

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION - 2023

Vision

To develop highly skilled Mechanical Engineers dedicated to serving society

Mission

M1: To Foster a dynamic learning environment that prepares competent student-research scholars in Mechanical Engineering.

M2: To Build state-of-the-art laboratories to meet technological advancements and transformations.

M3: To Uphold moral and ethical principles among faculty and students.

Program Educational Objectives (PEOs)

This Course is conducted to achieve the following Programme Educational Objectives (PEOs):

PEO 1. Academic Excellence: Excel as successful engineers or entrepreneurs.

PEO 2. Leadership Quality: Become effective leaders, demonstrating professionalism and a commitment to lifelong learning.

PEO 3. Research skill and Ethics: Handle real-time projects while upholding ethical values.

Program Outcomes (POs)

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO1: Apply fundamental and advanced concepts in mechanical engineering across multiple domains, such as materials, design, manufacturing, and thermal engineering, to effectively design, develop, and implement complex products and systems.

PSO2: Identify, select, and effectively utilize ICT tools commonly employed Mechanical Engineering such as Computer-Aided Design (CAD) software, simulation software, and data analysis tools to create and apply innovative solutions for the betterment of society.

Course Outcomes (COs) of All Courses.

Autonomous Regulation – R2023

S.NO	COURSE CODE.	SUBJECT CODE	COURSE TITLE
1	C2301	U23HST11	Communicative English
2	C2302	U23MAT12	Matrices and Calculus
3	C2303	U23PHT13	Physics for Engineers and Technologists
4	C2304	U23CYT14	Chemistry for Engineering and Technology
5	C2305	U23GET16	Engineering Graphics
6	C2306	GE3152	Heritage of Tamils
7	C2307	U23BSP11	Physics and Chemistry Laboratory
8	C2308	U23HSP12	English Laboratory
9	C2309	U23GEP14	Engineering Practices Laboratory
10	C2310	U23HST21	Professional English

11	C2311	U23MAT22	Statistics and Numerical Methods
12	C2312	U23GET15	Problem Solving and Python Programming
13	C2313	U23PHT23	Applied Material Science
14	C2314	U23EET23	Basic Electrical and Electronics Engineering
15	C2315	U23MET21	Engineering Mechanics
16	C2316	GE3252	Tamils and Technology
17	C2317	U23GEP13	Problem Solving and Python Programming Laboratory
18	C2318	U23EEP22	Basic Electrical and Electronics Engineering Laboratory
19	C2319	U23HSP22	Communication Laboratory
20	C2320	U23MAT31	Transforms and Partial Differential Equations
21	C2321	U23MET31	Engineering Thermodynamics
22	C2322	U23MET32	Fluid Mechanics and Machinery
23	C2323	U23MET34	Engineering Materials and Metallurgy
24	C2324	U23MET35	Manufacturing Processes
25	C2325	U23MEP31	Computer Aided Machine Drawing Laboratory
26	C2326	U23MEP32	Manufacturing Technology Laboratory
27	C2327	U23GE3361	Professional Development
28	C2328	U23MET41	Kinematics of Machinery
29	C2329	U23MET42	Thermal Engineering
30	C2330	U23MET43	Strength of Materials
31	C2331	U23MET44	Computer Aided Design
32	C2332	U23MET45	Manufacturing Technology
33	C2333	U23GET41	Environmental Sciences and Engineering
34	C2334	U23MEP41	Strength of Materials and Fluid Machinery Laboratory
35	C2335	U23MEP42	Thermal Engineering Laboratory
36	C2336	U23MET51	Design of Machine Elements
37	C2337	U23MET52	Dynamics of Machines
38	C2338	U23MET53	Metrology and Measurements
39	C2339	U23MET61	Heat and Mass Transfer
40	C2340	U23MET62	Design of Transmission System
41	C2341	U23GET61	Human Values and Ethics
42	C2342	U23MEP51	Metrology and Measurements Laboratory
43	C2343	U23MEP52	Dynamics Laboratory
44	C2344	U23MEP61	CAD/CAM Laboratory
45	C2345	U23MEP62	Heat Transfer Laboratory
46	C2346	U23MET71	Mechatronics and IoT
47	C2347	U23MET72	Computer Integrated Manufacturing
48	C2348	U23MET73	Power Plant Engineering
49	C2349	U23MET81	Production Planning and Control
50	C2350	U23GET76	Industrial Management
51	C2351	U23MEP81	Project Work
52	C2352	U23MEV11	Design of Pressure Vessels
53	C2353	U23MEV12	Failure Analysis and NDT Techniques
54	C2354	U23MEV13	Material Handling and Solid Processing Equipment
55	C2355	U23MEV14	Rotating Machinery Design

56	C2356	U23MEV15	Thermal and Fired Equipment Design
57	C2357	U23MEV16	Industrial Layout Design and Safety
58	C2358	U23MEV17	Design Codes and Standards
59	C2359	U23RAT42	Sensors and Instrumentation
60	C2360	U23RAT33	Electrical Drives and Actuators
61	C2361	U23RAT51	Embedded Systems and Programming
62	C2362	U23MEV24	Modeling and Control of Robot
63	C2363	U23RAV33	Smart Mobility and Intelligent Vehicles
64	C2364	U23MEV26	Haptics and Immersive Technologies
65	C2365	U23RAV12	Drone Technologies
66	C2366	U23MEV31	Bio energy Conversion Technologies
67	C2367	U23MEV32	Carbon Footprint Estimation and Reduction Techniques
68	C2368	U23MEV33	Energy Conservation in Industries
69	C2369	U23CEV67	Energy Efficient Buildings
70	C2370	U23MEV35	Energy Storage Devices
71	C2371	U23MEV36	Renewable Energy Technologies
72	C2372	U23MEV37	Equipment for Pollution Control
73	C2373	U23MEV41	Introduction to Product Design
74	C2374	U23MEV42	Additive Manufacturing Processes
75	C2375	U23MEV43	Design for Additive Manufacturing
76	C2376	U23MEO12	Reverse Engineering
77	C2377	U23MEV45	Business Value Enhancement with Additive Manufacturing
78	C2378	U23MEV46	Lithographic process
79	C2379	U23MEV47	Printing Technology
80	C2380	U23MEV51	Automobile Engineering
81	C2381	U23MEV52	Measurements and Controls
82	C2382	U23MEV53	Non-traditional Machining Processes
83	C2383	U23MEV54	Composite Materials and Mechanics
84	C2384	U23MEV55	Gas Dynamics and Jet Propulsion
85	C2385	U23MEV56	Hydraulics and Pneumatics
86	C2386	U23MEV57	Refrigeration And Air Conditioning
87	C2387	U23MEV61	Automotive Materials, Components, Design and Testing
88	C2388	U23MEV62	Conventional and Futuristic Vehicle Technology
89	C2389	U23MEV63	Renewable Powered Off Highway Vehicles and Emission Control Technology
90	C2390	U23MEV64	Vehicle Health Monitoring, Maintenance and Safety
91	C2391	U23MEV65	CAE and CFD Approach in Future Mobility
92	C2392	U23MEV66	Hybrid and Electric Vehicle Technology
93	C2393	U23MEV67	Thermal Management of Batteries and Fuel Cells
94	C2394	U23MEO11	Applied Design Thinking
95	C2395	U23MEO13	Quality Engineering
96	C2396	U23MEO14	Functional Materials
97	C2397	U23MEO15	Fire Safety Engineering
98	C2398	U23MEO21	Industrial Design & Rapid Prototyping Techniques
99	C2399	U23MEO22	Micro and Precision Engineering

100	C2400	U23MEO23	Energy Conservation and Management
101	C2401	U23MEO24	Nanomaterials and applications
102	C2402	U23RAO11	Industrial Robotics And Material Handling Systems

SEMESTER-I

U23HST11 (C2301) COMMUNICATIVE ENGLISH

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2301.1 Remember appropriate words in a situational conversation.
- C2301.2 Gain understanding of basic grammatical structures and use them in right context.
- C2301.3 Read and infer the denotative and connotative meanings of technical texts.
- C2301.4 Write Dialogue, Letter and paragraphs on various topics.
- C2301.5 Make the students prepare effective notes for main sources available.
- C2301.6 Enhance them to give operational talk.

