SR UNIVERSITY
Department of Mechanical Engineering
R25 Course Structure

I SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC104PC101	Graphics Design and Modeling	1	0	4	3
2	25MEC104ES104	Product Design Studio	1	0	4	3
3	25EEE312ES103	Electrical and Electronics Engineering	3	1	2	4.5
4	25MAT310BS107	Calculus and Differential Equations	3	1	0	3.5
5	25SCI312BS105	Applied Physics and Chemistry for Mechanical Engineering	3	1	2	4.5
		Total	**11**	**3**	**12**	**18.5**
II SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC310PC102	Mechanics for Engineers	3	1	0	3.5
2	25ECE104ES102	Smart Product Design	1	0	4	3
3	25MAT310BS108	Linear Algebra and Numerical Methods	3	1	0	3.5
4	25HUM204HS101	Life Skills: Enterpreneurship, Language, Communication, and Personality	2	0	4	4
5	25SCI202BS106	Computational Chemistry and Biology	2	0	2	3
6	25HUM300HS102	Ancient Knowledge and Constitution of India	3	0	0	3
		Hobbies, Co-Curricular and Extra-Curricular Elective	0	0	2	1
		Total	**14**	**2**	**12**	**21**
III SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC310PC201	Thermodynamics	3	1	0	3.5
2	25MEC312PC202	Mechanics of Solids	3	1	2	4.5
3	25MEC302PC203	Material Science Engineering	3	0	2	4
4	25MEC300PC204	Machines and Mechanisms	3	0	0	3
5	25CAI214ES210	Problem Solving Using Python	2	1	4	4.5
6	25MEC302PC205	Manufacturing Technology	3	0	2	4
		Total	**17**	**3**	**10**	**23.5**
IV SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC302PC206	Fluid Mechanics	3	0	2	4
2	25MEC302PC207	Applied Thermodynamics	3	0	2	4
3		Program Elective - I	2	0	2	3
4		Specialization Core - I	3	0	2	4
5	25MEC302PC208	Additive Manufacturing	3	0	2	4
6		Open Elective - I	3	0	0	3
7	25MAT310BS109	Probability and Statistics	3	1	0	3.5
		Total	**20**	**1**	**10**	**25.5**

V SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC302PC301	Machine Tools and Metrology	3	0	2	4
2	25MEC310PC302	Machine Design	3	1	0	3.5
3	25HUM006HS202	Quantitative Aptitude and Logical Reasoning	0	0	6	3
4	25MEC302ES301	AI for Mechanical Engineering	3	0	2	4
5	25CIV200HS301	Sustainability and Ethical Innovation	2	0	0	2
6	25MEC002PR301	Undergraduate Research in Mechanical Engineering	0	0	2	1
7		Specialization Core - II	3	0	2	4
		Total	**14**	**1**	**14**	**21.5**
VI SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC300PC303	Design of Power Transmission Elements	3	0	0	3
2	25MEC006PC304	CAD-CAM	0	0	6	3
3	25MEC204PC305	Finite Element Method	2	0	4	4
4	25HUM104HS201	Critical Thinking and Interpersonal Skills	1	0	4	3
5	25MEC302PC306	Heat Transfer	3	0	2	4
6		Specialization Elective - I	2	0	2	3
		Total	**11**	**0**	**18**	**20**
VII SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1		Open Elective - II	2	0	2	3
2		Program Elective - II	2	0	2	3
3		Program Elective - III	2	0	2	3
4		Program Elective - IV	2	0	2	3
5		Specialization Elective - II	2	0	2	3
6	25MEC010PR401	Capstone Project	0	0	10	5
		Total	**10**	**0**	**20**	**20**
		Or				
1	25MEC040PR402	Industrial Project/ R&D Project/ Industry Internship/Start-up/Externship	0	0	40	20
		Total	**0**	**0**	**40**	**20**
VIII SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC040PR403	Major Project/Industrial Project/ R&D Project/ Industry Internship/Start-up/Externship	0	0	40	20
		Total	**0**	**0**	**40**	**20**
		Total Credits	**170**			

