, Biomass, Geothermal, Hydro), Energy Conservation Methods, Energy Auditing, Carbon Footprint, Energy Efficient Systems.

CO's: CO2

Self-Learning Topics: Recent advancements in solar and wind energy technologies.

UNIT–III **12 Hours**

Pollution Prevention and Waste Management: Air, Water and Soil Pollution, Sources and Control Measures, Waste Minimization Techniques, Recycling and Reuse, Solid Waste Management, E-Waste Management, Hazardous Waste Treatment, Cleaner Production Technologies. **CO's: CO3**

Self-Learning Topics: Applications of recycling technologies in modern industries.

UNIT–IV **12 Hours**

Green Manufacturing and Green Buildings: Green Manufacturing Concepts, Lean and Green Production, Eco-friendly Materials, Sustainable Product Design, Green Supply Chain Management, Green Building Concepts, LEED Certification, Smart and Sustainable Infrastructure. **CO's: CO4**

Self-Learning Topics: Green supply chain practices in manufacturing industries

UNIT–V **10 Hours**

Life Cycle Assessment and Sustainable Engineering: Life Cycle Assessment (LCA), Environmental Impact Assessment (EIA), Sustainability Indicators, Environmental Management Systems (ISO 14001), Circular Economy, Sustainable Transportation, Future Trends in Green Engineering. C**O's: CO5**

Self-Learning Topics: Applications of Life Cycle Assessment in product design.

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Allen, D. T. and Shonnard, D. R., Sustainable Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. David T. Allen and David R. Shonnard, Green Engineering: Environmentally Conscious Design of Chemical Processes, Pearson Education.

Reference Books:

1. Anastas, P. T. and Zimmerman, J. B., Green Engineering: Principles and Practice, McGraw Hill.
2. Graedel, T. E. and Allenby, B. R., Industrial Ecology and Sustainable Engineering, Pearson Education.

Web References:

1. NPTEL – Green Manufacturing Systems
2. United States Environmental Protection Agency – Green Engineering

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level–1: Remembering

1. Define green engineering.
2. What is sustainable development?
3. List any four renewable energy sources.
4. Define carbon footprint.
5. What is Life Cycle Assessment (LCA)?
6. Explain the concepts and principles of green engineering.
7. Describe different renewable energy resources and their applications.
8. Explain various types of pollution and their control measures.
9. Discuss green manufacturing concepts and sustainable product design.
10. Explain Life Cycle Assessment methodology and its applications.

Level–2: Understanding

1. Explain the principles of green engineering.
2. Differentiate between renewable and non-renewable energy resources.
3. Explain the concept of waste minimization.
4. Describe the importance of green buildings.
5. Discuss the objectives of Environmental Impact Assessment (EIA).
6. Discuss the importance of sustainable development in engineering practices.
7. Explain energy conservation techniques and energy auditing methods.
8. Describe waste management techniques including recycling and reuse.
9. Explain green building concepts and LEED certification process.
10. Discuss Environmental Management Systems and ISO 14001 standards.

Level–3: Applying

1. Apply energy conservation techniques in industrial systems.
2. Demonstrate methods for recycling and reuse of industrial waste.
3. Apply cleaner production techniques for pollution prevention.
4. Illustrate the use of renewable energy systems in engineering applications.

5. Apply sustainability indicators for evaluating engineering projects.
6. Apply green engineering principles for designing sustainable engineering systems.
7. Demonstrate the implementation of renewable energy technologies in industries.
8. Apply pollution prevention methods for industrial waste reduction.
9. Illustrate sustainable manufacturing techniques with suitable examples.
10. Apply Life Cycle Assessment tools for evaluating environmental impacts of products.

Level–4: Analyzing

1. Analyze the environmental impacts of industrial activities.
2. Compare various renewable energy technologies based on efficiency and sustainability.
3. Analyze green manufacturing practices in modern industries.
4. Examine the role of circular economy in sustainable engineering.
5. Analyze the effectiveness of waste management systems in urban areas.
6. Analyze the impact of industrialization on environmental sustainability.
7. Compare conventional and renewable energy systems in terms of environmental impact.
8. Analyze the role of green supply chain management in sustainable industries.
9. Examine the effectiveness of cleaner production technologies.
10. Analyze sustainability challenges in modern engineering projects.

Level–5: Evaluating

1. Evaluate the role of green engineering in sustainable industrial development.
2. Assess the effectiveness of energy auditing methods in industries.
3. Evaluate green building technologies for environmental sustainability.
4. Critically evaluate pollution control techniques for industrial applications.
5. Assess the future scope of sustainable engineering technologies.
6. Evaluate the role of green engineering in achieving sustainable development goals.
7. Assess the effectiveness of renewable energy technologies for future energy needs.
8. Critically evaluate waste management and recycling practices in industries.
9. Evaluate sustainable infrastructure and smart city concepts.
10. Assess future trends and innovations in green engineering and sustainable technologies.

Chairperson

Board of Studies (ME)

R24MEOE13 **INDUSTRIAL AUTOMATION** **3 0 0 3**

(Open Elective-III)

Course Objectives:

1. **To understand** the basic concepts, types, and levels of industrial automation systems.
2. **To analyze** numerical control systems and NC programming techniques used in manufacturing.
3. **To study** assembly systems such as manual assembly lines and transfer lines and their performance analysis.
4. **To understand** automation technologies including pneumatic, hydraulic, and machine tool automation systems.
5. **To analyze** automated material handling and storage systems used in modern manufacturing industries.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE 06.1	Understand the fundamentals of industrial automation systems and computer process control.	3	2	1	2	2	-	-	-	-	-	1	2	2	L1 L2
R24MEOE 06.2	Apply NC concepts and manual part programming techniques in manufacturing systems.	3	3	2	2	3	-	-	-	-	-	1	3	2	L2 L3
R24MEOE 06.3	Analyze performance and design of assembly lines and transfer lines.	3	3	3	2	2	1	-	-	-	-	1	2	3	L3 L4
R24MEOE 06.4	Understand pneumatic, hydraulic, and machine tool automation systems.	3	2	2	2	3	1	-	-	-	-	1	2	3	L2 L3
R24MEOE 06.5	Evaluate automated material handling and storage systems in manufacturing environments.	3	3	3	3	3	1	-	-	-	1	1	2	3	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction To Automation: Need-types, basic elements of an automated system, levels of automation computer process control, forms of computer process control, input/output devices for discrete data, overview of material handling equipment. **CO's: CO1**

Self-Learning Topics: Study the role of PLC in industrial automation, SCADA systems, industrial sensors and actuators, and recent trends in Industry 4.0 automation technologies.

UNIT-II **14 Hours**

Numerical Control: Introduction-nc procedure, nc coordinate systems, elements of nc systems, classification of nc systems, advantages and dis-advantages of nc systems, applications of nc, nc manual part programming, apt language. **CO's: CO2**

Self-Learning Topics: Learn CNC programming basics, G-codes and M-codes, modern NC machine tool systems, and computer aided part programming tools.

UNIT–III **14 Hours**

Manual Assembly Lines And Transfer Lines: Fundamentals of manual assembly lines and automated production lines, alternative assembly systems, design for assembly, applications of automated production lines, analysis of transfer lines with no internal storage, analysis of transfer lines with storage buffers. **CO's: CO3**

Self-Learning Topics: Study balancing of assembly lines, productivity improvement techniques, lean manufacturing concepts in assembly systems, and simulation of transfer lines.

UNIT–IV **12 Hours**

Strategies of Automation: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, mechanical feeding and tool changing and machine tool control. **CO's: CO4**

Self-Learning Topics: Learn electro-pneumatic and electro-hydraulic systems, programmable automation controllers (PAC), and industrial robot integration in machine tools.

UNIT–V **10 Hours**

Automated Material Handling and Storage Systems: Types of equipment, functions, analysis and design of material handling systems, conveyor systems, and automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing. **CO's: CO5**

Self-Learning Topics: Study warehouse automation systems, AGVs in logistics, robotic material handling systems, and automated inventory control techniques.

Board of Studies : Mechanical Engineering
Approved in BoS No : 03
Approved in ACM No: 03

Text Books:

1. Mikell P. Groover, *Automation, Production Systems and Computer-Integrated Manufacturing*, Pearson Education, 2008.
2. S. R. Deb, *Robotics Technology and Flexible Automation*, Tata McGraw-Hill, 2009.

Reference Books:

1. T. O. Boucher, *Computer Automation in Manufacturing*, Chapman & Hall, 1996.
2. Richard C. Dorf & Andrew Kusiak, *Handbook of Manufacturing and Automation*, Wiley, 1994.

Web References:

1. https://nptel.ac.in/courses/112/101/112101099/
2. https://nptel.ac.in/courses/108/105/108105063/
3. https://ocw.mit.edu/courses/mechanical-engineering/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	40
L5 (Evaluating)	-	30
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remembering

1. Define automation.
2. Define NC system.
3. What is a transfer line?
4. Define pneumatic system.
5. Define AGVS.
6. Define automation and explain the basic elements of an automated system.
7. Explain the types and levels of automation used in manufacturing industries.
8. Define Numerical Control (NC) systems and explain the elements of an NC system.
9. Define automation and explain the need for automation in industries.
10. Explain computer process control and different forms of computer process control.

L2: Understanding

1. Explain levels of automation.
2. Explain NC coordinate systems.
3. Explain fundamentals of manual assembly lines.
4. Explain hydraulic components used in automation.
5. Explain automated storage and retrieval systems.
6. Explain the types and levels of automation with suitable examples.
7. Explain NC coordinate systems and elements of NC systems.
8. Explain automated storage and retrieval systems and their applications.
9. Discuss NC coordinate systems and elements of NC systems.
10. Analyze the classification, advantages, and limitations of NC systems.

L3: Applying

1. Apply computer process control concepts in automated systems.
2. Develop a simple NC manual part program.
3. Apply transfer line analysis for a production system.
4. Design a basic pneumatic circuit for automation.
5. Apply AGVS concepts in material handling systems.
6. Develop a manual NC part program for a simple machining operation.
7. Apply transfer line analysis for a manufacturing system with storage buffers.
8. Design and explain a pneumatic or hydraulic circuit used in automation.
9. Explain the fundamentals of manual assembly lines and automated production lines.
10. Analyze the applications of automated production lines in industries.

L4: Analyzing

1. Analyze advantages and disadvantages of NC systems.
2. Compare manual assembly lines and automated production lines.
3. Analyze transfer lines with and without storage buffers.
4. Analyze automation strategies used in machine tools.
5. Analyze conveyor systems in automated material handling.
6. Analyze advantages, disadvantages, and applications of NC systems.
7. Compare manual assembly lines with automated production lines.
8. Analyze different automation strategies used in machine tools.
9. Explain the types and strategies of automation used in industries.
10. Discuss pneumatic and hydraulic components with suitable circuits.

L5: Evaluating

1. Evaluate the importance of automation in manufacturing industries.
2. Evaluate applications of NC systems in modern production.
3. Evaluate efficiency of automated production lines.
4. Evaluate pneumatic and hydraulic automation systems.
5. Evaluate automated storage systems in manufacturing industries.
6. Evaluate the role of industrial automation in modern manufacturing industries.
7. Evaluate the effectiveness of automated material handling systems in industries.
8. Evaluate the importance of AGVS and ASRS in flexible manufacturing systems.
9. Explain different types of automated material handling equipment and their functions.
10. Discuss the analysis and design of material handling systems.