U23MAT12 (C2302) MATRICES AND CALCULUS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2302.1 Use the matrix algebra methods for solving practical problems.
- C2302.2 Use both the limit definition and rules of differentiation to differentiate functions.
- C2302.3 Apply differential calculus tools in solving various application problems.
- C2302.4 Able to use differential calculus ideas on several variable functions.
- C2302.5 Apply multiple integral ideas in solving areas, volumes and other practical problems.
- C2302.6 Solve the ordinary differential equations using different techniques for that model engineering problems.

U23PHT13 (C2303) PHYSICS FOR ENGINEERS AND TECHNOLOGISTS

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

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| C2303.1 | Differentiate the elastic and plastic nature of the materials. |
| C2303.2 | Know the experimental techniques in both production and applications of ultrasonic waves. |
| C2303.3 | Gain knowledge in the basics of quantum mechanics concepts. |
| C2303.4 | Develop new devices based on LASER source. |
| C2303.5 | Understand the advantages of optical fiber than metal wire. |
| C2303.6 | Demonstrate the some useful experiments based on optical fibre. |

U23CYT14 (C2304) CHEMISTRY FOR ENGINEERING AND TECHNOLOGY

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

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| C2304.1 | Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost. |
| C2304.2 | Apply the basic knowledge of Corrosion and various electrodes. |
| C2304.3 | Know the economically and new methods of synthesis nano materials. |
| C2304.4 | Apply the knowledge of phase rule and composites for material selection requirements. |
| C2304.5 | Understand the concepts of suitable fuels for engineering processes and applications. |
| C2304.6 | Have the knowledge of different forms of energy resources and apply them for suitable applications in energy sectors. |

U23GET16 (C2305) ENGINEERING GRAPHICS

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

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| C2305.1 | Identify the significance of graphics in engineering applications. |
| C2305.2 | Project straight lines inclined to both principal planes and determine true lengths and inclinations. |
| C2305.3 | Apply orthographic projection techniques to project solids. |
| C2305.4 | Apply the principles of development to prisms, pyramids, cylinders, and cones. |
| C2305.5 | Combine two solid objects in simple vertical positions using isometric projection. |
| C2305.6 | Utilize the isometric scale effectively. |

GE3152 (C2306) HERITAGE OF TAMILS

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

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| C2306.1 | Understand the evolution and significance of Tamil as a classical language and literature. |
| C2306.2 | Comprehend the rich artistic heritage, sculptures, and cultural contributions of Tamils. |
| C2306.3 | Appreciate the traditional folk arts, martial arts, and sports of Tamil culture. |
| C2306.4 | Analyze the Thinaï concept and the socio-economic life during the Sangam age. |
| C2306.5 | Recognize the contributions of Tamils to the Indian National Movement. |
| C2306.6 | Understand the role of Tamil Siddha medicine and ancient scripts. |

U23BSP11 (C2307) PHYSICS AND CHEMISTRY LABORATORY

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

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| C2307.1 | Learn the proper use of various kinds of physics laboratory equipment. |
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C2307.2	Collect, present and interpret experimental data in a clear and concise manner.
C2307.3	Solve problems related to physics principles and interpretation of experimental data.
C2307.4	Determine error in experimental measurements and techniques used to minimize such error.
C2307.5	Test basic understanding of water quality parameters like hardness, acidity, and alkalinity.
C2307.6	Utilize electro analytical techniques such as pH metry and conductometry for analysis.

U23HSP12 (C2308) ENGLISH LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

C2308.1	Enhance listening skills through audio-visual aids and speech drills.
C2308.2	Practice neutralization of accent for better intelligibility.
C2308.3	Develop effective presentation skills for academic and professional contexts.
C2308.4	Improve group discussion and debate skills.
C2308.5	Strengthen vocabulary and sentence structure through exercises.
C2308.6	Comprehend and respond to verbal and non-verbal communication cues.

U23GEP14 (C2309) ENGINEERING PRACTICES LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

C2309.1	Understand the basics of house wiring and electrical safety measures.
C2309.2	Demonstrate soldering techniques and PCB fabrication for simple circuits.
C2309.3	Identify and use various hand tools and machine tools for basic carpentry.
C2309.4	Perform basic fitting operations like filing, drilling, and tapping.
C2309.5	Practice sheet metal work to fabricate simple models like trays and funnels.
C2309.6	Demonstrate basic welding operations like arc welding and gas welding.

SEMESTER: II

U23HST21 (C2310) PROFESSIONAL ENGLISH

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2310.1 Draft effective technical reports, project proposals, and documentation.
- C2310.2 Enhance vocabulary specific to engineering and technology.
- C2310.3 Deliver professional presentations with visual aids effectively.
- C2310.4 Practice resume writing and facing job interviews confidently.
- C2310.5 Develop skills in writing formal letters, emails, and memos.
- C2310.6 Analyze case studies and participate in group discussions.

U23MAT22 (C2311) STATISTICS AND NUMERICAL METHODS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2311.1 Test hypothesis for large and small samples using appropriate statistical techniques.
- C2311.2 Calculate correlation and regression coefficients to analyze data.
- C2311.3 Apply probability distributions (Normal, Binomial, Poisson) to solve engineering problems.
- C2311.4 Find numerical solutions for algebraic and transcendental equations.
- C2311.5 Apply numerical integration techniques to solve engineering problems.
- C2311.6 Solve ordinary differential equations using numerical methods.

U23GET15 (C2312) PROBLEM SOLVING AND PYTHON PROGRAMMING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2312.1 Develop algorithmic flowcharts for solving computational problems.
- C2312.2 Write Python programs using basic data types and operators.
- C2312.3 Implement control structures (loops and conditionals) in Python.
- C2312.4 Utilize functions and modules for modular programming.
- C2312.5 Perform file handling operations in Python.
- C2312.6 Solve engineering problems using lists, tuples, and dictionaries.

U23PHT23 (C2313) APPLIED MATERIAL SCIENCE

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

- C2313.1 Understand the structure-property relationship of engineering materials.
- C2313.2 Analyze phase diagrams to predict microstructure.
- C2313.3 Comprehend the properties and applications of conducting, semiconducting, and magnetic materials.
- C2313.4 Understand the characteristics of dielectric, superconducting, and optical materials.
- C2313.5 Select appropriate materials for specific engineering applications.
- C2313.6 Apply knowledge of nanomaterials and their properties.