Program Electives						
Program Elective - I						
1	25MEC202PE401	Production and Operations Management	2	0	2	3
2	25MEC202PE402	Mechanical Vibrations	2	0	2	3
Program Elective - II						
1	25MEC202PE403	Production Planning and Control	2	0	2	3
2	25MEC300PE404	Refrigeration and Air Conditioning	3	0	0	3
Program Elective - III						
1	25MEC202PE405	Factory Automation	2	0	2	3
2	25MEC300PE406	Power Plant Engineering	3	0	0	3
Program Elective - IV						
1	25MEC202PE407	Unconventional Machining Process	2	0	2	3
2	25MEC202PE408	Computational Fluid Dynamics	2	0	2	3
Smart Manufacturing Specialization Core						
Specialization Core						
1	25MEC302SC201	Smart Manufacturing	3	0	2	4
2	25MEC302SC301	Digital Manufacturing System Design	3	0	2	4
Specialization Elective - I (Smart Manufacturing)						
1	25MEC202SE301	Industrial IoT	2	0	2	3
2	25MEC202SE302	Smart Materials	2	0	2	3
Specialization Elective - II (Smart Manufacturing)						
1	25MEC202SE401	Data Analytics in Manufacturing	2	0	2	3
2	25MEC202SE402	Advanced Digital Technology in Manufacturing	2	0	2	3
Robotics and Automation Specialization						
Specialization Core						
1	25MEC302SC202	Robotics and Automation	3	0	2	4
2	25MEC302SC302	Robotic System Design	3	0	2	4
Specialization Elective - I (Robotics and Automation)						
1	25MEC300SE303	Sensors and Control for Robotics	3	0	0	3
2	25MEC300SE304	AI in Robotics	3	0	0	3
Specialization Elective - II (Robotics and Automation)						
1	25MEC300SE403	Robotics Operating System	3	0	0	3
2	25MEC300SE404	Machine Vision and Safety	3	0	0	3
Courses for Honors in Mechanical Engineering						
Semester - III						
1	25MEC302HN401	Advanced Solid Mechanics	3	0	2	4
Semester - IV						
2	25MEC302HN402	Precision Manufacturing	3	0	2	4
Semester - V						
3	25MEC302HN403	Advanced Heat and Mass Transfer	3	0	2	4
Semester - VI						
4	25MEC302HN404	Sustainable Manufacturing	3	0	2	4

Courses for Minors in Smart Manufacturing						
Semester III						
1	25MEC302MN401	Introduction to Digital Manufacturing and Design	3	0	2	4
Semester IV						
2	25MEC302MN402	Foundations of Smart Manufacturing	3	0	2	4
Semester V						
3	25MEC302MN403	3D Printing	3	0	2	4
Semester VI						
4	25MEC302MN404	Mechatronics	3	0	2	4

Hobbies, Co-Curricular and Extra-Curricular (HCE) Electives							
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**	
1	25HUM002AU401	Community Engagement and Social Responsibility through NSS	0	0	2	1	
2	25HUM002AU402	Leadership and Collaboration through Student Clubs	0	0	2	1	
3	25HUM002AU403	Physical Education and Sports for Holistic Development	0	0	2	1	
4	25HUM002AU404	Experiential Learning through Internships	0	0	2	1	
5	25HUM002AU405	Skill Enrichment and Creativity through Hobby Activities	0	0	2	1	
6	25HUM002AU406	Visual Storytelling and Documentation through Photography	0	0	2	1	
7	25HUM002AU407	Skill Acceleration and Applied Learning through Boot Camps	0	0	2	1	
8	25HUM002AU408	Indian Classical Music	0	0	2	1	
9	25HUM002AU409	Classical and Folk Dance Traditions of India	0	0	2	1	
10	25HUM002AU410	Traditional Indian Culinary Practices	0	0	2	1	
In Special Cases Open Electives, Program Electives, Specialization Electives may be considered							
Minor Courses offered by NEST							
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**	
1	25BUS400MN401	Startup Garage	4	0	0	4	
2	25BUS400MN402	Startup Launch and Business Operation	4	0	0	4	
3	25BUS400MN403	Digital Marketing Strategy	4	0	0	4	
4	25BUS400MN404	Growth Hacking	4	0	0	4	
Open Electives							
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**	
1	25CAI202OE401	Fundamentals of Database Management Systems	2	0	2	3	CSE
2	25CAI202OE402	Fundamentals of Data Structures	2	0	2	3	
3	25CAI202OE403	Analysis and Design of Algorithms	2	0	2	3	
4	25ECE300OE404	Principles of Communication	3	0	0	3	ECE
5	25ECE300OE405	Sensors and Transducers	3	0	0	3	
6	25ECE300OE406	Design for Social Impact	3	0	0	3	
7	25EEE300OE407	Introduction to Electric Vehicle Technologies	3	0	0	3	EEE
8	25EEE202OE408	Introduction to PLC Programming	2	0	2	3	
9	25MEC300OE409	Operations Research	3	0	0	3	ME
10	25MEC300OE410	3D Printing	3	0	0	3	
11	25MEC300OE411	Renewable Energy Resources	3	0	0	3	
12	25MEC104OE412	Workshop Practices	1	0	4	3	
13	25CIV300OE413	Disaster Management	3	0	0	3	CE
14	25CIV300OE414	Pollution and Control Engineering	3	0	0	3	
15	25CIV300OE415	Smart Cities	3	0	0	3	
16	25BUS300OE416	Digital Marketing	3	0	0	3	SoB
17	25BUS300OE417	Startup Launch and Ecosystems	3	0	0	3	
18	25BUS300OE418	Finance for Engineers	3	0	0	3	
19	25SCI202OE419	Space Physics	2	0	2	3	Bi Sc