Chairperson
Board of Studies (ME)

R24MEOE14 FUNDAMENTALS OF DRONE TECHNOLOGY 3 0 0 3

(Open Elective-III)

Course Objectives:

1. **To introduce** fundamentals, classifications, and applications of drone technology.
2. **To understand** drone components, propulsion systems, and assembly concepts
3. **To study flight** mechanics, navigation, and control systems in drones.
4. **To understand** drone programming, communication, and IoT integration.
5. **To analyze** industrial applications and future trends of drone technology.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE 14.1	Explain fundamentals, classifications, and applications of drones.	3	2	-	-	2	-	-	-	-	-	-	2	2	**L1 L2**
R24MEOE 14.2	Describe drone components, propulsion systems, and assembly methods.	3	3	2	2	3	-	-	-	-	-	-	3	2	**L2 L3**
R24MEOE 14.3	Analyze flight mechanics, navigation, and control systems of drones.	3	3	2	2	3	-	-	-	-	-	-	3	3	**L3 L4**
R24MEOE 14.4	Apply drone programming and communication techniques in UAV systems.	3	3	3	2	3	-	-	-	-	-	-	3	3	**L4 L5**
R24MEOE 14.5	Evaluate applications and future developments in drone technology.	3	2	2	2	3	2	2	-	-	1	-	2	3	**L5**

SYLLABUS

UNIT-I **12 Hours**

Fundamentals of Drone Technology: Introduction to drones and UAVs, history and evolution of drones, classifications of drones, applications of drones, basic components of drone systems, regulations and safety guidelines. **CO's:CO1**

Self learning Topics: Drone regulations and modern drone applications.

UNIT-II **14 Hours**

Drone Components and Propulsion Systems: Drone frame structures, motors, propellers, batteries, ESC, flight controllers, sensors, power systems and drone assembly basics. **CO's: CO2**

Self **learning Topics:** Advanced propulsion systems and drone frame design.

UNIT-III **14 Hours**

Flight Mechanics and Navigation Systems: Principles of flight mechanics, stability and control, GPS navigation, communication systems, telemetry systems, autonomous flight concepts

CO's:CO3

Self learning Topics: Autonomous drone navigation and flight stabilization systems.

UNIT-IV **14 Hours**

Drone Programming and Communication: Introduction to drone programming, embedded systems in drones, wireless communication systems, IoT integration, obstacle detection and path planning. **CO's:CO4**

Self learning Topics: AI-based drones and drone communication technologies.

UNIT-V **12 Hours**

Applications of Drone Technology: Drone applications in agriculture, surveillance, delivery systems, disaster management, mapping, inspection, photography, and future trends in drone technology. **CO's:CO5**

Self learning Topics: Smart drone systems and industrial drone applications.

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. M. LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. D. Levy, Drone Programming: A Guide to Code Your Own Drones, Packt Publishing, n.d.
4. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
5. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.
6. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.

REFERENCE BOOKS:

1. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, Apress, 2019.
3. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
4. G. C. Camara Leal, Flying Robots: An Introduction to Autonomous Aerospace Systems, Springer,2017

Web References:

1.https://www.youtube.com/watch?v=yC_hFm0BX28&list=PLxApjaSnQGi6Jm7LLSxvmNQjS_rt9swsu

2.https://www.youtube.com/watch?v=nzZkKoREEGo&list=PL9ooVrP1hQOGPQVeapGsJCktzIO4DtI4_

3.https://www.youtube.com/watch?v=6wi5DI6du4&list=PL_uaeekrhGzJlB8XQBxU3z_-hDwT95xlk

4. https://www.youtube.com/watch?v=KqSqyKwVuA8

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	

L3	30	50
L4	--	40
L5		10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define drone technology.
2. What is a UAV?
3. List different types of drones.
4. Define flight controller.
5. What is an ESC?
6. List components of a drone.
7. Define thrust-to-weight ratio.
8. What is GPS navigation?
9. Define telemetry system.
10. List applications of drones.

L2: Understand

1. Explain working of brushless motors in drones.
2. Describe drone propulsion systems.
3. Explain drone flight mechanics.
4. Discuss GPS navigation systems in drones.
5. Explain functions of drone sensors.
6. Describe wireless communication systems used in drones.
7. Explain drone assembly procedure.
8. Discuss obstacle detection techniques in drones.
9. Explain autonomous drone systems.
10. Describe drone applications in agriculture and surveillance.

L3: Apply

1. Apply suitable motor selection for a drone system.
2. Analyze drone stability and control mechanisms.
3. Select suitable battery for drone applications.
4. Apply GPS systems for autonomous drone navigation.
5. Analyze communication systems used in drones.
6. Determine thrust requirements for a quadcopter.
7. Apply drone programming techniques for UAV operation.
8. Analyze drone performance under different payload conditions.
9. Apply IoT integration concepts in drones.
10. Analyze drone safety measures for industrial applications.

L4: Apply

1. Compare quadcopter and hexacopter configurations.
2. Analyze flight control systems of drones.
3. Compare brush and brushless motors used in drones.
4. Analyze effects of payload on drone performance.
5. Compare manual and autonomous drones.

6. Analyze communication challenges in drone systems.
7. Compare drone navigation systems.
8. Analyze industrial applications of drones.
9. Compare various drone sensors and controllers.
10. Analyze drone applications in disaster management.

L5: Evaluate

1. Evaluate advantages of drone technology in industries.
2. Assess effectiveness of autonomous drone systems.
3. Evaluate drone applications in agriculture and healthcare.
4. Assess safety measures required for drone operations.
5. Evaluate performance of different propulsion systems.
6. Assess environmental impact of drone usage.
7. Evaluate GPS-based drone navigation systems.
8. Assess role of AI in drone technology.
9. Evaluate future scope of smart drone systems.
10. Assess effectiveness of drones in surveillance and delivery applications.

Chairperson
Board of Studies (ME)

R24MEOE15 **NON-DESTRUCTIVE TESTING** **3 0 0 3**

(Open Elective -III)

Course Objectives:

1. **To learn** basic concepts of non-destructive testing and industrial applications
2. **To learn** the elements of ultrasonic test and limitations of ultrasonic test
3. **To learn** the concepts involved in the liquid penetrant test and eddy current test
4. **To learn** the basic principles and operating procedures of magnetic particle testing
5. **To learn** the basic concepts involved in the infrared and thermal testing

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE15.1	Understand the concepts of various NDE techniques and the requirements of radiography techniques and safety aspects.	3	2	-	-	1	-	-	-	-	-	1	2	1	L1 L2
R24MEOE15.2	Interpret the principles and procedure of ultrasonic testing	3	3	2	1	2	-	-	-	-	-	1	3	1	L2 L3
R24MEOE15.3	Understand the principles and procedure of Liquid penetration and eddy current testing.	3	2	2	2	2	-	-	-	-	-	2	3	2	L3 L4
R24MEOE15.4	Illustrate the principles and procedure of Magnetic particle testing.	3	2	2	2	2	1	1	-	-	-	1	3	3	L4 L5
R24MEOE15.5	Interpret the principles and procedure of infrared testing and thermal testing.	3	3	3	2	2	1	1	-	-	-	1	3	3	L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to non-destructive testing and industrial Applications of NDE: Span of NDE

Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions. Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography, neutron ray radiography **Digital radiography, computed radiography (CR), safety standards.** **CO's: CO1**

Self-Learning: Study of Digital Radiography (DR), Radiation safety standards (IAEA basics) Case study: Pipeline inspection, Basics of radiation shielding.

UNIT-II **14 Hours**

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing. Phased array ultrasonic testing (PAUT), TOFD techniques. **CO's: CO2**

Self-Learning: Study of **Phased Array UT (PAUT)**, Simulation of wave propagation, Case study: Ultrasonic testing in railways, Use of UT software tools.

UNIT–III **12 Hours**

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness, DPI, FPI, Limitations of Liquid Penetrant Testing. Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing**. Advanced eddy current testing, surface crack detection techniques.** **CO's: CO3**

Self-Learning: Study of DPI & FPI methods, Eddy current probe design, Case study: Aircraft inspection, Basics of electromagnetic testing.

UNIT–IV **12 Hours**

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test. Wet vs dry MPI, residual vs continuous methods. **CO's: CO4**

Self-Learning: Study of MPI techniques, Magnetic field simulation, Case study: Bridge inspection Calibration methods.

UNIT–V **10 Hours**

Infrared And Thermal Testing: Heat transfer fundamentals, Infrared thermography techniques Active & passive thermography, Applications in aerospace and electronics, **AI-based thermal imaging, drone-based inspection.** **CO's: CO5**

Self-Learning: Study of infrared cameras, Thermography software tools, Case study: Aircraft thermal inspection, AI in thermal imaging.

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text books:

1. Nondestructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers

2. Ultrasonic testing of materials/ H Kraut Kramer/Springer
3. Nondestructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

References:

1. Ultrasonic inspection training for NDT/E.A.Gingel/PrometheusPress,
2. ASTM Standards, Vol3.01, Metalsandalloys
3. Non-destructive, Hand Book – R. HamChand

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Non-Destructive Testing (NDT).
2. List the industrial applications of NDE.
3. What is radiographic testing?
4. Define ultrasonic testing.
5. What is Liquid Penetrant Testing (LPT)?
6. Define Eddy Current Testing (ECT).
7. What is Magnetic Particle Inspection (MPI)?
8. Define infrared thermography.
9. What are X-rays and Gamma rays?
10. List the parameters affecting ultrasonic testing.

L2: Understand

1. Explain the principles of radiographic testing.
2. Explain the interaction of X-rays and Gamma rays with matter.
3. Describe the working principle of ultrasonic testing.
4. Explain reflection, refraction, and diffraction in ultrasonic waves.
5. Explain the working procedure of Liquid Penetrant Testing.
6. Describe the principle of Eddy Current Testing.
7. Explain the principle of Magnetic Particle Testing.
8. Describe wet and dry MPI methods.
9. Explain active and passive thermography techniques.
10. Explain the importance of NDT in aerospace and nuclear industries.

L3: Apply

1. Apply radiographic testing for weld inspection in pipelines.
2. Use ultrasonic testing for crack detection in metals.

3. Demonstrate thickness measurement using ultrasonic testing.
4. Apply Liquid Penetrant Testing for surface crack detection.
5. Use Eddy Current Testing for heat exchanger tube inspection.
6. Apply Magnetic Particle Inspection for weld testing.
7. Implement demagnetization techniques after MPI testing.
8. Use infrared thermography for electrical component inspection.
9. Apply drone-based thermal inspection in industries.
10. Use phased array ultrasonic testing (PAUT) for defect detection.

L4: Analyze

1. Compare X-ray and Gamma ray radiography techniques.
2. Analyze the effectiveness and limitations of radiographic testing.
3. Compare conventional UT and phased array ultrasonic testing (PAUT).
4. Analyze the role of TOFD techniques in flaw detection.
5. Compare DPI and FPI methods in penetrate testing.
6. Analyze the effectiveness of Eddy Current Testing for crack detection.
7. Compare wet and dry Magnetic Particle Inspection methods.
8. Analyze residual and continuous MPI methods.
9. Compare active and passive thermography techniques.
10. Analyze AI-based thermal imaging systems in industrial inspection.