U23EET23 (C2314) BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

- C2314.1 Analyze DC and AC electrical circuits using network theorems.
- C2314.2 Explain the working principle and characteristics of DC machines and transformers.
- C2314.3 Understand the operation of three-phase induction motors and synchronous machines.
- C2314.4 Analyze the characteristics of PN junction diodes, BJT, and FET.
- C2314.5 Understand the working of rectifiers, amplifiers, and oscillators.

C2314.6 Apply the concepts of digital electronics and logic gates.

U23MET21 (C2315) ENGINEERING MECHANICS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2315.1 Resolve forces and calculate moments for coplanar force systems.
- C2315.2 Determine the centroid and moment of inertia for plane areas.
- C2315.3 Analyze the equilibrium of rigid bodies subjected to forces and moments.
- C2315.4 Analyze the kinetics of particles and rigid bodies using work-energy principles.
- C2315.5 Solve problems related to friction, belt, and rope drives.
- C2315.6 Apply principles of mechanics to simple trusses and frames.

GE3252 (C2316) TAMILS AND TECHNOLOGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2316.1 Understand the evolution of Tamil language and its computing history.
- C2316.2 Identify the contributions of ancient Tamil scholars to science and technology.
- C2316.3 Comprehend the role of Tamils in traditional irrigation and water management.
- C2316.4 Analyze the technological advancements in ancient Tamil architecture and sculpture.
- C2316.5 Recognize the modern technological developments in Tamil Nadu.
- C2316.6 Relate Tamil cultural ethics to modern engineering practices.

U23GEP13 (C2317) PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2317.1 Develop Python programs for arithmetic and logical operations.
- C2317.2 Write programs using decision-making constructs (if-else).
- C2317.3 Implement loops and iteration for solving computational problems.
- C2317.4 Create and manipulate lists, tuples, and dictionaries.
- C2317.5 Develop Python functions for reusable code.
- C2317.6 Solve engineering problems using Python file handling and string operations.

U23EEP22 (C2318) BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2318.1 Verify network theorems and calculate circuit parameters.
- C2318.2 Study the characteristics of PN junction diode and Zener diode.
- C2318.3 Analyze the characteristics of BJT and FET transistors.
- C2318.4 Measure the performance of single-phase and three-phase transformers.
- C2318.5 Study the speed control of DC motors and induction motors.
- C2318.6 Implement digital logic circuits using logic gates.

U23HSP22 (C2319) COMMUNICATION LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2319.1 Participate effectively in group discussions and role plays.
- C2319.2 Deliver formal presentations on technical topics using visual aids.
- C2319.3 Demonstrate effective listening and comprehension skills through audio exercises.
- C2319.4 Practice correct pronunciation, stress, and intonation in spoken English.
- C2319.5 Write effective technical reports and summaries.
- C2319.6 Develop interpersonal skills through mock interviews.

SEMESTER: III

U23MAT31 (C2320) TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2320.1 Understand the formation and solution of first and second-order partial differential equations.
- C2320.2 Compute Fourier series expansion for periodic and non-periodic functions.
- C2320.3 Apply Fourier transforms to solve boundary value problems.
- C2320.4 Solve differential equations using Laplace transforms.
- C2320.5 Analyze discrete-time systems using Z-transforms.
- C2320.6 Apply transform techniques to problems in heat conduction and vibrations.

U23MET31 (C2321) ENGINEERING THERMODYNAMICS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2321.1 Apply the First and Second Laws of Thermodynamics to closed and open systems.
- C2321.2 Analyze the properties of pure substances and steam processes using steam tables and Mollier chart.
- C2321.3 Evaluate the performance of air standard cycles (Otto, Diesel, Dual).
- C2321.4 Understand the properties of ideal and real gases.
- C2321.5 Solve problems related to psychrometry and air conditioning.
- C2321.6 Apply thermodynamic principles to real-time engineering applications.

U23MET32 (C2322) FLUID MECHANICS AND MACHINERY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2322.1 Understand fluid properties and fluid statics including manometry.
- C2322.2 Apply Bernoulli's equation and continuity equation for fluid flow problems.
- C2322.3 Analyze fluid flow through pipes and determine head losses due to friction.
- C2322.4 Perform dimensional analysis and apply similarity laws for model testing.
- C2322.5 Explain the working principle and performance of hydraulic turbines (Pelton, Francis, Kaplan).
- C2322.6 Study the characteristics and performance of centrifugal and reciprocating pumps.

U23MET34 (C2323) ENGINEERING MATERIALS AND METALLURGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2323.1 Classify ferrous and non-ferrous metals and understand their phase diagrams.
- C2323.2 Explain heat treatment processes like annealing, normalizing, hardening, and tempering.
- C2323.3 Analyze the microstructure and properties of steels and cast irons.
- C2323.4 Understand the properties and applications of non-metallic materials (polymers, ceramics, composites).
- C2323.5 Select appropriate materials for specific engineering applications based on properties.
- C2323.6 Explain the fracture behavior and testing methods of engineering materials.

U23MET35 (C2324) MANUFACTURING PROCESSES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2324.1 Classify and explain various casting processes and their defects.
- C2324.2 Describe different metal joining processes like welding, brazing, and soldering.
- C2324.3 Explain metal forming processes such as rolling, forging, extrusion, and drawing.

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| C2324.4 | Describe sheet metal operations and press tools. |
| C2324.5 | Explain the working of conventional machine tools like lathe, shaper, and drilling machine. |
| C2324.6 | Understand the fundamentals of powder metallurgy and plastic processing. |

U23MEP31 (C2325) COMPUTER AIDED MACHINE DRAWING LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

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| C2325.1 | Create orthographic views of machine elements using CAD software. |
| C2325.2 | Prepare detailed drawings of standard machine parts like shafts, keys, and couplings. |
| C2325.3 | Draw assembly drawings of machine elements like bearings, jigs, and fixtures. |
| C2325.4 | Apply geometric dimensioning and tolerancing (GD&T) symbols. |
| C2325.5 | Interpret and create drawings from physical components. |
| C2325.6 | Generate 3D models and 2D drafting sheets as per standards. |

U23MEP32 (C2326) MANUFACTURING TECHNOLOGY LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

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| C2326.1 | Practice various machining operations on a centre lathe. |
| C2326.2 | Perform milling operations for gear cutting and keyway cutting. |
| C2326.3 | Study the tool geometry and cutting parameters in machining. |
| C2326.4 | Demonstrate different casting processes and pattern making. |
| C2326.5 | Perform welding operations (Arc and Gas welding) and inspect welds. |
| C2326.6 | Study the mechanisms and operations of shaper and slotter machines. |

U23GE3361 (C2327) PROFESSIONAL DEVELOPMENT

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2327.1 Identify personal strengths and weaknesses through self-assessment.
- C2327.2 Develop goal-setting strategies for academic and career growth.
- C2327.3 Enhance interpersonal skills and teamwork ability.
- C2327.4 Understand professional ethics and corporate culture.
- C2327.5 Develop leadership and problem-solving skills.
- C2327.6 Prepare a career roadmap and develop resume writing skills.