20	25SCI202OE420	Nanomaterials and Technology	2	0	2	3	Basic Science
21	25SCI202OE421	AI for Drug Discovery	2	0	2	3	
22	25MAT300OE422	Integral Transforms and Partial Differential Equations	3	0	0	3	Math
23	25MAT300OE423	Optimization Techniques	3	0	0	3	
24	25HUM202OE424	LSRW Language Skills	2	0	2	3	English
25	25HUM300OE425	Learning How to Learn	3	0	0	3	
26	25HUM300OE426	German for Professionals	3	0	0	3	
27	25HUM300OE427	Japanese Language and Culture	3	0	0	3	
28	25HUM300OE428	Spanish for Global Work Place	3	0	0	3	
29	25NCC300OE429	NCC Foundation course	3	0	0	3	NCC
30	25NCC300OE430	NCC Basic course	3	0	0	3	
31	25NCC300OE431	NCC Advanced Course	3	0	0	3	
32	25AGR300OE432	Food Safety and Quality Management from Farm to Fork	3	0	0	3	AGRI
33	25AGR300OE433	Socio-Economic Transformations in Indian	3	0	0	3	
34	25AGR300OE434	Smart Farming Technologies for Doubling the	3	0	0	3	
35	25AGR300OE435	Sky Farming and Urban Horticulture Systems	3	0	0	3	

Flexible Courses for Open Electives and Professional Electives

S.No.	Course Code	Course	L	R	P	C
1	25HUM202CR401	Industry Certification	2	0	2	3
2	25HUM300CR402	Professional Skill Development	3	0	0	3
3	25HUM300CR403	Self-Paced Learning	3	0	0	3

In Special Cases Open Electives may be considered as Program Electives

In Special Cases Program Electives may be considered as Open Electives

In Special Cases Program Electives may be considered as Specialization Electives

In Special Cases Specialization Electives may be considered as Program Electives

In Special Cases Specialization Electives may be considered as Open Electives

In Special Cases Open Electives may be considered as Specialization Electives

In Special Cases Open Electives may be considered as LHS Electives

In Special Cases LHS Electives may be considered as Open Electives

Assistant Dean Academics
ME, SR University

HOD
ME, SR University

RECITATION
NA

TEXTBOOKS

1. **A. K. Sarathe**, *Engineering Workshop Practice | AICTE Prescribed Textbook – English*, **Khanna Book Publishing Co. Pvt. Ltd.**, **2021**.
2. **Er. R. K. Jain**, *Workshop Technology (as per AICTE Curriculum Diploma)*, **Khanna Publishers**, **2023**.

REFERENCE BOOKS

1. **C. P. Paul; A. N. Jinoop**, *Additive Manufacturing*, **McGraw Hill Education (India)**, **2021**.
2. **Hans Bernhard Kief; Helmut A. Roschiwal; Karsten Schwarz**, *The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0*, **Industrial Press**, **2021**.