L5: Evaluate

1. Evaluate the effectiveness of radiographic testing in industrial applications.
2. Assess the importance of radiation safety standards in radiography.
3. Evaluate ultrasonic testing methods used in railway inspection.
4. Assess the suitability of PAUT for aerospace component inspection.
5. Evaluate the effectiveness of Liquid Penetrant Testing for defect detection.
6. Judge the performance of Eddy Current Testing in corrosion detection.
7. Evaluate Magnetic Particle Inspection techniques used in structural steel inspection.
8. Assess the effectiveness of infrared thermography in aerospace industries.
9. Evaluate AI-based thermal imaging techniques in modern industries.
10. Justify the importance of NDT techniques in quality and safety assurance.

Chairperson
Board of Studies (ME)

R24MEPE19 REFRIGERATION AND AIR CONDITIONING 3 0 0 3

(Refrigeration and Psychrometric tables and charts allowed)

(PROFESSIONAL ELECTIVE-IV)

Course Objectives:

1. **To introduce** the fundamentals of refrigeration systems, air refrigeration cycles, and their applications.
2. **To understand** the working and performance analysis of vapour compression refrigeration systems and refrigerants.
3. **To explain** vapour absorption refrigeration systems and their practical significance.
4. **To study** non-conventional refrigeration systems and emerging technologies.
5. **To understand** principles of air conditioning, psychrometry, and load calculations for comfort and industrial applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs										DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO10	PSO1	PSO2	
R24MEPE 19.1	Perform thermodynamic analysis on Ideal Refrigeration cycle .	3	2	-	-	2	-	-	-	2	2	**L1**
R24MEPE 19.2	Describe components and analyze COP of vapor compression cycles including subcooling and super-heating.	3	3	2	2	3	-	-	-	3	3	**L2 L3**
R24MEPE 19.3	Describe components and analyze COP of vapor absorption cycles. Explain the working of essential components of vapor absorption refrigeration	3	3	-	2	2	-	-	-	2	3	**L3 L4**
R24MEPE 19.4	Explain the working principles of non-conventional refrigeration systems like thermoelectric, vortex-tube and pulse tube refrigeration systems.	3	2	2	2	2	-	-	-	2	3	**L4**
R24MEPE 19.5	Solve problems based on RSHF, GSHF, ESHF and ADP. Calculate air-conditioning cooling load.	3	3	2	2	2	2	2	1	2	2	**L5**

SYLLABUS

UNIT-I **12 Hours**

Introduction to Refrigeration: Necessity and applications – Unit of refrigeration and COP – Types of Refrigeration cycles. Ideal cycle of Refrigeration, Mechanical Refrigeration.

Air Refrigeration: Bell Coleman cycle Actual air refrigeration systems – problems, Need of Refrigeration in Air- crafts. Aircraft Refrigeration systems. **CO's:CO1**

Self-learning Topics – Advanced insulation materials and composite heat transfer systems.

UNIT-II **14 Hours**

Vapour Compression Refrigeration: – working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – Representation of cycle on T-S, P-h and h.s. charts – effect of sub cooling and super heating – cycle analysis – Actual cycle influence of

various parameters on system performance – Use of p-h charts. Refrigerants – Desirable properties – common refrigerants used – Nomenclature. Alternative of Refrigerants **CO's: CO2**

Self-learning Topics – CFD analysis and advanced refrigerants (eco-friendly alternatives).

UNIT-III **14 Hours**

Vapour Absorption Refrigeration System – Working Principle, Essential components, Maximum COP of the Ideal VAR, Description and working of Li-Br – Water Absorption Refrigeration System, Aqua- Ammonia Refrigeration System. Three Fluid absorption system - Principle of operation, salient features. **CO's:CO3**

Self-learning Topics – Boundary layer theory and turbulence modeling in heat transfer.

UNIT-IV **14 Hours**

Non-conventional Refrigeration System: Thermo electric refrigeration, Vortex tube refrigeration, Pulse tube refrigeration, Steam jet refrigeration **CO's:CO4**

Self-learning Topics – Compact heat exchangers and phase change heat transfer

UNIT-V **12 Hours**

Need for Ventilation, infiltration – concepts of RSHF, GSHF, ESHF and ADP. – comfort Air conditioning - industrial air conditioning – Air conditioning load calculations for simple application of a small room.

Air Conditioning Systems - classification of Air Conditioning Systems: Summer Air Conditioning System, winter air Conditioning System, Year-Round Air-Conditioning System, Psychrometric processes used in Summer Air Conditioning System & winter air Conditioning System

Self-learning Topics – Radiation exchange and advanced HVAC system design. **CO's:CO5**

Board of Studies : Mechanical Engineering
Approved in BoS No : 03
Approved in ACM No: 03

Text Books:

1. Refrigeration and Air Conditioning, CP Arora, Tata McGraw Hill Publications,
2. Refrigeration and Air Conditioning by R C Arora

Reference books:

1. Principles of Refrigerations, Dossat, Willey Eastern Pub.
2. Refrigeration and Air Conditioning, Manohar Prasad, New Age Pub.
3. Refrigeration and Air Conditioning, R.S. Khurmi, J.K. Gupta, S.Chand Pub.
4. Refrigeration and Air Conditioning, P.L. Ballaney, Khanna Pub.

Web References:

1. **https://www.youtube.com/playlist?list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0**
2. **https://www.youtube.com/@refrigerationandair-condit1572**
3. **https://www.youtube.com/watch?v=4w3Obp8ILpA**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	
L3	30	40
L4	--	40
L5		20
Total (%)	**100**	**100**

Sample Questions of Various Cognitive Levels

L1: Remember

1. Define refrigeration and COP.
2. What is Bell-Coleman cycle?
3. List desirable properties of refrigerants.
4. Define psychrometry.
5. Calculate refrigeration effect if COP = 4 and work input = 5 kW.
6. Convert 10 TR into kW.
7. Define RSHF and GSHF.
8. What is vapour absorption refrigeration system?
9. Calculate COP if refrigeration effect is 200 kJ and work input is 50 kJ.
10. List applications of air conditioning systems.

L2: Understand

1. Explain working of vapour compression refrigeration system.
2. Describe Bell-Coleman refrigeration cycle with sketch.
3. Explain psychrometric processes in summer air conditioning.
4. Discuss effects of subcooling and superheating.
5. Determine compressor power for a 15 TR system with COP = 3.
6. Calculate mass flow rate of refrigerant for a 12 TR plant.
7. Explain Li-Br absorption refrigeration system.
8. Discuss properties of eco-friendly refrigerants.
9. Calculate bypass factor of cooling coil for given temperatures.
10. Explain working of thermoelectric refrigeration system.

L3: Apply

1. Compare VCR and VAR systems.
2. Analyze performance of refrigeration system using p-h chart.
3. Compare summer and winter air conditioning systems.
4. Analyze environmental impact of refrigerants.
5. Determine COP improvement due to subcooling.
6. Analyze psychrometric process for industrial air conditioning.
7. Compare Li-Br and Aqua-Ammonia systems.
8. Evaluate cooling load for a classroom with given conditions.
9. Analyze energy consumption of HVAC systems.
10. Compare performance of R134a and ammonia systems.

L4: Analyze

1. Design a refrigeration system for cold storage application.
2. Develop an HVAC system for a commercial building.
3. Propose eco-friendly refrigerants for modern RAC systems.
4. Design an energy-efficient air conditioning system.
5. Analyze industrial applications of absorption refrigeration systems.
6. Calculate cooling load for an office considering occupants and appliances.
7. Design duct arrangement for centralized air conditioning.
8. Develop methods to improve COP of refrigeration systems.
9. Analyze waste heat recovery using absorption refrigeration.
10. Design sustainable cooling systems for industries.

L5: Evaluate

1. Evaluate performance of vapour compression refrigeration systems.
2. Assess suitability of eco-friendly refrigerants.
3. Evaluate energy efficiency of HVAC systems.
4. Compare and evaluate different refrigeration systems.
5. Assess environmental impact of refrigerants.
6. Evaluate thermal comfort conditions in air conditioning systems.

7. Compare conventional and non-conventional refrigeration systems.
8. Assess feasibility of solar-powered air conditioning systems.
9. Evaluate industrial applications of RAC systems.
10. Assess future scope of sustainable refrigeration technologies.

Chairperson
Board of Studies (ME)

R24MESC05 **Mechatronics lab** **0 1 2 2**

Course Objectives:

1. **To understand** the basic concepts and components of mechatronic systems.
2. **To study** sensors, transducers, and instrumentation systems used in mechanical engineering applications.
3. **To analyze** open loop and closed loop control systems.
4. **To develop** practical skills in PLC, electro-pneumatic systems, and automation.
5. **To implement** microcontroller-based motor control and industrial automation applications.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MESC05.1	Understand the basic concepts of Mechatronic systems, sensors, transducers, and measurement techniques used in automation applications.	3	2	2	-	2	1	-	1	1	1	-	3	2	L1, L2
R24MESC05.2	Apply control system principles and analyze the performance of sensors, controllers, and automation systems in Mechatronic applications.	3	3	2	2	3	1	1	1	1	1	-	3	3	L2, L3
R24MESC05.3	Develop basic PLC and microcontroller programs and study industrial automation systems such as robots and CNC machines.	3	2	3	3	3	2	1	1	1	1	1	3	3	L2, L3

Developing the following programs:

WEEK 1

1. Study of basic mechatronic system components such as sensors, actuators, relays, switches, and controllers. **CO's-CO1**

WEEK 2

2. Calibration of LVDT for linear displacement measurement and plotting calibration characteristics. **CO's-CO1**

WEEK 3

3. Measurement of temperature using Thermocouple and RTD and comparison of their characteristics. **CO's-CO1**

WEEK 4

4. Measurement of rotational speed using Tachogenerator and Proximity Sensor. **CO's-CO1**

WEEK 5

5. Study and calibration of Strain Gauge using Wheatstone bridge arrangement.

CO's-CO1

WEEK 6

6. Analysis of Open Loop and Closed Loop Control Systems and comparison of their responses.

CO's-CO2

WEEK 7

7. Temperature control using ON/OFF controller and analysis of controller performance.

CO's-CO2

WEEK 8

8. Implementation of basic logic gates using PLC ladder programming.

CO's-CO2

WEEK 9

9. Traffic Light Control using PLC

CO's-CO2

WEEK 10

10. Study of Industrial Robot and Its Applications

CO's-CO3

WEEK 11

11. Study of CNC Machine and Its Control System

CO's-CO3

WEEK 12

12. LED Blinking using 8051 Microcontroller

CO's-CO3

Board of Studies : Mechanical Engineering
Approved in BOS No : 03
Approved in ACM No: 03

Text Books:

1. W. Bolton, Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education.
2. Nagrath & Gopal, Control Systems Engineering, New Age International Publishers.
3. A.K. Sawhney, Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai Publications.
4. Benjamin C. Kuo, Automatic Control Systems, Wiley Publications.

Reference Books:

1. Devdas Shetty and Richard Kolk, Mechatronics System Design, Cengage Learning.
2. Mahalik N.P., Mechatronics Principles, Concepts and Applications, Tata McGraw Hill.
3. Andrew Parr, Hydraulics and Pneumatics, Elsevier Publications.
4. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall.
5. Krishna Kant, Computer-Based Industrial Control, PHI Learning.