SEMESTER: IV

U23MET41 (C2328) KINEMATICS OF MACHINERY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2328.1 Classify kinematic pairs, chains, and mechanisms.
- C2328.2 Analyze the displacement, velocity, and acceleration of links in mechanisms.
- C2328.3 Apply graphical methods to determine velocity and acceleration in mechanisms.
- C2328.4 Analyze the motion of cams and followers and design cam profiles.
- C2328.5 Explain the terminology and kinematics of gears (Spur, Helical, Bevel, Worm).
- C2328.6 Analyze friction in machine elements like belt drives, clutches, and brakes.

U23MET42 (C2329) THERMAL ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2329.1 Explain the construction and working of internal combustion engines (SI and CI).
- C2329.2 Calculate the performance parameters of IC engines (indicated power, brake power, efficiency).

- C2329.3 Analyze the flow through nozzles and steam turbines.
- C2329.4 Explain the working principles of reciprocating and rotary air compressors.
- C2329.5 Understand the vapor compression refrigeration cycle and psychrometric processes.
- C2329.6 Compare different refrigerants and their properties.

U23MET43 (C2330) STRENGTH OF MATERIALS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2330.1 Understand the concepts of stress, strain, and elasticity.
- C2330.2 Analyze the shear force and bending moment diagrams for beams.
- C2330.3 Calculate the slope and deflection of beams using double integration and moment area methods.
- C2330.4 Determine principal stresses and strains using Mohr's circle.
- C2330.5 Design shafts, springs, and columns for various loading conditions.
- C2330.6 Analyze thick and thin cylindrical shells under pressure.

U23MET44 (C2331) COMPUTER AIDED DESIGN

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2331.1 Understand the hardware and software requirements of CAD systems.
- C2331.2 Explain the concepts of geometric modeling (wireframe, surface, solid).
- C2331.3 Apply parametric and feature-based modeling techniques.
- C2331.4 Understand the concepts of product data exchange and standards (IGES, STEP).
- C2331.5 Analyze assemblies and perform tolerance stack-up analysis.
- C2331.6 Apply finite element analysis concepts for design verification.

U23MET45 (C2332) MANUFACTURING TECHNOLOGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2332.1 Describe the working principle and operations of drilling, milling, and grinding machines.
- C2332.2 Explain the gear generation methods and gear cutting processes.
- C2332.3 Understand the principles of CNC machines and CNC part programming.
- C2332.4 Explain the concepts of Group Technology (GT) and cellular manufacturing.
- C2332.5 Describe advanced machining processes like ECM, EDM, and USM.
- C2332.6 Select appropriate machining processes for specific engineering applications.

U23GET41 (C2333) ENVIRONMENTAL SCIENCES AND ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2333.1 Define environment and its segments with relevance to engineering.
- C2333.2 Understand the structure and function of ecosystems.
- C2333.3 Analyze the causes, effects, and control of air, water, and soil pollution.
- C2333.4 Explain the impact of population growth and urbanization on the environment.
- C2333.5 Understand the principles of waste management and renewable energy.
- C2333.6 Apply environmental ethics and legislation in engineering projects.

U23MEP41 (C2334) STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2334.1 Perform tension, compression, and shear tests on materials.
- C2334.2 Analyze the deflection of beams using experimental setups.
- C2334.3 Conduct hardness and impact tests on metals.

- C2334.4 Study the performance characteristics of centrifugal pumps.
- C2334.5 Analyze the performance characteristics of Pelton and Francis turbines.
- C2334.6 Verify Bernoulli's theorem and study flow through orifices and venturimeters.

U23MEP42 (C2335) THERMAL ENGINEERING LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2335.1 Conduct performance tests on IC engines (2-stroke and 4-stroke).
- C2335.2 Determine the calorific value of fuels using bomb calorimeters.
- C2335.3 Study the heat balance sheet of engines.
- C2334.4 Conduct tests on reciprocating air compressors.
- C2335.5 Study the performance of refrigeration test rig.
- C2335.6 Analyze the psychrometric properties using air conditioning test rig.

SEMESTER: V

U23MET51 (C2336) DESIGN OF MACHINE ELEMENTS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2336.1 Design shafts, keys, and couplings for power transmission.
- C2336.2 Design permanent and detachable joints (welded, riveted, bolted).
- C2336.3 Design belt, chain, and gear drives for specific applications.
- C2336.4 Design helical, bevel, and worm gears for strength and wear.
- C2336.5 Design springs (helical, leaf) and bearings (journal, ball/roller).
- C2336.6 Apply standards and codes (IS) for machine element design.

U23MET52 (C2337) DYNAMICS OF MACHINES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2337.1 Analyze static and dynamic forces in reciprocating engines.
- C2337.2 Balance rotating masses and multi-cylinder engines.
- C2337.3 Analyze free and forced vibrations of single degree of freedom systems.
- C2337.4 Determine the natural frequency and damping of mechanical systems.
- C2337.5 Analyze the working principles of governors and calculate their sensitivities.
- C2337.6 Understand the gyroscopic effects on planes, ships, and automobiles.

U23MET53 (C2338) METROLOGY AND MEASUREMENTS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2338.1 Understand the concepts of metrology and measurement systems.
- C2338.2 Explain the working principles of linear and angular measuring instruments.
- C2338.3 Analyze the errors in measurements and their calibration.
- C2338.4 Explain the principles of interferometry and laser metrology.
- C2338.5 Describe the working of form and surface roughness measuring instruments.
- C2338.6 Understand the concept of machine vision and coordinate measuring machines (CMM).

U23MEV11 (C2352) DESIGN OF PRESSURE VESSELS (PE - VERTICAL - I)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2352.1 Classify pressure vessels and understand design codes (ASME).
- C2352.2 Design thin cylindrical and spherical shells for internal pressure.

- C2352.3 Design heads and closures for pressure vessels.
- C2352.4 Analyze stresses in thick cylinders and high-pressure vessels.
- C2352.5 Select materials for pressure vessel construction based on corrosion and temperature.
- C2352.6 Design supports for horizontal and vertical pressure vessels.

U23MEV12 (C2353) FAILURE ANALYSIS AND NDT TECHNIQUES (PE - VERTICAL - I)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2353.1 Understand different types of material failure (ductile, brittle, fatigue).
- C2353.2 Analyze the causes of failure using fractography.
- C2353.3 Explain the principles of Non-Destructive Testing (NDT) methods like UT, RT, MT, and PT.
- C2353.4 Select appropriate NDT methods for detecting surface and internal defects.
- C2353.5 Understand the standards for NDT evaluation.
- C2353.6 Perform failure analysis of mechanical components.

U23MEP51 (C2342) METROLOGY AND MEASUREMENTS LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2342.1 Measure linear dimensions using vernier calipers, micrometers, and slip gauges.
- C2342.2 Measure angles using sine bars and optical bevel protractors.
- C2342.3 Measure surface roughness using surface roughness testers.
- C2342.4 Inspect gear parameters using gear tooth vernier calipers.
- C2342.5 Measure temperature, pressure, and force using transducers.
- C2342.6 Calibrate measuring instruments and analyze errors.

U23MEP52 (C2343) DYNAMICS LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2343.1 Determine the moment of inertia using compound pendulum.
- C2343.2 Analyze the undamped and damped free vibrations of spring-mass systems.
- C2343.3 Analyze the forced vibrations of spring-mass systems.
- C2343.4 Study the performance of Porter and Proell governors.
- C2343.5 Balance rotating masses using balancing machine.
- C2343.6 Study the whirling of shafts.