USEFUL LINKS

1. https://www.osha.gov/welding-cutting-brazing?utm_source=chatgpt.com
2. https://nptel.ac.in/courses/112107219?utm
3. https://onlinecourses.nptel.ac.in/noc22_me122/preview?utm

(25MEC104OE412) WORKSHOP PRACTICES			L	R	P	C
			1	0	4	3
Course type	Program Core	Pre-requisite				

UNIT I: Workshop Orientation and Manufacturing Methods Overview

1. **Manufacturing classification:** casting, forming, machining, joining and introduction to advanced manufacturing.
2. **Safety culture:** safe working practices, tool handling, measurement and quality awareness.

UNIT II: Carpentry – Pattern Preparation

3. Wood tools, marking, cutting, planning, basic joints.

UNIT III: Metal Casting

4. Pattern, moulding, gating concept, melting/pouring safety; simple sand mould practice.

UNIT IV: Welding & Brazing

5. Arc and gas welding basics; joints; defects; safety
6. **Typical models: butt** and **lap** joints.

UNIT V: Modern Manufacturing Exposure – CNC and Additive Manufacturing

7. **CNC basics:** coordinate system, tool concepts, simple part-program idea.
8. **Case methodology:** CAD → Core/Cavity → CAM → CNC machining → Injection molding (PP) → Final assembly.
9. **Additive manufacturing workflow:** CAD → STL → slicing → printing → post-processing.

LAB SESSIONS

1. Lab induction, PPE, safety rules; tool identification and handling
2. Basic measurements (vernier/micrometer) + inspection checklist
3. Carpentry Job-1: marking, cutting and planning
4. Carpentry Job-2: one joint and finishing
5. Sand mould preparation (cope/drag), gating layout
6. Defects observation and tolerance/finish discussion
7. Bead practice and edge preparation
8. Butt joint, lap joint, defect identification CAD model, CAM simulation demo, and CNC demonstration/worksheet
9. AM: slicing parameter study, printing, post-processing and dimensional check

36. Future Trends in Renewable Energy

LEARNING RESOURCES

TEXTBOOKS

1. Mehmat Kanoglu, Yunus A. Cengel, John M. Simbala, Fundamentals and Applications of Renewable Energy, McGraw-Hill, 1st edition, 2020.
2. Nilamoni Saikia, Renewable Energy and Energy Harvesting, Mahaveer Publications, 1st edition, 2022.

REFERENCE BOOKS

1. S.P. Sukhatme, Solar Energy, McGraw-Hill, 3rd edition, 2008.
2. B. H. Khan, Non Conventional Energy Sources, McGraw-Hill, 1st edition, 2009.

(25MEC300OE411) RENEWABLE ENERGY RESOURCES			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Principles of Solar Radiation

1. Introduction to Renewable Energy
2. Types of Renewable Energy Resources
3. Global Energy Scenario
4. Indian Energy Scenario
5. Sustainability and Environmental Impact
6. Basic Concepts of Thermodynamics
7. Energy Conversion Techniques
8. Introduction to Energy Storage

UNIT II: Solar Energy

9. Introduction to Solar Energy
10. Solar Photovoltaic (PV) Technology
11. Types of Solar Cells
12. Solar PV System Components
13. Solar PV System Design
14. Solar Thermal Systems
15. Performance Analysis of Solar PV Systems
16. Applications of Solar Energy

UNIT III: Wind & Hydro Energy

17. Introduction to Wind Energy
18. Wind Turbine Technology
19. Horizontal vs Vertical Axis Wind Turbines
20. Wind Power Plant Design
21. Introduction to Hydro Energy
22. Types of Hydro Power Plants
23. Hydropower System Components
24. Session 24 (50 min): Applications of Wind and Hydro Energy

UNIT IV: Biomass & Geothermal Energy

25. Introduction to Biomass Energy
26. Biomass Conversion Technologies
27. Biogas Production
28. Biofuels: Biodiesel and Ethanol
29. Introduction to Geothermal Energy
30. Types of Geothermal Power Plants
31. Geothermal Energy Applications
32. Challenges and Opportunities of Geothermal and Biomass

UNIT V: Energy Storage and Future Trends

33. Energy Storage Systems: Batteries
34. Energy Storage systems: Pumped Hydro and Compressed Air Storage
35. Smart Grids and Renewable Energy Integration