Online Learning Resources:

1. NPTEL Mechatronics Courses
2. Arduino Official Website
3. PLC Academy Learning Resources
4. All About Circuits
5. MIT OpenCourseWare – Control Systems

Chairperson
Board of Studies (CSE)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech Mechanical Engineering **Regulation: R24**

Course Structure: IV Year II Semester (or) Semester-VIII

S.No	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	PE-V	R24MEPE21 R24MEPE22 R24MEPE23 R24MEPE24 R24MEPE25	1. Entrepreneurship 2. Unconventional Machining Processes 3. Hybrid Vehicles 4. Alternative Fuels & Emissions 5. 12 Week MOOCS Swayam / NPTEL Course recommended by the BoS	3	0	0	3
2	OE-IV	R24MEOE16 R24MEOE17 R24MEOE18 R24MEOE19 R24MEOE20	1. Internal Combustion Engines 2. Smart Manufacturing Systems 3. Industry 4.0 4. Renewable Energy Systems 5. Industrial Internet of Things (IIoT)	3	0	0	3
3	PJ	R24CSPJ02	Internship & Project Work	0	0	24	12
			Total	**06**	**00**	**24**	**18**

Category	Courses	Credits
PE- Professional Elective Courses	1	03
OE- Open Elective Courses	1	03
PJ- Internship & Project Work	1	12
Total	03	18

Note:

1. Student need to do at least ONE MOOC/NPTEL Course (of 3 credits out of 160 credits) to meet the mandatory requirement (11th criteria, as per R24 Regulations); they are allowed to register one semester in advance.
2. Open Elective can be Inter Department Disciplinary Course, Emerging Courses or MOOC. Final decision will be taken by the department.

Chairperson
Board of Studies (ME)

R24MEPE21 **ENTREPRENEURSHIP** **3 0 0 3**

(Professional Elective - V)

Course Objectives:

1. **To analyze** concept of entrepreneurship and its characteristics
2. **To recognize** entrepreneurial environment and policies
3. **To illustrate** business plan preparation
4. **To interpret** finance and Human Resource mobilization and operations planning
5. **To analyze** management of small business

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE21.1	Analyze concept of entrepreneurship and its characteristics	2	2	2	-	-	-	-	3	2	2	3	2	2	L1 L2
R24MEPE21.2	Recognize entrepreneurial environment and policies	2	3	2	2	-	2	-	3	2	2	3	2	2	L2 L3
R24MEPE21.3	Illustrate business plan preparation	2	3	3	2	2	-	-	3	2	3	3	3	2	L3 L4
R24MEPE21.4	Interpret finance and Human Resource mobilization and operations planning	2	3	3	2	2	2	-	3	3	3	3	3	3	L4
R24MEPE21.5	Analyze management of small business	2	3	3	2	2	2	-	3	3	3	3	3	3	L4 L5

SYLLABUS

UNIT-I **12Hours**

Entrepreneurial Competence: Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur. **CO's:CO1**

Self-Learning Topics: Startup culture and entrepreneurial success stories

UNIT-II **12Hours**

Entrepreneurial Environment And Policies: Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services – Central and State Government Industrial Policies and Regulations - International Business.

Self-Learning Topics: Government schemes for startups and digital entrepreneurship **CO's: CO2**

UNIT–III **12 Hours**

Business Plan Preparation : Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria. **CO's: CO3**

Self-Learning Topics: Business model canvas and startup funding strategies

UNIT–IV **12 Hours**

Launching Of Small Business: Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection -Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

Self-Learning Topics: E-commerce business models and incubation centers. **CO's: CO4**

UNIT–V **12 Hours**

Management of Small Business: Monitoring and Evaluation of Business – Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

Self-Learning Topics: Small business management using digital tools and analytics **CO's: CO5**

Board of Studies : Mechanical Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

Reference Books:

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition 2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_mg81

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level–1: Remembering

1. Define entrepreneurship.
2. Who is an entrepreneur?
3. List characteristics of a successful entrepreneur.
4. Define business environment.
5. What is a business plan?
6. Define venture capital.
7. What is incubation center?
8. Define small business.
9. What is project feasibility study?
10. List sources of finance for business.

Level–2: Understanding

1. Explain entrepreneurship as a career.
2. Describe entrepreneurial personality traits.
3. Explain role of government policies in entrepreneurship.
4. Discuss entrepreneurship development programs.
5. Explain importance of business plan preparation.
6. Describe market and channel selection methods.
7. Explain project feasibility analysis.
8. Discuss operations planning in small business.
9. Explain role of venture capital in startups.
10. Describe growth strategies for small businesses.

Level–3: Applying

1. Apply entrepreneurial skills for startup development.
2. Prepare a basic business plan for a startup.
3. Apply feasibility study methods for business projects.
4. Demonstrate budgeting techniques for small businesses.
5. Apply market analysis for product launch.
6. Analyze suitable funding sources for startups.
7. Apply HR mobilization strategies in business.
8. Demonstrate business opportunity identification methods.
9. Apply business growth strategies for startups.
10. Analyze project profile preparation techniques.

Level–4: Analyzing

1. Compare entrepreneur and manager roles.
2. Analyze factors affecting entrepreneurial growth.
3. Compare different sources of business finance.
4. Analyze challenges faced by startups.
5. Compare traditional and digital business models.
6. Analyze role of incubation centers in entrepreneurship.
7. Compare small-scale and large-scale businesses.
8. Analyze risk factors in entrepreneurship.

9. Compare various market selection strategies.
10. Analyze causes for sickness in small business units.

Level–5: Evaluating

1. Evaluate importance of entrepreneurship in economic development.
2. Assess effectiveness of government entrepreneurial policies.
3. Evaluate business plan preparation methods.
4. Assess role of venture capital in startup success.
5. Evaluate strategies for successful product launching.
6. Assess effectiveness of small business management techniques.
7. Evaluate financial planning methods for startups.
8. Assess impact of digital entrepreneurship in modern business.
9. Evaluate rehabilitation methods for sick business units.
10. Assess future scope of entrepreneurship in India.

Chairperson
Board of Studies (ME)

R24MEPE22 UNCONVENTIONAL MACHINING PROCESSES 3 0 0 3

(Professional Elective-V)

Course Objectives

1. **To understand** the classification, and applications of non-traditional machining (NTM) processes.
2. **To analyze** various mechanical-type NTM processes such as USM, AJM, AWJM and their process parameters.
3. **To gain knowledge** of electrochemical and chemical machining processes and their industrial relevance.
4. **To Study** electrical discharge and advanced hybrid machining processes like EDM, ESD, and STEM.
5. **To understand** advanced machining processes such as EBM, LBM, and PAM used in modern manufacturing.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PSO2	
R24MEPE22.1	Explain the principles, classifications, process parameters, applications, and limitations of ultrasonic and hybrid non-traditional machining processes.	3	2	1	1	2	-	-	-	-	-	2	2	3	L1, L2
R24MEPE22.2	Analyze the working principles and performance characteristics of abrasive jet, water jet, abrasive water jet, and magnetic abrasive finishing processes.	3	3	2	2	2	-	-	-	-	-	2	3	3	L3, L4
R24MEPE22.3	Apply the concepts of electrochemical and chemical machining processes for evaluating material removal mechanisms, tool design, and machining performance.	3	3	2	2	2	1	-	-	-	-	2	2	3	L3, L4

R24MEPE22.4	Examine the principles, process parameters, tooling, and machining accuracy of EDM, Wire EDM, ESD, and STEM processes.	3	3	2	2	3	-	-	-	-	-	2	3	3	L3, L4
R24MEPE22.5	Illustrate the working principles, process parameters, and industrial applications of EBM, LBM, and PAM in advanced manufacturing.	3	2	2	1	2	1	-	-	-	-	3	2	3	L4, L5

SYLLABUS

UNIT - I **12 Hours**

Introduction: Need for non-traditional machining methods – Classification of modernmachining processes – considerations in process selection and applications.

Ultrasonic Machining: Elements of the process, mechanics of material removal, MRR process parameters, applications and limitations.Hybrid Non-Traditional Machining Processes.

CO's: CO1

Self-Learning Topics: Comparative study: Conventional vs non-traditional machining, Industrial applications of Ultrasonic Machining (USM)

UNIT - II **12 Hours**

Abrasive Jet Machining (AJM): Water jet machining, abrasive water jet machining, abrasive flow machining, magnetic abrasive finishing - process parameters, material removal rate, process capabilities, abrasive particle size, limitations and applications. Robotic Abrasive Water Jet Machining Systems. **CO's: CO2**

Self-Learning Topics: Magnetic Abrasive Finishing for nano-level surface finishing, Optimization of process parameters in AJM/AWJM.

UNIT - III **14 Hours**

Electro-Chemical Machining (ECM): Fundamentals of electrochemical machining, electrochemical grinding, Electrochemical honing and deburring process, metal removal rate in ECM, tool design, surface finish and accuracy, economic aspects of ECM.

Chemical Machining (CHM): Fundamentals of Chemical machining, masks, etchants, advantages and applications. Green Electrolytes and Sustainable Chemical Machining.

CO's: CO3

Self-Learning Topics: Tool design challenges in Electrochemical Machining (ECM), Environmental impacts and safety in Chemical Machining (CHM).

UNIT - IV **12 Hours**

Electric Discharge Machining (EDM): General principle and application, Electric Discharge Grinding (EDG) and Wire EDM – Mechanics of metal removal inEDM, process parameters, selection of tool electrodes and dielectric fluids, surface finish andmachining accuracy.

Electro Stream Drilling (ESD): Introduction, ESD setup, electrolyte, drilling of curved hole, penetration drilling, dwell drilling, right angle drilling, process performance.

Shaped Tube Electrolytic Machining (STEM): Introduction, construction details, processes parameters, MRR, surface finish.CNC and AI-based Wire EDM Automation**.** **CO's: CO4**

Self-Learning Topics: Wire EDM in precision manufacturing industries, Advanced drilling techniques using ESD and STEM.

UNIT - V **12 Hours**

Electron Beam Machining (EBM) and Laser Beam Machining (LBM): Basic principle and theory, process parameters and applications.

Plasma Arc Machining (PAM): Applications of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma inmanufacturing industry.Fiber Laser Machining and Ultrafast Laser Processing **CO's: CO5**

Self-Learning Topics: Comparison: EBM vs LBM vs PAM, Role of plasma technology in modern manufacturing.

Board of Studies: Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books

1. Advanced Machining Processes, V. K. Jain, Allied Publications.
2. Modern Machining Process, P.C. Pandey, Tata McGraw Hill Publications

Reference Books

1. Production Technology, HMT, Tata McGraw Hill Publications
2. New Technology, A. Bhattacharyya, Institution of Engineers (India) Publication

Web References:

1. http://archive.nptel.ac.in/courses/
2. http://onlinecourses.nptel.ac.in/noc24_me46/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	20	-
L2 (Understanding)	30	10
L3 (Applying)	30	30
L4 (Analyzing)	20	40
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remembering

1. Define unconventional machining.
2. List classification of modern machining processes.
3. What is Ultrasonic Machining?
4. Define EDM.
5. Describe classification of unconventional machining processes.
6. Explain working of Ultrasonic Machining.
7. Describe ECM process.
8. Explain EDM process.

9. Define ultrasonic machining.
10. Describe the principle of laser beam machining.

L2: Understanding

1. Explain need for non-traditional machining methods.
2. Describe working of AJM.
3. Explain principle of ECM.
4. Describe working of Wire EDM.
5. Explain need and advantages of unconventional machining.
6. Describe AJM and its applications.
7. Explain working of AWJM.
8. Describe WEDM process.
9. Discuss dielectric fluids used in EDM.
10. Describe electrochemical machining process and applications

L3: Applying

1. Apply USM for machining brittle materials.
2. Demonstrate working of AWJM for cutting operations.
3. Apply ECM for shaping complex profiles.
4. Use EDM for die manufacturing.
5. Apply ECM for machining complex cavities.
6. Apply EDM in tool and die making.
7. Demonstrate use of LBM in micro machining.
8. Apply PAM for industrial cutting.
9. Apply chemical machining principles in precision manufacturing.
10. Compare ECM and EDM processes.