SEMESTER: VI

U23MET61 (C2339) HEAT AND MASS TRANSFER

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2339.1 Apply Fourier's law to solve steady-state heat conduction problems.
- C2339.2 Solve transient heat conduction problems using lumped capacitance method.
- C2339.3 Apply empirical correlations for forced and natural convection heat transfer.
- C2339.4 Analyze heat exchange using LMTD and NTU methods for heat exchangers.
- C2339.5 Apply radiation laws to solve radiative heat transfer problems.
- C2339.6 Apply mass transfer principles to drying and diffusion processes.

U23MET62 (C2340) DESIGN OF TRANSMISSION SYSTEM

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2340.1 Design stepped pulleys, V-belts, and flat belt drives.

- C2340.2 Design chain drives and sprockets.
- C2340.3 Design spur, helical, bevel, and worm gear units.
- C2340.4 Design gear boxes (multi-speed) and their structural elements.
- C2340.5 Design clutches, brakes, and flywheels.
- C2340.6 Select wire ropes, pulleys, and hoists for material handling.

U23GET61 (C2341) HUMAN VALUES AND ETHICS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2341.1 Understand the concept of human values and their importance.
- C2341.2 Relate professional ethics to engineering practice.
- C2341.3 Analyze ethical dilemmas and moral issues in engineering.
- C2341.4 Understand the responsibilities towards society and the environment.
- C2341.5 Understand the rights and safety of workers in an industrial setup.
- C2341.6 Practice integrity and honesty in professional life.

U23RAT42 (C2359) SENSORS AND INSTRUMENTATION (PE - VERTICAL - II)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2359.1 Understand the characteristics of sensors and transducers.
- C2359.2 Select appropriate sensors for measuring temperature, pressure, and displacement.
- C2359.3 Explain the working of piezoelectric, optical, and magnetic sensors.
- C2359.4 Understand signal conditioning circuits for sensors.
- C2359.5 Analyze data acquisition systems and interfacing.
- C2359.6 Apply sensors in industrial automation and robotics.

U23RAT33 (C2360) ELECTRICAL DRIVES AND ACTUATORS (PE - VERTICAL - II)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2360.1 Classify electrical drives and understand their characteristics.
- C2360.2 Explain the operation of DC drives and speed control methods.
- C2360.3 Analyze induction motor drives and speed control techniques.
- C2360.4 Explain the working of stepper motors and servo motors.
- C2360.5 Select appropriate actuators (hydraulic, pneumatic, electric) for applications.
- C2360.6 Understand the protection and cooling of electric drives.

U23MEP61 (C2344) CAD/CAM LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2344.1 Create 3D models and assemblies using advanced CAD software.
- C2344.2 Perform kinematic and dynamic analysis using CAD tools.
- C2344.3 Write manual and computer-assisted part programs for CNC machining.
- C2344.4 Simulate tool paths and verify CNC programs.
- C2344.5 Apply CAM techniques for process planning and manufacturing.
- C2344.6 Understand the integration of CAD and CAM systems.

U23MEP62 (C2345) HEAT TRANSFER LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2345.1 Determine thermal conductivity of insulating materials.
- C2345.2 Study free and forced convection heat transfer.

- C2345.3 Determine the emissivity of a gray surface.
- C2345.4 Study the performance of parallel flow and counter-flow heat exchangers.
- C2345.5 Analyze the heat transfer through extended surfaces (fins).
- C2345.6 Study the performance of a refrigeration test rig.

SEMESTER: VII

U23MET71 (C2346) MECHATRONICS AND IoT

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2346.1 Understand the architecture and scope of mechatronics systems.
- C2346.2 Analyze the characteristics of sensors, actuators, and transducers.
- C2346.3 Explain the working principles of PLCs and pneumatic/hyumatic systems.
- C2346.4 Understand the fundamentals of microcontrollers and interfacing.
- C2346.5 Apply concepts of IoT for industrial monitoring and control.
- C2346.6 Design simple mechatronic systems for automation.

U23MET72 (C2347) COMPUTER INTEGRATED MANUFACTURING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2347.1 Understand the concepts of Computer Aided Process Planning (CAPP).
- C2347.2 Explain the structure and components of Flexible Manufacturing Systems (FMS).
- C2347.3 Understand the application of robots in manufacturing.
- C2347.4 Explain the principles of Group Technology (GT) and coding.
- C2347.5 Understand Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP).
- C2347.6 Apply quality control techniques and automated inspection in CIM.

U23MET73 (C2348) POWER PLANT ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2348.1 Explain the layout and working of thermal power plants.
- C2348.2 Analyze the performance of steam turbines and condensers.
- C2348.3 Understand the working of diesel and gas turbine power plants.
- C2348.4 Explain the principles of nuclear power generation and types of reactors.
- C2348.5 Describe the working of hydroelectric and pumped storage power plants.
- C2348.6 Understand the environmental and safety aspects of power plants.

U23MEV24 (C2362) MODELING AND CONTROL OF ROBOT (PE - VERTICAL - II)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2362.1 Understand the spatial descriptions and transformations in robotics.
- C2362.2 Perform forward and inverse kinematic analysis of robot manipulators.
- C2362.3 Analyze the dynamics of robot manipulators using Lagrange-Euler formulation.
- C2362.4 Design control systems for robotic manipulators.
- C2362.5 Explain trajectory planning and motion control.
- C2362.6 Analyze the dynamics of mobile robots.

U23MEV41 (C2373) INTRODUCTION TO PRODUCT DESIGN (PE - VERTICAL - IV)

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2373.1 Understand the product design process and methodology.

- C2373.2 Apply creativity techniques for concept generation.
- C2373.3 Evaluate design concepts using decision matrices.
- C2373.4 Apply principles of Design for Manufacturing (DFM) and Assembly (DFA).
- C2373.5 Understand the importance of ergonomics and aesthetics in product design.
- C2373.6 Document the product development process.

U23MEP71 (C2346) MECHATRONICS AND IoT LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2346.1 Program microcontrollers for mechatronic applications.
- C2346.2 Interfacing sensors and actuators with microcontrollers.
- C2346.3 Design and simulate pneumatic and hydraulic circuits.
- C2346.4 Program PLCs for industrial automation tasks.
- C2346.5 Implement IoT protocols for data acquisition.
- C2346.6 Design simple control systems for robotics.

U23MEP72 (C2347) SIMULATION AND ANALYSIS LABORATORY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2347.1 Apply Finite Element Method (FEM) to solve structural problems.
- C2347.2 Perform modal analysis to determine natural frequencies.
- C2347.3 Analyze thermal stress and heat transfer using FEM.
- C2347.4 Simulate and optimize structural components for strength.
- C2347.5 Perform computational fluid dynamics (CFD) analysis.
- C2347.6 Interpret simulation results and validate them.

SEMESTER: VIII

U23MET81 (C2349) PRODUCTION PLANNING AND CONTROL

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2349.1 Understand the objectives and functions of production planning.
- C2349.2 Explain product and process planning.
- C2349.3 Apply aggregate planning strategies.
- C2349.4 Develop production scheduling using different techniques (Gantt, MRP).
- C2349.5 Understand line balancing and batch balancing.
- C2349.6 Apply Just-In-Time (JIT) and Lean manufacturing principles.