(25MEC300OE410) 3D PRINTING			L	R	P	C
			3	0	0	3
Course type	Program Core	**Pre-requisite**				

UNIT I: Introduction to 3D Printing and Mechanical Systems

1. Basics of 3D Printing: Principles, applications, and impact.
2. ASTM Categories of Additive Manufacturing.
3. Hardware Control and Mechanical Systems: Components and calibration of desktop 3D printers.
4. Troubleshooting and maintenance procedures.
5. Motion control systems (stepper motors, rails, etc.).
6. Build considerations: CAD preparation, support structures, and post-processing.
7. Hands-on assembly and disassembly exercises.

UNIT II: Materials, Extrusion System, and Build Considerations

8. Types of materials used in 3D printing (PLA, ABS, composites, metals, ceramics, etc.).
9. Experimental and composite materials.
10. Extrusion principles, nozzle sizes, and temperature control.
11. Troubleshooting extrusion issues.
12. Post-processing techniques: Surface treatment, sanding, painting, bonding, and assembly methods.
13. Quality control measures in 3D printing.

UNIT III: Preparing for 3D Printing

14. Slicing Software: Introduction, slicing parameters, generating G-code.
15. Design for Additive Manufacturing (DfAM): Mass customization, personalisation, data-driven approaches.
16. Part consolidation, lightweighting, complex optimization, and lattice structures.
17. Pre-printing checks: Support structures, print orientation, calibration prints, and quality control.
18. Hands-on exercises in slicing software and CAD preparation.

UNIT IV: Advanced Design and Modeling Techniques

19. Sketching for 3D printing: Introduction to Tinkercad and Fusion 360.
20. Algorithmic modeling and simulation in CAD.
21. Additive tooling and fixtures.
22. Different technologies for 3D modeling: 3D scanners, Microsoft Kinect, structure sensors.
23. Embed function and optimization strategies in design.

UNIT V: Future Trends, Economy, and Sustainability in 3D Printing

24. Emerging trends in 3D printing: Industrial applications and scalability.
25. Rapid tooling, automation, and flexibility.
26. Environmental impact and sustainable practices in additive manufacturing.
27. Redistributed manufacturing and economic implications.
28. Additive manufacturing at scale: Production chains, material optimization, and quality assurance.

34. Crashing of Project Network
35. Integration of Techniques in Operations Research

TEXT BOOKS:

1. H.A. Taha, Operations Research: An Introduction, Pearson, 2023.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, McGraw Hill, 2021.

REFERENCE BOOKS:

1. J.K. Sharma, Operations Research: Theory and Applications, Macmillan, 2021.
2. S.D. Sharma, Operations Research, Kedarnath Ramnath, 2020.

OPEN ELECTIVE

(25MEC300OE409) OPERATIONS RESEARCH			**L**	**R**	**P**	**C**
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT 1
1. Linear Programming
2. Mathematical Formulation.
3. Graphical Method
4. Simplex Method with two variables
5. Simplex Method with three variables
6. Penalty Methods

UNIT II
7. Transportation Problem - Formulation and Solution (Min and Max)
8. Northwest Corner Rule, Row Minima, Column Minima Method.
9. Least Cost Method.
10. Vogel's Approximation Method (VAM).
11. Travelling Salesman Problem (TSP) Sequencing Problems.
12. Assignment Problems.

UNIT III
13. Flow Shop Sequencing
14. n Jobs Through Three Machines.
15. Job Shop Sequencing,
16. Two Jobs Through 'm' Machines Replacement Models
17. Replacement of Items Deteriorating with Time (No Money Value Counted).
18. Replacement of Items Deteriorating with Time (Money Value Counted).
19. Group Replacement Models.