L4: Analyzing

1. Compare AJM and AWJM processes.
2. Analyze parameters affecting MRR in ECM.
3. Compare EDM and ECM.
4. Analyze surface finish in EDM.
5. Analyze differences between ECM and EDM.
6. Compare AJM and WJM.
7. Analyze process parameters affecting machining.
8. Compare LBM and EBM.
9. Analyze material removal mechanisms in EDM and ECM.
10. Analyze machining accuracy in Wire EDM.

L5: Evaluating

1. Evaluate suitability of LBM for precision machining.
2. Justify selection of PAM for cutting thick materials.
3. Evaluate advantages of WEDM.
4. Select suitable machining process for hard materials.
5. Evaluate advantages and limitations of ECM.
6. Evaluate EDM performance in precision machining.
7. Justify use of laser machining in industry.
8. Evaluate selection of machining process for aerospace components.

9. Evaluate AI-based automation in Wire EDM systems.
10. Justify the use of fiber laser machining.

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Board of Studies (ME)

R24MEPE23 **HYBRID VEHICLES** **3 0 0 3**

(Professional Elective-V)

Course Objectives:

1. **To introduce** the fundamentals, architecture, and technologies of electric and hybrid electric vehicles.
2. **To explain** the principles of vehicle dynamics, motion, and performance characteristics of electric vehicles.
3. **To study** various electric drive systems and their applications in hybrid electric vehicles.
4. **To understand** different energy storage systems, battery technologies, and control strategies used in hybrid electric vehicles.
5. **To analyze** the role of power electronic converters and electrical machines in the operation of hybrid electric vehicles.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE23.1	Define and Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.	3	2	1	-	1	1	_	_	1	_	2	1	2	L1 L2
R24MEPE23.2	Explain the fundamentals of vehicle movement and performance of electric vehicle.	3	3	2	1	2	1	_	_	1	_	2	2	3	L2 L3
R24MEPE23.3	Analyze various electric drives suitable for hybrid electric vehicles.	3	3	2	2	3	1	_	_	1	_	2	3	2	L3 L4
R24MEPE23.4	Discuss different energy storage technologies used for hybrid electric vehicles and their control.	3	2	2	2	3	2	_	_	1	_	2	2	3	L2 L3
R24MEPE23.5	Analyse the use of different power electronics devices and electrical machines in hybrid electric vehicles.	3	3	3	2	3	1	_	_	1	_	2	3	2	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Hybrid Electric Vehicles History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Vehicle fundamentals General Description of Vehicle Movement, Vehicle Resistance, Dynamic Equation, Basics of vehicle performance and braking performance. **CO's: CO1**

Self-Learning Topics: Evolution of electric vehicles, Recent trends in EV technology, Vehicle safety standards in EVs

UNIT-II **14 Hours**

Hybrid Electric Drive-trains:

Basic concept of hybrid drive train, introduction to various hybrid drivetrain topologies.

Electric Drive-trains:

Introduction to various electric drive-train topologies, Performance of Electric Vehicle, Tractive effort in normal driving, Energy Consumption. **CO's: CO2**

Self-Learning Topics: Regenerative braking systems, Battery management systems (BMS), Drive cycle analysis of EVs

UNIT–III **12 Hours**

Electric propulsion system Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Vector control of AC Drives, PMSM Drives, SRM Drives, and Advanced Control Strategies. **CO's:CO3**

Self-Learning Topics: BLDC motor applications in EVs, Sensorless motor control techniques, AI-based motor control strategies

UNIT–IV **12 Hours**

Energy Storage:

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. **CO's:CO4**

Self-Learning Topics: Supercapacitors in EVs, Hydrogen energy systems, Battery recycling and sustainability

UNIT–V **10 Hours**

Power Electronics Control Power Electronics in HEVs: Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics. **CO's: CO5**

Self-Learning Topics: Fast charging technologies, Wide band-gap semiconductor devices, Smart charging and V2G technology

Board of Studies : Mechanical Engineering

Approved in BoS No : 03

Approved in ACM No: 03

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013.

Web References:

1. https://nptel.ac.in/courses/108/103/108103009/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	50
L4 (Analyzing)	-	40
L5 (Evaluating)	-	10
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Level 1: Remembering

1. Define Hybrid Electric Vehicle (HEV).
2. What is an Electric Vehicle (EV)?
3. List the types of hybrid vehicles.
4. State the importance of electric vehicles.
5. Define vehicle resistance.
6. What is braking performance?
7. Name the forces acting on a moving vehicle.
8. Define rolling resistance.
9. What is aerodynamic drag?
10. List applications of hybrid electric vehicles.

Level 2: Understanding

1. What is vehicle resistance?
2. State the social importance of hybrid electric vehicles.
3. Explain the basics of braking performance in electric vehicles.
4. Define hybrid drivetrain.
5. Define energy storage system in EVs.
6. Discuss the social and environmental importance of hybrid electric vehicles.
7. Discuss the basics of vehicle performance and braking performance in electric vehicles.
8. Explain various hybrid electric drivetrain topologies with neat sketches.
9. Explain the performance characteristics of electric vehicles.
10. What is parallel hybrid topology?

Level-3: Applying

1. What is tractive effort in electric vehicles?
2. What is regenerative braking?
3. What are the major electric components used in HEVs?
4. Define vector control of AC drives.
5. Define hybridization of energy storage devices.
6. Explain various vehicle resistances acting on an electric vehicle

7. Derive and explain the dynamic equation of vehicle motion.
8. Derive the expression for tractive effort during normal driving conditions.
9. Discuss the factors affecting energy consumption in electric vehicles.
10. Explain the working and advantages of PMSM drives in electric vehicles.

Level-4: Analyzing

1. What is an SRM drive?
2. Define sensorless motor control.
3. Define power electronics in HEVs.
4. What is DC-AC conversion?
5. Compare PMSM, SRM, and induction motor drives used in EV applications.
6. Discuss advanced control strategies used in electric propulsion systems.
7. Explain the role of power electronics in hybrid electric vehicles.
8. Discuss AC-DC and DC-AC conversion techniques used in EVs.
9. Explain different electronic devices and circuits used for power control in HEVs.
10. What is a battery management system (BMS)?

Level-5: Evaluating

1. Define thermal management in HEVs.
2. What is V2G technology?
3. Analyze the importance of thermal management in HEV power electronics.
4. Evaluate the role of fast charging and smart charging technologies in electric vehicles.
5. Define smart charging.
6. What is V2G technology?
7. List applications of power electronics in EVs.
8. What are wide band-gap semiconductor devices?
9. Define switching devices.
10. What is charging infrastructure?

Chairperson
Board of Studies (ME)

R24MEOE16 **INTERNAL COMBUSTION ENGINES** **3 0 0 3**

(Open Elective - IV)

Course Objectives:

1. **To understand** the construction, working principles, and performance analysis of S.I. and C.I. engines operating on two-stroke and four-stroke cycles.
2. **To analyze** combustion phenomena in spark ignition and compression ignition engines, including normal and abnormal combustion characteristics.
3. **To study** fuel supply systems, carburetion, fuel injection techniques, and combustion chamber designs used in modern IC engines.
4. **To gain** knowledge of conventional and alternative fuels, fuel properties, combustion analysis, and emission-related fuel characteristics.
5. **To understand** supercharging, turbo charging, cooling, and lubrication systems and their Influence on IC engine performance and efficiency.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs											DOK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO10	PO11	PSO1	PSO2	
R24ME OE16.1	Explain the working, performance parameters, and thermodynamic analysis of S.I. and C.I. engines operating on two-stroke and four-stroke cycles.	3	2	-	-	2	-	-	-	1	2	3	L1 L2
R24ME OE16.2	Analyze combustion processes in S.I. engines, including flame propagation, ignition phenomena, and abnormal combustion effects.	3	3	1	2	2	1	-	-	1	2	3	L2 L3
R24ME OE16.3	Evaluate combustion characteristics in C.I. engines and understand fuel injection systems, carburetion, and modern fuel metering techniques.	3	3	2	2	3	1	-	-	1	3	3	L2 L3
R24ME OE16.4	Classify IC engine fuels, evaluate fuel properties and ratings, and analyze the suitability of alternative fuels for SI and CI engines.	2	2	2	1	1	3	1	-	2	1	3	L3 L4

R24ME OE16.5	Examine supercharging, turbocharging, cooling, and lubrication systems and assess their effects on engine performance and efficiency.	3	2	3	2	2	2	-	1	2	2	3	L4 L5

SYLLABUS

UNIT-I **12Hours**

Introduction of IC Engine: Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines

Self-Learning Topics: Comparative study of modern SI and CI engine technologies used in automobiles. **CO's:CO1**

UNIT-II **12Hours**

Combustion in SI engines: Flame development and propagation, Pressure-Crank Angle diagram, Stages of Combustion ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects, abnormal Combustion, effect of engine and fuel variables on abnormal combustion, pre-ignition, its causes and remedy, salient features of various type combustion chambers

Self-Learning Topics: Recent advancements in spark ignition systems for SI engines. Study of knock detection and control techniques in SI engines. **CO's: CO2**

UNIT–III **12 Hours**

Combustion in CI Engines: Various stages of combustion in CI Engines, delay period, diesel knock, knock inhibitors, salient features of various types of combustion chambers. Fuel injection in CI engine, Working Principle of fuel pump & fuel injectors, types of nozzles. Fuel injection in SI engine (MPFI, TBI,CRDI), Theory of carburetion, Solex Carburetor, simple problems on carburetion. Fuel metering in CI engines

Self-Learning Topics: Electronic fuel injection systems in modern diesel engines (CRDI technology**.** **CO's: CO3**

UNIT–IV **12 Hours**

Fuel: Classification of IC Engine fuels, Desirable characteristics of SI & CI engine fuels, Rating of SI & CI engine fuels, Alternative fuels for SI and CI engine (liquid, gaseous, hydrogen, LPG, CNG, Biogas etc.), Air requirement, Analysis of combustion products, HHV and LHV of fuels

Self-Learning Topics: Utilization of hydrogen and biofuels in IC engines. **CO's: CO4**

UNIT–V **12 Hours**

Supercharging & Turbo charging: Methods of supercharging, & turbo charging Effects of super charging and turbo charging. Engine Modifications for supercharging, supercharging of two stroke engines. Microprocessor controlled supercharging. Cooling & lubrication of SI & CI Engines.

Self-Learning Topics: Applications of turbochargers in high-performance and commercial vehicles. **CO's: CO5**

Board of Studies : Mechanical Engineering
Approved in BOS No: 03
Approved in ACM No: 03

Text Books:

1. V. Ganesan, Internal Combustion Engines, McGraw Hill Education, New Delhi.
2. Mathur & Sharma, A Course in Internal Combustion Engines, Dhanpat Rai Publications.

Reference Books:

1. Heywood John B., Internal Combustion Engine Fundamentals, McGraw Hill International Edition.
2. Colin R. Ferguson and Allan T. Kirkpatrick, Internal Combustion Engines: Applied Thermo sciences, Wiley India.

Web References:

1. NPTEL – Internal Combustion Engines Course
2. MIT OpenCourseWare – Internal Combustion Engines

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

Short Answer Questions

Level–1: Remembering

1. Define mean effective pressure in IC engines.
2. What is ignition delay in CI engines?
3. List the factors affecting volumetric efficiency.
4. Define octane number and cetane number.
5. What is supercharging in IC engines?
6. Explain the working of four-stroke SI and CI engines with neat sketches.
7. Describe the construction and working of a Solex carburetor.
8. Explain the stages of combustion in SI and CI engines.
9. Discuss different types of IC engine fuels and their properties.
10. Explain the methods of supercharging and turbocharging.