U23GET76 (C2350) INDUSTRIAL MANAGEMENT

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2350.1 Understand the principles of management and organization structure.
- C2350.2 Analyze personnel management and human resource development.
- C2350.3 Explain financial management, cost accounting, and depreciation.
- C2350.4 Understand marketing concepts and sales forecasting.
- C2350.5 Apply principles of project management (PERT/CPM).
- C2350.6 Analyze project feasibility and investment appraisal.

U23MEP81 (C2351) PROJECT WORK

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2351.1 Identify a real-time engineering problem and define objectives.
- C2351.2 Conduct literature review and gather information.
- C2351.3 Design and develop a solution/prototype for the problem.
- C2351.4 Analyze the results and validate the solution.
- C2351.5 Prepare a comprehensive technical report.
- C2351.6 Present the project work effectively to a panel.

PROFESSIONAL ELECTIVES - VERTICAL - I (PROCESS EQUIPMENT AND PIPING DESIGN)

U23MEV13 (C2354) MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2354.1 Select appropriate material handling equipment for bulk materials.
- C2354.2 Design conveyors, elevators, and hoppers.
- C2354.3 Understand the principles of solid-solid separation and size reduction.
- C2354.4 Design mixers and agitators for solid processing.
- C2354.5 Analyze flow characteristics of bulk solids.
- C2354.6 Select equipment for drying and filtration.

U23MEV14 (C2355) ROTATING MACHINERY DESIGN

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2355.1 Analyze the loads and stresses in rotating machinery.
- C2355.2 Design rotors and shafts for high-speed applications.
- C2355.3 Design bearings and seals for rotating equipment.
- C2355.4 Analyze vibration and critical speeds of rotors.

- C2355.5 Design couplings and flywheels.
- C2355.6 Understand API standards for rotating machinery.

U23MEV15 (C2356) THERMAL AND FIRED EQUIPMENT DESIGN

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2356.1 Design heat exchangers (shell and tube, air cooled).
- C2356.2 Design fired heaters and boilers.
- C2356.3 Analyze thermal stresses in heat transfer equipment.
- C2356.4 Select refractory and insulation materials.
- C2356.5 Design thermosiphon reboilers.
- C2356.6 Understand the design aspects of fired heaters in refineries.

U23MEV16 (C2357) INDUSTRIAL LAYOUT DESIGN AND SAFETY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2357.1 Principles of plant layout and material flow.
- C2357.2 Design efficient process layouts.
- C2357.3 Understand safety regulations and hazard analysis (HAZOP).
- C2357.4 Design fire safety systems and emergency planning.
- C2357.5 Apply ergonomics in industrial layout.
- C2357.6 Understand OSHA and environmental safety standards.

U23MEV17 (C2358) DESIGN CODES AND STANDARDS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2358.1 Understand the need and application of design codes (ASME, IS).
- C2358.2 Interpret the rules for pressure vessel design.
- C2358.3 Select appropriate materials based on code specifications.
- C2358.4 Apply stress analysis methods according to codes.
- C2358.5 Understand fabrication and inspection codes.
- C2358.6 Apply design codes for piping and pipeline systems.

PROFESSIONAL ELECTIVES - VERTICAL - II (ROBOTICS AND AUTOMATION)

U23RAV33 (C2363) SMART MOBILITY AND INTELLIGENT VEHICLES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2363.1 Understand the architecture of intelligent vehicles.
- C2363.2 Explain the working of Advanced Driver Assistance Systems (ADAS).
- C2363.3 Analyze vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication.
- C2363.4 Apply navigation systems and GPS in vehicles.
- C2363.5 Understand the principles of autonomous driving.
- C2363.6 Analyze the ethical and safety issues in smart mobility.

U23MEV26 (C2364) HAPTICS AND IMMERSIVE TECHNOLOGIES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2364.1 Understand the principles of haptics and touch feedback.
- C2364.2 Design haptic interfaces for virtual environments.
- C2364.3 Analyze human perception in immersive technologies.

- C2364.4 Apply haptics in medical simulation and robotics.
- C2364.5 Understand VR and AR integration with haptics.
- C2364.6 Design immersive interfaces for engineering applications.

U23RAV12 (C2365) DRONE TECHNOLOGIES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2365.1 Understand the aerodynamics of multi-rotor and fixed-wing drones.
- C2365.2 Explain the working of flight controllers and propulsion systems.
- C2365.3 Analyze the stability and control of drones.
- C2365.4 Apply drone navigation and path planning algorithms.
- C2365.5 Understand the regulations and ethical use of drones.
- C2365.6 Select drones for specific applications (photography, survey, delivery).

PROFESSIONAL ELECTIVES - VERTICAL - III (CLEAN AND GREEN ENERGY TECHNOLOGIES)

U23MEV31 (C2366) BIO ENERGY CONVERSION TECHNOLOGIES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2366.1 Understand the types and sources of biomass.
- C2366.2 Explain thermochemical conversion processes (combustion, pyrolysis, gasification).
- C2366.3 Explain biochemical conversion processes (anaerobic digestion, fermentation).
- C2366.4 Design biogas plants and biodigesters.
- C2366.5 Analyze the economics of bioenergy production.
- C2366.6 Understand the environmental impact of bioenergy systems.

U23MEV32 (C2367) CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- | | |
|---------|--|
| C2367.1 | Define carbon footprint and understand its significance. |
| C2367.2 | Estimate carbon footprint for products and organizations. |
| C2367.3 | Apply carbon accounting methodologies. |
| C2367.4 | Analyze strategies for carbon reduction (energy efficiency, renewable energy). |
| C2367.5 | Understand carbon trading and carbon credits. |
| C2367.6 | Design low-carbon processes and products. |

U23MEV33 (C2368) ENERGY CONSERVATION IN INDUSTRIES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- | | |
|---------|--|
| C2368.1 | Identify energy wastage in industrial systems. |
| C2368.2 | Apply energy conservation measures in thermal systems. |
| C2368.3 | Apply energy conservation measures in electrical systems. |
| C2368.4 | Conduct energy audits. |
| C2368.5 | Understand Energy Management Systems (ISO 50001). |
| C2368.6 | Analyze financial feasibility of energy conservation projects. |

U23CEV67 (C2369) ENERGY EFFICIENT BUILDINGS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- | | |
|---------|--|
| C2369.1 | Understand the principles of passive and active building design. |
| C2369.2 | Analyze heat transfer through building envelopes. |

- C2369.3 Select energy-efficient lighting and HVAC systems.
- C2369.4 Apply renewable energy integration in buildings (solar, wind).
- C2369.5 Understand building energy rating systems (LEED, GRIHA).
- C2369.6 Design energy-efficient building concepts.

U23MEV35 (C2370) ENERGY STORAGE DEVICES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2370.1 Understand the principles of energy storage.
- C2370.2 Analyze different types of batteries (Li-ion, Lead-acid, Flow batteries).
- C2370.3 Explain the working of supercapacitors and fuel cells.
- C2370.4 Design battery management systems.
- C2370.5 Analyze thermal management of storage systems.
- C2370.6 Select appropriate storage devices for specific applications (grid, EV).

U23MEV36 (C2371) RENEWABLE ENERGY TECHNOLOGIES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2371.1 Understand the principles of solar energy conversion (PV and Thermal).
- C2371.2 Analyze wind energy conversion systems and site selection.
- C2371.3 Explain the working principles of biomass and geothermal energy.
- C2371.4 Design renewable energy systems for off-grid and hybrid applications.
- C2371.5 Understand the integration of renewable energy into the grid.
- C2371.6 Analyze the environmental impact of renewable technologies.