UNIT IV
20. Basics of Game Theory
21. Two-Person Zero-Sum Games.
22. Properties of Dominance
23. Graphical Solution of Two-Person Zero-Sum Games.
24. Algebraic Method for Game Theory.
25. Introduction to Queuing Models
26. Single-Channel Queuing Models
27. Multi-Channel Queuing Models

UNIT V
28. Simulation Basics and Random Number Generation.
29. Monte Carlo Simulation for Queuing Problems
30. Introduction to Project Management
31. Construction of Network Diagrams
32. Critical Path Method (CPM)
33. Project Evaluation and Review Technique (PERT)

33. Basics of Digital Signal Processing (DSP)s
34. Digital Communication Fundamentals
35. Communication Interfaces
36. Practical Applications and Case Studies

LIST OF EXPERIMENTS:

1. Design and simulation of pneumatic and hydraulic circuits using Automation Studio or equivalent software.
2. Implementation of electro-pneumatic and electro-hydraulic control circuits using directional control valves and actuators.
3. Development of PLC ladder logic programs for logic gates, latching, sequencing, timers, counters, and shift registers.
4. Programming of PLC-based industrial automation applications such as motor control, traffic light control, and sequential operations.
5. Interfacing and calibration of industrial sensors including proximity, displacement, temperature, pressure, and light sensors.
6. Design and implementation of signal conditioning circuits using operational amplifiers, filters, ADCs, and DACs.
7. Simulation and analysis of first-order and second-order dynamic systems using MATLAB/Simulink or equivalent software.
8. Design, tuning, and performance evaluation of PID controllers for closed-loop control systems.
9. Speed and position control of DC motors, AC motors, stepper motors, and servo motors using suitable control techniques.
10. Mini project involving the integration of sensors, actuators, PLCs, and controllers for a complete mechatronic automation system.

LEARNING RESOURCES

TEXTBOOKS

1. Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and Measurement Systems, McGraw Hill Publications, 8th Edition, 2022.
2. Bolton, W., Mechatronics, Pearson Education India, 2020.

REFERENCEBOOKS

1. Malvino, A. P., and Bates, D. J., Electronic Principles, TMH Publishing Company Ltd., New Delhi, 12th Edition, 2022.
2. Gaonkar, R.S., Microprocessor Architecture, Programming and Applications with 8085, Penram Publishers India, 10th Edition, 2023.

SEMESTER - VI

(25MEC302MN404) MECHATRONICS			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Fundamentals of Mechatronic Systems and Sensor Technology
1. Introduction to Mechatronic Systems
2. Basic Characteristics of Mechatronic Systems
3. Applications of Mechatronics
4. Introduction to Sensors and Transducers
5. Classification and Applications of Sensors & Transducers
6. Simple Electronic Elements in Mechatronic Systems
7. Operational Amplifiers in Mechatronics

UNIT II: Actuation Systems and Dynamic Modeling in Mechatronics
8. Introduction to Actuators and Actuation Systems
9. Pneumatic and Hydraulic Actuation Systems
10. Electrical and Mechanical Actuation Systems
11. Micro Actuators and Advanced Actuation Technologies
12. Modeling and Simulation of Physical Systems
13. System Models and Dynamic Responses
14. System Transfer Functions and Control Analysis

UNIT III:Digital Logic and Microcontroller Systems
15. Introduction to Digital Logic and Number Systems
16. Boolean Algebra and Logic Gates
17. Applications and Design of Digital Logic Gates
18. 18.Applications of Digital Logic Gates
19. Introduction to Microprocessors and Microcontrollers
20. Microprocessor Architecture
21. Instruction Codes and Implementation Issues
22. Case studies of microprocessors and microcontrollers in real-world applications

UNIT IV: Programmable Logic Controllers and Industrial Automation
23. Introduction to Programmable Logic Controllers (PLCs)
24. Basic structure of PLCs
25. I/O Processing in PLCs
26. PLC Programming Basics
27. Timers and Their Applications
28. Internal Relays and Counters
29. Mechatronic Systems Case Studies

UNIT V: Signal Conditioning and Digital Communication Systems
30. Basics of Signal Conditioning
31. Filtering Techniques
32. Data Acquisition Systems (DAS)

28. Additive manufacturing at scale: Production chains, material optimization, and quality assurance.

LIST OF EXPERIMENTS:

1. Introduction to CAD Modelling
2. Preparation of 3D printing Design (3D Modelling using any CAD software Creo, Inventor, Solid works, Catia, Fusion 360).
3. Processing the CAD data in Catalyst software (Selection of Orientation, supports generation, Slicing, Tool path generation) usingCura Software
4. Sending the tool path data to FDM RP machine
5. Fabricating the physical part on FDM/SLA machine
6. Post-processing of Fabricated metal parts by Shot-peening, polishing, etc., to improve the surface quality of the produced parts.
7. Introduction to Ansys Additive Suit
8. Topology optimization of Brake Pedal using Ansys Additive Suit
9. Topology optimization of Throttle Pedal using Ansys Additive Suit
10. Modelling and Simulation of Powder bead system.