Level–2: Understanding

1. Differentiate between SI and CI engines.
2. Explain abnormal combustion in SI engines.
3. Describe the stages of combustion in CI engines.
4. Explain the working principle of a turbocharger.
5. Discuss the importance of cooling systems in IC engines.
6. Explain the real cycle analysis of SI and CI engines.

7. Discuss abnormal combustion phenomena and methods to control knocking in SI engines.
8. Explain fuel injection systems used in modern CI engines.
9. Describe combustion chamber designs used in SI and CI engines.
10. Explain cooling and lubrication systems used in IC engines.

Level–3: Applying

1. Calculate brake thermal efficiency from given engine data.
2. Determine air-fuel ratio for complete combustion of a fuel.
3. Apply heat balance analysis for an IC engine.
4. Compare MPFI and carburetor systems for practical applications.
5. Analyze the effect of fuel injection timing on engine performance.
6. Solve problems related to engine dimensions, speed, and fuel consumption.
7. Apply thermodynamic relations to evaluate engine performance parameters.
8. Calculate volumetric efficiency and brake power for given engine data.
9. Solve numerical problems on carburetion and air-fuel mixture requirements.
10. Apply combustion analysis to determine HHV and LHV of fuels.

Level–4: Analyzing

1. Analyze the causes and effects of knocking in SI engines.
2. Compare combustion chamber designs used in CI engines.
3. Analyze the influence of turbocharging on engine efficiency.
4. Examine the effect of engine variables on flame propagation.
5. Analyze performance characteristics of multi-cylinder engines.
6. Analyze the effect of ignition timing and turbulence on combustion in SI engines.
7. Compare MPFI, TBI, and CRDI systems with respect to performance and emissions.
8. Analyze the performance characteristics of naturally aspirated and turbocharged engines.
9. Examine the factors influencing diesel knock and methods to reduce it.
10. Analyze heat balance and energy distribution in IC engines.

Level–5: Evaluating

1. Evaluate the suitability of alternative fuels for IC engines.
2. Assess the advantages and limitations of CRDI systems.
3. Evaluate the performance of SI and CI engines under varying load conditions.
4. Justify the need for lubrication systems in modern engines.
5. Evaluate the environmental impact of conventional and alternative fuels.
6. Evaluate the role of alternative fuels in sustainable IC engine operation.
7. Assess the impact of supercharging on engine power and efficiency.
8. Evaluate modern fuel injection technologies for emission reduction.
9. Compare SI and CI engines for automotive and industrial applications.
10. Critically evaluate recent advancements in IC engine technology for future mobility applications.

Chairperson
Board of Studies (ME)

R24MEPE24 ALTERNATIVE FUELS &EMISSIONS 3 0 0 3

(Professional Elective-V)

Course Objectives:

1. **To introduce** various alternative fuels and their characteristics for SI and CI engines.
2. **To understand** the properties, production, and performance of liquid alternative fuels such as biodiesel and alcohols.
3. **To study** gaseous fuels like CNG, LPG, hydrogen, and biogas along with their storage and usage in engines.
4. **To analyze** the formation and control of automobile emissions in SI and CI engines.
5. **To understand** emission standards, measurement techniques, and environmental impact of automobile emissions.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEPE24.1	Explain types of alternative automobile fuels and their properties along with basic concepts of EV, hybrid, and fuel cell	3	2	-	-	2	2	2	-	-	-	-	2	2	L1 L2
R24MEPE24.2	Analyze performance and emission characteristics of liquid alternative fuels such as biodiesel and alcohol blends.	3	3	2	2	2	-	2	-	-	-	-	3	3	L2 L3
R24MEPE24.3	Evaluate properties, storage, and performance of gaseous fuels like CNG, LPG, hydrogen, and biogas in engines.	3	3	2	2	2	-	3	-	-	-	-	3	3	L3 L4
R24MEPE24.4	Analyze formation, types, and control of automobile emissions in SI and CI engines.	3	3	2	3	2	2	3	-	-	-	-	2	3	L4 L5
R24MEPE24.5	Assess emission standards, measurement techniques, and environmental impact of automobile emissions.	3	2	2	2	3	2	3	-	-	1	-	2	3	L5

SYLLABUS

UNIT-I **12 Hours**

Introduction Automobile Fuels: Classification of Automobile alternative fuels(liquid, gaseous, hydrogen, LPG, CNG, Biogas etc.), Desirable characteristics of SI & CI engine alternative fuels, Rating of SI & CI engine fuels, Introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar cars. merits and demerits of various alternate fuels. **CO's:CO1**

Self-learning Topics– Latest trends in electric and fuel cell vehicles.

UNIT-II **14 Hours**

Liquid alternative fuels: Vegetable Oils: Various vegetable oils for automobile engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics. Alcohols: Properties as engine fuel, alcohols and gasoline blends, performance in automobile engine, methanol and gasoline blends. **CO's: CO2**

Self-learning Topics - Advanced biofuels and emission analysis using CFD

UNIT-III **14 Hours**

Gaseous Fuels: Biogas: Introduction to Biogas system, Process during gas formation, Factors affecting biogas formation. Usage of Biogas in SI engine & CI engine., Properties of Natural gas, Hydrogen gas, LPG & CNG as engine fuels, storage and handling, performance and safety aspects to all gaseous fuel, fuel metering systems. **CO's:CO3**

Self-learning Topics - Storage technologies and safety of gaseous fuels

UNIT-IV **14 Hours**

Automobile emissions: Types of automobile emissions, emission characteristics, formation of automobile emissions, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission CI engine emissions: formation of smoke, factors affecting the smoke formation, unburned hydrocarbons, carbon monoxide, oxides of nitrogen, smog and comparison of diesel and petrol emissions.

C**O's:CO4**

Self-learning Topics - Advanced emission reduction techniques and after-treatment systems.

UNIT-V **12 Hours**

Emissions Norms & Measurement: Emission norms as per Bharat Standard up to BS – IV and procedures for confirmation on production. Demerits of automobile emission to environment. Types Of Catalytic Conversion, Measurement Techniques Emission Standards and Test Procedure NDIR,FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards.

CO's:CO5

Self-learning Topics – Latest Bharat Stage norms and modern emission analyzers.

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. J.B. Heywood. Internal combustion Engines, Wiley
2. Ganeshan V; Internal Combustion engines; TMH
3. Mathur M L & Sharma RP; A. Course in IC engines; Dhanpat Rai
4. R Yadav, Internal Combustion Engines
5. 5 Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson

6. DomKundwar; Internal Combustion Engines; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)

Reference books:

1. Alternate Fuels, Dr. S. Thipse, Jaico Publications.
2. Hydrogen and Fuel Cells: Emerging Technologies and Applications,Bent Sorensen, Elsevier Academic Press, UK
3. Automotive Emission Control, Crouse and Anglin , McGraw Hill Alternative Fuels Guidebook, Bechtold R.
4. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma.

Web References:

1..https://nptel.ac.in/courses/112/104/112104122/

2..https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmentalissues-in-materials-selection-fall-2005/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	--
L2	40	
L3	30	60
L4	--	40
Total (%)	**100**	**100**

Sample Questions of Various Cognitive Levels

L1: Remember

1. Define alternative fuels.
2. List types of gaseous fuels used in automobiles.
3. What is biodiesel?
4. Define emission standards.
5. List types of automobile emissions.
6. What is CNG?
7. Define hybrid vehicle.
8. What is a fuel cell vehicle?
9. List properties of SI engine fuels.
10. Define catalytic converter.

L2: Understand

1. Explain properties of biodiesel.
2. Describe alcohol-gasoline blends.
3. Explain working of fuel cell vehicles.
4. Discuss biogas production process.
5. Explain formation of CO emissions in SI engines.
6. Describe storage and handling of LPG.
7. Explain advantages of EVs and hybrid vehicles.

8. Discuss performance of biodiesel in CI engines.
9. Explain emission measurement techniques.
10. Describe Bharat emission norms.

L3: Apply

1. Apply suitable alternative fuel for SI engine applications.
2. Analyze performance of biodiesel blends in CI engines.
3. Determine suitable gaseous fuel for commercial vehicles.
4. Analyze emission characteristics of alcohol blends.
5. Apply fuel metering systems in gaseous fuel engines.
6. Compare performance of CNG and LPG fuels.
7. Analyze effects of alternative fuels on engine efficiency.
8. Determine factors affecting smoke formation in CI engines.
9. Apply catalytic converters for emission reduction.
10. Analyze performance of hydrogen-fueled engines.

L4: Analyze

1. Compare petrol and diesel engine emissions.
2. Analyze advantages and limitations of biodiesel.
3. Compare EV, hybrid, and fuel cell vehicles.
4. Analyze emission formation mechanisms in SI engines.
5. Compare properties of LPG and CNG fuels.
6. Analyze environmental impact of automobile emissions.
7. Compare performance of liquid and gaseous fuels.
8. Analyze effects of alternative fuels on engine life.
9. Compare emission control techniques in automobiles.
10. Analyze fuel storage systems for hydrogen vehicles

L5: Evaluate

1. Evaluate suitability of biodiesel as an alternative fuel.
2. Assess environmental benefits of alternative fuels.
3. Evaluate performance of fuel cell vehicles.
4. Judge effectiveness of catalytic converters in emission control.
5. Evaluate advantages of EVs over conventional vehicles.
6. Assess impact of Bharat Stage norms on pollution control.
7. Evaluate emission reduction techniques in CI engines.
8. Assess feasibility of hydrogen as automobile fuel.
9. Evaluate economic benefits of alternative fuels.
10. Assess future scope of green automobile technologies.

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R24MEOE17 **SMART MANUFACTURING SYSTEMS (OE-4)** **3 0 0 3**

Course Objectives:

1. **To apply** knowledge of smart manufacturing systems' components in the context of Industry 4.0 2) **To understand** the concepts of smart machines and smart sensors
2. **To understand** and apply the concepts of IoT connectivity to Industry 4.0
3. **To understand** the concepts of Digital Twin and apply Machine Learning and Artificial Intelligence concepts in Manufacturing
4. **To understand** the concepts of Met averse.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE17.1	Learn about smart manufacturing systems' components and can handle it more effectively in context of Industry 4.0	3	2	-	-	1	-	-	-	-	-	1	2	1	L1 L2
R24MEOE17.2	Learn about the smart machines and smart sensors	3	3	2	1	2	-	-	-	-	-	1	3	1	L2 L3
R24MEOE17.3	Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry	3	2	2	2	2	-	-	-	-	-	2	3	2	L3 L4
R24MEOE17.4	Learn about concepts of Digital Twin and able to apply Machine Learning and Artificial Intelligence concepts in Manufacturing	3	2	2	2	2	1	1	-	-	-	1	3	3	L4 L5
R24MEOE17.5	Learn the concepts of AR/VR and Metaverse platform	3	3	3	2	2	1	1	-	-	-	1	3	3	L5

SYLLABUS

UNIT-I **14 Hours**

Concepts of Smart Manufacturing: Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing six big losses in manufacturing with Industry 4.0, and their benefits. **CO's: CO1**

Self-Learning Topics: Industry 5.0 case studies, Smart factory simulations.