U23MEV37 (C2372) EQUIPMENT FOR POLLUTION CONTROL

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2372.1 Identify sources of air pollution and design control equipment (scrubbers, ESP, filters).
- C2372.2 Identify sources of water pollution and design treatment systems.
- C2372.3 Design noise control equipment and enclosures.
- C2372.4 Understand solid waste management equipment.
- C2372.5 Apply process modifications to reduce pollution at source.
- C2372.6 Understand environmental regulations and standards.

PROFESSIONAL ELECTIVES - VERTICAL - IV (3D PRINTING)

U23MEV42 (C2374) ADDITIVE MANUFACTURING PROCESSES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2374.1 Classify additive manufacturing processes and understand their scope.
- C2374.2 Explain the working of FDM, SLA, SLS, and DMLS processes.
- C2374.3 Understand material compatibility (polymers, metals, ceramics).
- C2374.4 Analyze the influence of process parameters on part quality.
- C2374.5 Compare additive manufacturing with subtractive manufacturing.
- C2374.6 Select appropriate AM process for a given application.

U23MEV43 (C2375) DESIGN FOR ADDITIVE MANUFACTURING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2375.1 Understand the design principles for additive manufacturing.

- C2375.2 Apply topology optimization for AM design.
- C2375.3 Design lattice structures and internal channels.
- C2375.4 Analyze support structure requirements.
- C2375.5 Convert 3D models to STL and AM format.
- C2375.6 Solve design issues specific to AM (warping, residual stress).

U23MEO12 (C2376) REVERSE ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2376.1 Understand the principles and workflow of reverse engineering.
- C2376.2 Apply non-contact scanning methods (3D scanners).
- C2376.3 Apply contact measurement methods (CMM) for digitization.
- C2376.4 Process point cloud data to generate CAD models.
- C2376.5 Analyze the functionality of existing components.
- C2376.6 Apply reverse engineering for product improvement and redesign.

U23MEV45 (C2377) BUSINESS VALUE ENHANCEMENT WITH ADDITIVE MANUFACTURING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2377.1 Analyze the cost-benefit of additive manufacturing over traditional methods.
- C2377.2 Understand the impact of AM on supply chain and inventory.
- C2377.3 Apply AM for rapid prototyping and product development.
- C2377.4 Understand business models for AM service providers.
- C2377.5 Analyze case studies of successful AM implementation in industry.
- C2377.6 Identify market opportunities for AM products.

U23MEV46 (C2378) LITHOGRAPHIC PROCESS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2378.1 Understand the principles of lithography (optical, electron-beam).
- C2378.2 Explain the photolithography process steps in MEMS fabrication.
- C2378.3 Analyze the role of resists and etchants in lithography.
- C2378.4 Understand alignment and exposure systems.
- C2378.5 Apply lithography for printing circuit boards.
- C2378.6 Understand the limitations and defects in lithography.

U23MEV47 (C2379) PRINTING TECHNOLOGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2379.1 Understand the basics of screen printing and flexography.
- C2379.2 Explain the working principles of inkjet and 3D printing.
- C2379.3 Analyze the properties of printing inks and substrates.
- C2379.4 Apply printing technology for electronics (printed electronics).
- C2379.5 Understand color management and printing quality.
- C2379.6 Compare different printing technologies for industrial applications.

PROFESSIONAL ELECTIVES - VERTICAL - V (DIVERSIFIED COURSES GROUP)

U23MEV51 (C2380) AUTOMOBILE ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2380.1 Understand the layout and construction of automobile chassis.
- C2380.2 Explain the working of clutches, gearboxes, and transmission systems.
- C2380.3 Explain the working principles of steering and suspension systems.
- C2380.4 Analyze the performance of braking systems.
- C2380.5 Understand the working of electrical and electronic systems in cars.
- C2380.6 Analyze the trends in electric and hybrid vehicle technology.

U23MEV52 (C2381) MEASUREMENTS AND CONTROLS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2381.1 Understand the general measurement system configuration.
- C2381.2 Analyze static and dynamic characteristics of instruments.
- C2381.3 Explain the working of sensors for mechanical quantities.
- C2381.4 Understand the principles of feedback control systems.
- C2381.5 Apply transfer function modeling for control systems.
- C2381.6 Analyze stability of control systems using root locus and Bode plots.

U23MEV53 (C2382) NON-TRADITIONAL MACHINING PROCESSES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2382.1 Classify non-traditional machining processes based on energy type.
- C2382.2 Explain the working principle of Mechanical processes (USM, AJM, WJM).
- C2382.3 Explain the working principle of Electrical processes (EDM, ECM).
- C2382.4 Explain the working principle of Thermal processes (LBM, PAM, EBM).
- C2382.5 Explain the working principle of Chemical and Electrochemical processes.
- C2382.6 Select appropriate NTM process for specific materials and geometries.

U23MEV54 (C2383) COMPOSITE MATERIALS AND MECHANICS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2383.1 Understand the classification and characteristics of composite materials.
- C2383.2 Analyze the mechanics of a single lamina.
- C2383.3 Analyze the mechanics of laminates (Classical Lamination Theory).
- C2383.4 Understand the fabrication methods of composites.
- C2383.5 Analyze the failure theories of composite materials.
- C2383.6 Select composites for specific engineering applications.

U23MEV55 (C2384) GAS DYNAMICS AND JET PROPULSION

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2384.1 Understand the fundamentals of compressible flow.
- C2384.2 Analyze flow through variable area ducts and nozzles.
- C2384.3 Analyze normal and oblique shocks.
- C2384.4 Explain the working of Fanno and Rayleigh flows.
- C2384.5 Explain the working principles of jet engines (Turbojet, Turbofan, Ramjet).
- C2384.6 Analyze the performance and efficiency of rocket engines.

U23MEV56 (C2385) HYDRAULICS AND PNEUMATICS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2385.1 Understand the properties of hydraulic and pneumatic fluids.

- C2385.2 Explain the working of hydraulic pumps and compressors.
- C2385.3 Design hydraulic and pneumatic circuits for control systems.
- C2385.4 Explain the working of control valves and actuators.
- C2385.5 Apply hydraulic and pneumatic systems in automation.
- C2385.6 Analyze the performance and maintenance of fluid power systems.

U23MEV57 (C2386) REFRIGERATION AND AIR CONDITIONING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2386.1 Understand the principles of refrigeration cycles (VCR, VAS).
- C2386.2 Explain the construction and working of refrigeration system components.
- C2386.3 Explain the working of air conditioning systems (window, split, central).
- C2386.4 Analyze psychrometric processes for cooling and dehumidification.
- C2386.5 Design duct systems for air conditioning.
- C2386.6 Understand cooling load calculations and estimation.

PROFESSIONAL ELECTIVES - VERTICAL - VI (MODERN MOBILITY SYSTEMS)

U23MEV61 (C2387) AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2387.1 Understand material requirements for automotive applications.
- C2387.2 Analyze the design of chassis and body components.
- C2387.3 Understand the design of automotive powertrain components.
- C2387.4 Apply testing methods for durability and crashworthiness.
- C2387.5 Understand NVH (Noise, Vibration, and Harshness) analysis.

C2387.6 Select materials based on lightweighting and performance.