LEARNING RESOURCES

TEX BOOKS

1. Gibson, I., Rosen, D. W., & Stucker, B. (2015). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (2nd ed.). Springer. ISBN: 978-1-4939-2113-3.
2. **Horvath, J.** (2020). Mastering 3D Printing: A Guide to Modeling, Printing, and Prototyping (2nd ed.). Apress. ISBN: 978-1484258415.

REFERENCES BOOKS

1. Liou LW and Liou FW, “Rapid Prototyping and Engineering Applications: A tool box for Prototype Development”, CRC Press, 2011.
2. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishing Company. ISBN: 978-9812778970.

SEMESTER - V

(25MEC302MN403) 3D PRINTING			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to 3D Printing and Mechanical Systems

1. Basics of 3D Printing: Principles, applications, and impact.
2. ASTM Categories of Additive Manufacturing.
3. Hardware Control and Mechanical Systems: Components and calibration of desktop 3D printers.
4. Troubleshooting and maintenance procedures.
5. Motion control systems (stepper motors, rails, etc.).
6. Build considerations: CAD preparation, support structures, and post-processing.
7. Hands-on assembly and disassembly exercises.

UNIT II: Materials, Extrusion System, and Build Considerations

8. Types of materials used in 3D printing (PLA, ABS, composites, metals, ceramics, etc.).
9. Experimental and composite materials.
10. Extrusion principles, nozzle sizes, and temperature control.
11. Troubleshooting extrusion issues.
12. Post-processing techniques: Surface treatment, sanding, painting, bonding, and assembly methods.
13. Quality control measures in 3D printing.

UNIT III: Preparing for 3D Printing

14. Slicing Software: Introduction, slicing parameters, generating G-code.
15. Design for Additive Manufacturing (DfAM): Mass customization, personalisation, data-driven approaches.
16. Part consolidation, lightweighting, complex optimization, and lattice structures.
17. Pre-printing checks: Support structures, print orientation, calibration prints, and quality control.
18. Hands-on exercises in slicing software and CAD preparation.

UNIT IV: Advanced Design and Modeling Techniques

19. Sketching for 3D printing: Introduction to Tinkercad and Fusion 360.
20. Algorithmic modeling and simulation in CAD.
21. Additive tooling and fixtures.
22. Different technologies for 3D modeling: 3D scanners, Microsoft Kinect, structure sensors.
23. Embed function and optimization strategies in design.

UNIT V: Future Trends, Economy, and Sustainability in 3D Printing

24. Emerging trends in 3D printing: Industrial applications and scalability.
25. Rapid tooling, automation, and flexibility.
26. Environmental impact and sustainable practices in additive manufacturing.
27. Redistributed manufacturing and economic implications.

LABORATORY EXPERIMENTS

1. Introduction to CAD Modeling - Creating 3D models using CAD software.
2. Finite Element Analysis (FEA) Simulation - Stress analysis of a mechanical component.
3. Computational Fluid Dynamics (CFD) Simulation - Analyzing fluid flow through a pipe.
4. Additive Manufacturing Process Demonstration – Fabricating part using 3D printing.
5. Digital Twin Implementation - Creating and analyzing a digital twin model.
6. Big Data Analytics for Smart Manufacturing - Using historical and real-time data for process optimization.
7. AI-based Predictive Maintenance - Implementing machine learning for fault detection and prediction.
8. Cybersecurity in Manufacturing - Simulating a cybersecurity breach and mitigation strategies.
9. Internet of Things (IoT) and Smart Sensors - Real-time data collection and analysis from sensors.
10. Virtual Factory Simulation - Simulating a production line using digital tools.
11. Human-Robot Collaboration Experiment - Testing collaborative robots in a manufacturing setup.
12. Cloud-Based Design Collaboration - Collaborative CAD modeling using cloud platforms.