UNIT-II **14 Hours**

Smart Machines and Smart Sensors: Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Introduction to IoT, IoT, and Cyber physical systems, Sensing for Manufacturing Process in IoT, Block Diagram of an IoT Sensing Device, Sensors in IoT Applications, Smart Machine Interfaces. **CO's: CO2**

Self-Learning Topics: Sensor calibration techniques, IoT device programming

UNIT–III **12 Hours**

IoT connectivity for Industry 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol. **CO's: CO3**

Self-Learning Topics: MQTT implementation, Industrial cybersecurity tools

UNIT–IV **12 Hours**

Digital Twin: Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing: Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML. **CO's: CO4**

Self-Learning Topics: Python for ML, Digital twin software (Siemens, ANSYS)

UNIT–V **10 Hours**

Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial Metaverse, How Web 3.0 is changing the Internet, Asset Classes Inside the Metaverse, Land, Coins, Characters/ Avatars, Skins, Utility, Industries Disrupted by the Metaverse, Smart wearables. **CO's: CO5**

Self-Learning Topics: Unity for AR/VR, Blockchain basics.

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text books:

1. Industry 4.0, the Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Housing Song Danda B. Rawat, Springer

References:

1. The Metaverse: And how it will revolutionize everything/Matthew Ball/Liveright Publishers

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define smart manufacturing.
2. List the key characteristics of smart manufacturing.
3. What are the six big losses in manufacturing?
4. Define smart machine.
5. What is a smart sensor?
6. Define Internet of Things (IoT).
7. What is a cyber physical system (CPS)?
8. Define digital twin technology.
9. What is Machine Learning (ML)?
10. Define Metaverse and AR/VR technologies.

L2: Understand

1. Explain the stages involved in smart manufacturing.
2. Explain the challenges faced in smart manufacturing industries.
3. Describe the concept and functions of smart machines.
4. Explain the need and benefits of smart sensors in industries.
5. Explain the architecture of IoT sensing devices.
6. Describe industrial communication requirements in Industry 4.0.
7. Explain TCP/IP model used in IoT connectivity.
8. Describe the applications and advantages of digital twin technology.
9. Explain supervised and unsupervised machine learning approaches.
10. Explain the role of AR/VR technologies in industrial metaverse applications.

L3: Apply

1. Apply Industry 4.0 concepts to minimize six big losses in manufacturing.
2. Demonstrate the use of smart sensors in predictive maintenance systems.
3. Develop a basic IoT sensing device block diagram for industrial applications.
4. Apply IoT protocols for industrial automation networks.
5. Implement mesh networks in industrial IoT systems.
6. Use smart machine interfaces in manufacturing systems.
7. Apply digital twin technology in aerospace manufacturing industries.
8. Use machine learning techniques for defect detection in industries.
9. Implement AR/VR technologies for virtual industrial training systems.
10. Apply smart wearable devices in industrial monitoring applications.

L4: Analyze

1. Compare traditional manufacturing systems with smart manufacturing systems.
2. Analyze the impact of Industry 4.0 technologies on manufacturing industries.
3. Compare smart machines and conventional machines.
4. Analyze the role of smart sensors in industrial automation.
5. Compare IoT and cyber physical systems in manufacturing applications.
6. Analyze different IoT connectivity protocols used in industries.
7. Compare supervised, unsupervised, and reinforcement learning techniques.
8. Analyze the advantages of digital twins in manufacturing industries.
9. Compare social metaverse and industrial metaverse applications.
10. Analyze the impact of Web 3.0 technologies on industrial systems.

L5: Evaluate

1. Evaluate the effectiveness of smart manufacturing systems in industries.
2. Assess the importance of Industry 4.0 technologies in minimizing manufacturing losses.
3. Evaluate the role of smart sensors in predictive maintenance systems.
4. Judge the effectiveness of IoT-based industrial automation systems.
5. Evaluate different IoT communication protocols for industrial applications.
6. Assess the effectiveness of digital twin technology in aerospace and automotive industries.
7. Evaluate machine learning applications in manufacturing industries.
8. Assess AI-based defect detection systems used in smart factories.
9. Evaluate AR/VR technologies used in industrial metaverse applications.
10. Justify the importance of smart wearables and metaverse technologies in future industries.

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R24MEOE18 **INDUSTRY 4.0** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

1. **To apply** knowledge of smart manufacturing systems' components in the context of Industry 4.0
2. **To understand** the concepts of smart machines and smart sensors
3. **To understand** and apply the concepts of IoT connectivity to Industry 4.0
4. **To understand** the concepts of Digital Twin and apply Machine Learning and Artificial Intelligence concepts in Manufacturing
5. **To understand** the concepts of Met averse.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE18.1	Explain the concept of Industry 4.0 and its applications in modern manufacturing systems.	3	2	-	-	1	-	-	-	-	-	1	2	3	L1 L2
R24MEOE18.2	Apply Internet of Things (IoT) concepts to solve real-time industrial and manufacturing problems.	3	3	2	1	2	-	-	-	-	-	1	3	3	L2 L3
R24MEOE18.3	Identify and analyze Industry 4.0 applications in manufacturing environments.	3	2	2	2	2	-	-	-	-	-	2	3	3	L3 L4
R24MEOE18.4	Apply lean manufacturing tools and techniques to improve efficiency in industrial systems.	3	2	2	2	2	1	1	-	-	-	1	2	3	L4 L5
R24MEOE18.5	Compare and analyze Industrial IoT applications and the impact of Industry 4.0 on manufacturing transformation.	3	3	3	2	2	1	1	-	-	-	1	2	3	L5

SYLLABUS

UNIT-I **14 Hours**

Introduction to Industry 4.0: Definition of Industry 4.0, Concept of Industry 4.0, Benefits of Industry 4.0, Globalization and emerging issues, The Fourth Industrial Revolution, Smart and

Connected Business Perspective, Smart Factories, Industry 4.0 Drivers and Enablers, Barriers and Challenges for Industry 4.0. **COs-CO1**

Self-Learning Topics: Case study: Siemens Smart Factory, Industry 4.0 trends

UNIT-II **14 Hours**

Internet of Things: Concept of Internet of things, Industrial internet of things, IT & OT Convergence, Requirements of Industry 4.0 concepts, Virtual and Augmented reality in Industry4.0, Digital twins in Industrial IoT and Industry 4.0. **COs-CO2**

Self-Learning Topics: AWS IoT / Azure IoT basics, Arduino IoT projects

UNIT–III **12 Hours**

Industry4.0 in Manufacturing Industry; Rise of Collaborative robot (COBOT), Edge Computing & IoT, and Industrial Data Space.Logistics4. O, Industrial Iot gateways, IoT Cybersecurity Risks and evolution, lot communication and connectivity technology, Maintenance and asset management with IoT. **COs-CO3**

Self-Learning Topics: Machine learning basics, Predictive maintenance models

UNIT–IV **12 Hours**

Lean Manufacturing: Introduction to Lean Manufacturing, Industry Examples, Lean Manufacturing Tools and Techniques, Overview of the Toyota Production System (TPS), Lean Manufacturing Company Application, and Lean Manufacturing Tools & Techniques application.

COs-CO4

Self-Learning Topics: Lean case studies (Toyota), Kaizen implementation

UNIT–V **10 Hours**

Industrial IoT Applications: Health Care Management, Chemical and Pharmaceutical industry, Industrial IoT in Power Plants, Quality Control and Inventory Management, Plant Safety and Security, Facility Management. **COs-CO5**

Self-Learning Topics: Smart supply chains, IoT in renewable energy.

Board of Studies : Mechanical Engineering

Approved in BOS No : 03

Approved in ACM No: 03

Text books:

1. Industrial Engineering and Production Management-Martand Telsang- S.Chand & CO.

References:

1. Samuel Eilon, "Elements of Production Planning and control", Universal Book Corp., 1999.
2. Buffa, E.S., "Modem Production/Operations Management", John Wiley sons, 2003
3. Elsayed A Elsayed, Thomas O. Boucher, "Analysis and control of Production System", Prentice Hall, 2002.

Web References:

1. Siemens – Smart Factories, Industry 4.0 & Digital Manufacturing
   https://new.siemens.com/global/en/company/topic-areas/industry.html
2. IBM – Industry 4.0, IoT & Digital Transformation
   https://www.ibm.com/topics/industry-4-0
3. Microsoft – Azure IoT & Digital Twin Technologies
   https://azure.microsoft.com/en-in/solutions/iot/

4. Amazon Web Services – AWS IoT & Industrial IoT Applications https://aws.amazon.com/iot/
5. Toyota Motor Corporation – Lean Manufacturing & Toyota Production System https://global.toyota/en/company/vision-and-philosophy/production-system/

Internal Assessment pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Industry 4.0.
2. What are smart factories?
3. List the drivers of Industry 4.0.
4. Define Internet of Things (IoT).
5. What is Industrial IoT (IIoT)?
6. Define Digital Twin technology.
7. What is a Collaborative Robot (COBOT)?
8. Define Edge Computing.
9. What is Lean Manufacturing?
10. List the applications of Industrial IoT in industries.

L2: Understand

1. Explain the concept and benefits of Industry 4.0.
2. Describe the barriers and challenges of Industry 4.0 implementation.
3. Explain IT and OT convergence in Industrial IoT systems.
4. Describe Virtual Reality (VR) and Augmented Reality (AR) applications in Industry 4.0.
5. Explain Digital Twins in Industrial IoT applications.
6. Describe the role of collaborative robots in manufacturing industries.
7. Explain IoT communication and connectivity technologies.
8. Explain the importance of predictive maintenance using IoT.
9. Describe Lean Manufacturing tools and techniques.
10. Explain the Toyota Production System (TPS) in Lean Manufacturing.

L3: Apply

1. Apply Industry 4.0 concepts in smart factory systems.
2. Implement IoT-based monitoring systems for industries.
3. Develop a simple Arduino IoT project for industrial applications.
4. Apply Digital Twin technology for industrial simulation.
5. Use collaborative robots in manufacturing automation.
6. Implement edge computing in Industrial IoT systems.

7. Apply predictive maintenance techniques using IoT data.
8. Use Lean Manufacturing tools for waste reduction.
9. Apply Kaizen principles in manufacturing industries.
10. Implement Industrial IoT applications in healthcare and power plants.

L4: Analyze

1. Compare traditional manufacturing systems with Industry 4.0 systems.
2. Analyze the impact of smart factories on industrial productivity.
3. Compare IoT and Industrial IoT applications.
4. Analyze the role of AR/VR technologies in Industry 4.0.
5. Compare cloud computing and edge computing in IoT systems.
6. Analyze cybersecurity risks in Industrial IoT systems.
7. Compare collaborative robots and traditional industrial robots.
8. Analyze the effectiveness of Lean Manufacturing techniques.
9. Compare Toyota Production System with conventional manufacturing systems.
10. Analyze Industrial IoT applications in quality control and inventory management.

L5: Evaluate

1. Evaluate the effectiveness of Industry 4.0 technologies in manufacturing industries.
2. Assess the importance of smart factories in digital transformation.
3. Evaluate IoT-based industrial monitoring systems.
4. Judge the effectiveness of Digital Twin technology in industries.
5. Evaluate collaborative robots used in industrial automation.
6. Assess the effectiveness of predictive maintenance models in industries.
7. Evaluate Lean Manufacturing techniques for waste reduction.
8. Assess cybersecurity measures used in Industrial IoT systems.
9. Evaluate Industrial IoT applications in healthcare and pharmaceutical industries.
10. Justify the importance of Industry 4.0 technologies in future manufacturing industries.