U23MEV62 (C2388) CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2388.1 Explain the technologies in conventional internal combustion engines.
- C2388.2 Compare fuel systems (MPFI, CRDI).
- C2388.3 Understand the architecture of Battery Electric Vehicles (BEV) and Fuel Cell Vehicles (FCV).
- C2388.4 Analyze powertrain topologies for hybrid vehicles (HEV, PHEV).
- C2388.5 Explain the trends in connected and autonomous vehicles.
- C2388.6 Compare the performance of conventional vs futuristic vehicles.

U23MEV63 (C2389) RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2389.1 Understand the emission formation mechanisms in engines.
- C2389.2 Explain the working of emission control devices (catalytic converters, DPF, SCR).
- C2389.3 Analyze alternative fuels (Hydrogen, Biofuels) for off-highway vehicles.
- C2389.4 Understand the design of electric propulsion for agricultural and construction machinery.
- C2389.5 Analyze the impact of regulations (Bharat Stage, Euro) on vehicle design.
- C2389.6 Apply emission reduction strategies.

U23MEV64 (C2390) VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2390.1 Apply diagnostic tools for vehicle troubleshooting.
- C2390.2 Understand predictive maintenance using sensors and data analysis.
- C2390.3 Analyze active and passive safety systems (Airbags, ABS, ESC).
- C2390.4 Understand the role of telematics in vehicle monitoring.
- C2390.5 Apply reliability engineering in vehicle systems.
- C2390.6 Design maintenance schedules and strategies.

U23MEV65 (C2391) CAE AND CFD APPROACH IN FUTURE MOBILITY

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

- C2391.1 Apply Finite Element Analysis (FEA) for structural analysis of vehicle components.
- C2392.2 Apply Computational Fluid Dynamics (CFD) for aerodynamic analysis.
- C2391.3 Simulate crash analysis for safety evaluation.
- C2391.4 Analyze thermal management systems using CAE tools.
- C2391.5 Understand Multi-body dynamics (MBD) simulation for suspension systems.
- C2391.6 Validate simulation results with physical testing.

U23MEV66 (C2392) HYBRID AND ELECTRIC VEHICLE TECHNOLOGY

COURSE OUTCOMES:

Course Code	Course Outcomes
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Upon completion of the course, the students will be able to:

- C2392.1 Classify EV architectures (Series, Parallel, Series-Parallel).
- C2392.2 Explain the working of electric motors and controllers.
- C2392.3 Analyze battery technologies and management systems (BMS).
- C2392.4 Understand on-board chargers and power electronics.
- C2392.5 Analyze regenerative braking systems.

C2392.6 Understand the charging infrastructure standards.

U23MEV67 (C2393) THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2393.1 Understand the thermal characteristics of Li-ion batteries and Fuel Cells.
- C2393.2 Design air-cooling systems for battery packs.
- C2393.3 Design liquid-cooling systems for battery packs.
- C2393.4 Analyze thermal management strategies for fuel cell stacks.
- C2393.5 Understand Phase Change Materials (PCM) for thermal control.
- C2393.6 Solve thermal runaway issues in battery packs.

OPEN ELECTIVES - I

U23MEO11 (C2394) APPLIED DESIGN THINKING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2394.1 Apply the design thinking process (Empathize, Define, Ideate, Prototype, Test).
- C2394.2 Develop empathy with users to identify real problems.
- C2394.3 Generate innovative ideas using brainstorming and ideation techniques.
- C2394.4 Create low-fidelity and high-fidelity prototypes.
- C2394.5 Test prototypes with users and iterate based on feedback.
- C2394.6 Solve complex problems using a human-centered approach.

U23MEO13 (C2395) QUALITY ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2395.1 Understand the principles of Total Quality Management (TQM).
- C2395.2 Apply seven basic tools of quality.
- C2395.3 Apply Statistical Process Control (SPC) using control charts.
- C2395.4 Design and implement Process Capability (C_p , C_{pk}) studies.
- C2395.5 Understand Taguchi methods for robust design.
- C2395.6 Apply Six Sigma concepts for process improvement.

U23MEO14 (C2396) FUNCTIONAL MATERIALS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2396.1 Understand the structure-property relationship of functional materials.
- C2396.2 Analyze the properties of smart materials (Piezoelectric, Shape memory).
- C2396.3 Explain the working of functional ceramics and polymers.
- C2396.4 Understand the properties of nanostructured materials.
- C2396.5 Select functional materials for sensors and actuators.
- C2396.6 Analyze the applications of biomaterials.

U23MEO15 (C2397) FIRE SAFETY ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2397.1 Understand the physics of combustion and fire dynamics.
- C2397.2 Analyze fire risks and hazards in buildings and industries.
- C2397.3 Apply active fire protection systems (sprinklers, alarms).
- C2397.4 Apply passive fire protection systems (firewalls, fire stops).

- C2397.5 Understand the principles of evacuation and egress design.
- C2397.6 Apply fire safety codes and regulations.

OPEN ELECTIVES - II

U23MEO21 (C2398) INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2398.1 Understand the fundamentals of industrial design and aesthetics.
- C2398.2 Apply ergonomics in product design.
- C2398.3 Develop concepts for product styling and detailing.
- C2398.4 Understand various rapid prototyping technologies (3D printing).
- C2398.5 Create physical prototypes using rapid prototyping methods.
- C2398.6 Evaluate prototypes for form, fit, and function.

U23MEO22 (C2399) MICRO AND PRECISION ENGINEERING

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2399.1 Understand the principles of micro-manufacturing.
- C2399.2 Explain MEMS fabrication techniques (micromachining).
- C2399.3 Analyze precision machining processes (diamond turning, grinding).
- C2399.4 Understand the metrology requirements for micro and precision components.
- C2399.5 Apply micro-forming and micro-molding techniques.
- C2399.6 Select applications for precision engineering in optics and electronics.

U23MEO23 (C2400) ENERGY CONSERVATION AND MANAGEMENT

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2400.1 Understand the global and national energy scenario.
- C2400.2 Conduct energy audits for domestic and industrial sectors.
- C2400.3 Apply energy efficiency measures in electrical systems.
- C2400.4 Apply energy efficiency measures in thermal systems.
- C2400.5 Understand financial analysis of energy conservation projects.
- C2400.6 Understand energy policy and legal frameworks.

U23MEO24 (C2401) NANOMATERIALS AND APPLICATIONS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2401.1 Understand the unique properties of nanomaterials (quantum effect, surface area).
- C2401.2 Explain synthesis methods for nanoparticles and nanotubes.
- C2401.3 Characterize nanomaterials using SEM, TEM, XRD.
- C2401.4 Analyze applications of nanomaterials in medicine (drug delivery).
- C2401.5 Analyze applications of nanomaterials in energy (solar cells, batteries).
- C2401.6 Understand the environmental and safety issues of nanomaterials.

U23RAO11 (C2402) INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS

COURSE OUTCOMES:

Course Code Course Outcomes

Upon completion of the course, the students will be able to:

- C2402.1 Classify industrial robots based on geometry and drive systems.
- C2402.2 Explain robot drive systems and end effectors.
- C2402.3 Analyze forward and inverse kinematics.

- C2402.4 Understand robot sensors and machine vision.
- C2402.5 Select robots for specific material handling tasks.
- C2402.6 Program robots for pick and place and palletizing operations.