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R24MEOE19 RENEWABLE ENERGY SYSTEMS **3 0 0 3**

(Open Elective-IV)

Course Objectives:

1. **To introduce** various renewable energy resources and their significance in sustainable energy generation.
2. **To understand** solar, wind, biomass, geothermal, and ocean energy conversion systems and applications.
3. **To study** energy efficient electrical and mechanical systems for conservation of energy.
4. **To analyze** green manufacturing processes and environmentally sustainable technologies.
5. **To understand** green building concepts, energy management, and eco-friendly construction materials.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24MEOE19.1	Explain principles of solar energy systems, solar radiation, collection, storage, and applications.	3	2	-	2	2	-	3	-	-	-	-	2	3	L1 L2
R24MEOE19.2	Analyze wind, biomass, geothermal, and ocean energy systems and their energy conversion methods.	3	3	2	2	2	-	3	-	-	-	-	2	3	L2 L3
R24MEOE19.3	Evaluate energy efficient electrical and mechanical systems for industrial applications.	3	3	2	2	3	-	2	-	-	-	-	3	3	L3 L4
R24MEOE19.4	Apply concepts of green manufacturing and sustainable energy efficient processes.	3	3	3	2	2	2	3	-	-	-	-	2	3	L3 L4
R24MEOE19.5	Assess green building technologies, sustainable materials, and energy management techniques.	3	2	2	-	2	2	3	-	-	1	-	2	2	L4 L5

SYLLABUS

UNIT-I **14 Hours**

Solar Energy Systems: Solar radiation, photovoltaic cells, solar collectors, and solar energy storage systems. Applications of solar heating, cooling, drying, and solar power generation.

CO's: CO1

Self-Learning Topics: Solar PV systems and solar tracking.

UNIT-II **14 Hours**

Renewable Energy Sources: Wind energy, biomass energy, geothermal energy, and ocean energy systems. Principles, energy conversion methods, and applications of renewable energy sources.

CO's: CO2

Self-Learning Topics: Hybrid renewable energy and wind farms

UNIT–III **12 Hours**

Energy Efficient Systems: Energy efficient electrical and mechanical systems including HVAC controls, efficient motors, fuel cells, compressors, and pumps for energy conservation.

CO's: CO3

Self-Learning Topics: Smart energy systems and fuel cells.

UNIT–IV **12 Hours**

Green Manufacturing: Sustainable manufacturing systems, recyclable materials, eco-friendly machining, alternate casting and joining methods, and zero waste manufacturing practices.

CO's: CO4

Self-Learning Topics: Green manufacturing and waste reduction.

UNIT–V **10 Hours**

Green Buildings: Concepts of green buildings, sustainable construction materials, energy management, eco-friendly roofing systems, and energy-efficient building design.

CO's: CO5

Self-Learning Topics: Smart buildings and energy auditing

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
3. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013

Reference Books:

1. Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New age international
2. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider / Taylor &Francis
3. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
4. Renewable Energy Technologies -Ramesh & Kumar /Narosa
5. Non conventional Energy Source- G.D Roy/Standard Publishers
6. Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd
7. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd

Web References:

1. https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk
2. https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=2
3. https://www.youtube.com/watch?v=ANZMrVGUlvA&list=PLwdnzlV3ogoVFaDTCr-N2b_TSBPEeBJdU

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1 – Remember

1. Define renewable energy.
2. What is solar radiation?
3. List types of solar collectors.
4. Define biomass energy.
5. What is wind energy conversion?
6. Define fuel cell.
7. What is geothermal energy?
8. Define green building.
9. What is energy conservation?
10. List applications of renewable energy systems.

L2 – Understand

1. Explain working of a solar photovoltaic cell.
2. Describe biomass energy conversion methods.
3. Explain the principle of wind energy systems.
4. Discuss applications of geothermal energy.
5. Explain energy efficient HVAC systems.
6. Describe fuel cell operation.
7. Explain green manufacturing concepts.
8. Discuss ocean thermal energy conversion (OTEC).
9. Explain energy management in buildings.
10. Describe sustainable construction materials.

L3 – Apply

1. Analyze advantages of solar energy systems.
2. Compare renewable and conventional energy sources.
3. Evaluate performance of wind energy systems.

4. Analyze energy conservation methods in industries.
5. Compare different biomass conversion techniques.
6. Evaluate applications of fuel cells.
7. Analyze green manufacturing practices.
8. Suggest suitable renewable energy source for rural areas.
9. Analyze factors affecting solar PV efficiency.
10. Evaluate importance of green buildings.

L4 – Analyze

1. Design a solar energy system for domestic use.
2. Develop a hybrid renewable energy model.
3. Propose energy conservation techniques for industries.
4. Design a smart green building system.
5. Evaluate economic feasibility of renewable energy projects.
6. Develop a waste-to-energy system using biomass.
7. Propose methods to improve wind turbine efficiency.
8. Design an energy management system for buildings.
9. Analyze environmental impact of renewable energy systems.
10. Develop sustainable manufacturing practices for industries.

L5 – Evaluate

1. Propose innovative renewable energy solutions for smart cities.
2. Develop advanced solar energy storage methods.
3. Investigate future trends in renewable energy technologies.
4. Design a net-zero energy building model.
5. Propose AI-based energy management systems.
6. Analyze role of renewable energy in sustainable development.
7. Develop innovative green manufacturing techniques.
8. Suggest advanced methods for energy conservation.
9. Propose smart grid integration with renewable energy sources.
10. Investigate future applications of hydrogen energy systems.

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Board of Studies (ME)

R24MEOE20 **INDUSTRIAL IoT** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

1. **To introduce** the concepts of IoT, IIoT, Industry 4.0, and smart factory systems.
2. **To understand** implementation of IIoT systems using sensors, actuators, embedded systems, and wireless communication protocols.
3. **To study** IoT data monitoring, cloud computing, edge systems, and predictive maintenance techniques.
4. **To explain** cyber physical systems, AI, AR/VR, big data, and advanced analytics in industrial applications.
5. **To explore** real-time industrial applications and case studies of IIoT in various sectors.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcome (CO)	Mapping with POs and PSOs													Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO01	PSO02	
R24MEOE03 .1	Explain the fundamentals of IoT, IIoT, Industry 4.0, and smart factory concepts.	3	2	-	-	2	-	-	-	-	-	-	2	2	L1
R24MEOE03 .2	Apply sensors, actuators, embedded systems, and wireless communication protocols in IIoT implementation.	3	3	2	2	3	-	-	2	-	-	-	3	2	L2
R24MEOE03 .3	Analyze IoT data monitoring, cloud computing, edge systems, and predictive maintenance techniques.	3	3	2	2	3	-	-	-	-	-	-	3	3	L3
R24MEOE03 .4	Evaluate cyber physical systems, AI, AR/VR, and big data applications in industrial environments.	3	2	2	2	3	2	2	-	-	-	-	2	3	L3L4
R24MEOE03 .5	Develop and assess IIoT applications and case studies for industrial automation and smart systems.	3	3	3	2	3	2	2	2	2	1	-	3	3	L5

SYLLABUS

UNIT-I **10 Hours**

Introduction to Industrial IoT (IIoT) Systems

Industrial Revolutions, Role of IoT & IIoT in Industry, Industry 4.0, Support Systems for Industry 4.0, Smart Factories. **CO's:CO1**

UNIT-II **14 Hours**

IIoT Implementation Systems

Sensors and Actuators, Sensor Networks, Process Automation and Data Acquisition, Microcontrollers and Embedded PCs in IIoT, Wireless Sensor Nodes using Bluetooth, WiFi, LoRa, IoT Hub Systems. **CO's: CO2**

UNIT–III **12 Hours**

IIoT Data Monitoring & Control

IoT Gateway, Edge Systems and Programming, Cloud Computing, Real-Time Dashboard for Data Monitoring, Data Analytics, Predictive Maintenance using IIoT. **CO's: CO3**

UNIT–IV **12 Hours**

Cyber Physical Systems

Next Generation Sensors, Collaborative Platforms, Product Lifecycle Management, Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence, Big Data and Advanced Analytics.

CO's: CO4

UNIT–V **10 Hours**

Industrial IoT Applications & Case Studies

IIoT Applications in Healthcare, Power Plants, Inventory Management, Quality Control, Plant Safety and Security, Facility Management, Case Studies using Embedded PC and Edge Development Boards, Mini Project Development. **CO's: CO5**

Board of Studies : Mechanical Engineering

Approved in BoS No: 03

Approved in ACM No: 03

Text Books:

1. Industry 4.0: The Industrial Internet of Things Alasdair GilchristPublications: Apres
2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.
3. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.
4. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers

Reference Books:

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0.
3. CRC Press.2020
4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights,2014
5. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015

Web References:

1. **https://www.youtube.com/watch?v=u4UebEMMkJc&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=4**
2. **https://www.youtube.com/watch?v=p7kYStiASLo&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR**

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1 (Remembering)	30	-
L2 (Understanding)	40	-
L3 (Applying)	30	30
L4 (Analyzing)	-	50
L5 (Evaluating)	-	20
Total	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1 – Remember

1. Define Industrial IoT (IIoT).
2. What is Industry 4.0?
3. List types of sensors used in IIoT.
4. Define smart factory.
5. What is cloud computing?
6. Define edge computing.
7. What is predictive maintenance?
8. Define cyber physical system.
9. List applications of IIoT.
10. What are wireless sensor networks?

L2 – Understand

1. Explain architecture of IIoT systems.
2. Describe process automation using IIoT.
3. Explain working of IoT gateways.
4. Discuss cloud computing in IIoT.
5. Explain edge computing applications.
6. Describe predictive maintenance techniques.
7. Explain role of AI in Industry 4.0.
8. Discuss applications of big data analytics in industries.
9. Explain AR and VR in industrial applications.
10. Describe communication protocols used in IIoT.

L3 – Apply

1. Analyze advantages of IIoT in industrial automation.
2. Compare cloud computing and edge computing.
3. Evaluate importance of predictive maintenance.
4. Analyze challenges in implementing IIoT systems.
5. Design a simple IIoT-based monitoring system.

6. Compare traditional industries with smart factories.
7. Analyze role of AI in smart industries.
8. Suggest suitable communication protocol for industries.
9. Evaluate security issues in IIoT systems.
10. Analyze IIoT applications in healthcare or power plants.

L4 – Analyze

1. Develop an IIoT model for smart manufacturing.
2. Design a predictive maintenance system using IoT sensors.
3. Propose an IIoT solution for energy management in industries.
4. Develop a smart factory framework using Industry 4.0 concepts.
5. Evaluate long-term benefits of IIoT in industrial growth.
6. Design a wireless sensor network for industrial monitoring.
7. Propose cybersecurity measures for IIoT systems.
8. Analyze economic impact of Industry 4.0 implementation.
9. Develop a cloud-based industrial monitoring system.
10. Investigate future trends and innovations in Industrial IoT.

L5 – Evaluate

1. Propose innovative IIoT applications for sustainable industries.
2. Develop a research model for AI-based predictive maintenance.
3. Design an advanced smart factory using AI and robotics.
4. Investigate integration of digital twins in IIoT systems.
5. Analyze impact of IIoT on future industrial employment.
6. Propose a novel edge computing architecture for industries.
7. Develop strategies for green and energy-efficient smart factories.
8. Evaluate future scope of IIoT in autonomous industries.
9. Design an IIoT-based intelligent transportation system.
10. Suggest innovative methods for secure industrial communication.

Chairperson
Board of Studies (ME)