LEARNING RESOURCES

TEXT BOOKS:

1. Handbook of Smart Manufacturing: Forecasting the Future of Industry 4.0, by Ajay Hari Singh, Parveen Kumar, Bandar AlMangour, Routledge, 2023.
2. Smart Manufacturing: The Lean Six Sigma Way by Anthony Tarantino, Wiley, 2022

REFERENCE BOOKS

3. Advances in Manufacturing Processes and Smart Manufacturing by R. Venkata Rao, K. Narasimhan, V. N. Gaitonde, et al., Springer, 2024.
4. Soft Computing in Smart Manufacturing and Materials by Rupesh Kumar Jha, Elsevier, 2024.

SEMESTER - IV

(25MEC302MN402) FOUNDATIONS OF SMART MANUFACTURING			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Smart Manufacturing

1. Overview of Smart Manufacturing - Definition, key principles, and significance.
2. Evolution of Manufacturing Paradigms - From traditional to Industry 4.0.
3. Impact of Industry 4.0 on Manufacturing - Technological and economic shifts.
4. Benefits of Smart Manufacturing - Efficiency, cost reduction, flexibility, and sustainability.
5. Key Challenges in Implementing Smart Manufacturing - Barriers and potential solutions.

UNIT II: Foundations of Industry 4.0

6. Cyber-Physical Systems (CPS) in Manufacturing - Integration of digital and physical systems.
7. Interoperability and Connectivity - Communication between machines, people, and processes.
8. Information Transparency and Data-Driven Manufacturing - Real-time data collection and analysis.
9. Decentralized Decision-Making in Smart Factories - AI-driven autonomous production systems.
10. Technologies Enabling Industry 4.0 - IoT, Big Data, Cloud Computing, and Edge Computing.

UNIT III: Digital Twins and Advanced Automation

11. Concept and Significance of Digital Twins - Virtual modeling of physical systems.
12. Applications and Use Cases of Digital Twins - Process optimization and predictive maintenance.
13. Automated Manufacturing Processes - Role of automation in smart factories.
14. Robotics and Collaborative Robots (Cobots) - Integration in manufacturing environments.
15. Integration of Automation with Smart Technologies - AI, IoT, and cloud computing.

UNIT IV: Artificial Intelligence (AI) in Manufacturing

16. Basics of AI and Machine Learning in Manufacturing - Fundamentals and use cases.
17. AI Applications in Manufacturing - Predictive maintenance, quality control, and adaptive systems.
18. AI-Driven Process Optimization - Enhancing manufacturing efficiency.
19. Decision Support Systems in Smart Manufacturing - AI for strategic decision-making.
20. Case Studies of AI Implementation in Manufacturing - Real-world examples and best practices.

UNIT V: Cybersecurity and Smart Manufacturing Platforms

21. Cybersecurity in Smart Manufacturing - Importance, threats, and countermeasures.
22. Security Measures and Best Practices - Implementing robust security frameworks.
23. Smart Manufacturing Platforms and Standards - Overview and applications.
24. Future Trends in Smart Manufacturing - Emerging technologies and innovations.

2. "Digital Manufacturing and Assembly Systems in Industry 4.0, by Kaushik Kumar, Divya Zindani, J. Paulo Davim, CRC press, 2021

25. Transitioning to the Digital Thread - Adoption strategies and best practices.
26. Challenges and Benefits of Implementing the Digital Thread - Real-world case studies.
27. Cyberinfrastructure Components of the Digital Thread - Key IT infrastructure requirements.
28. Information Technology Components and Computing Resources - Software and hardware.
29. Virtualization and Cloud-Based Computing - Benefits and applications.

UNIT V: Technology in Design and Manufacturing

30. Design Process Technologies - Overview of modern design tools.
31. Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) - Role in design validation.
32. Mold Design, Verification, and Validation - Digital tools for precision manufacturing.
33. Digital Thread on the Shop Floor - How digital technologies enhance production.
34. Digital Work Instructions and Records - Role in process documentation.
35. Digital Metrology Approaches - Quality assurance in manufacturing.
36. Digital Thread in Manufacturing Enterprise - Industrial IoT, MRP, ERP, and MES integration.

LIST OF EXPERIMENTS:

1. Introduction to Computer-Aided Design (CAD) software and digital product development.
2. Creation of two-dimensional sketches and three-dimensional solid models using CAD tools.
3. Parametric modeling and assembly design of mechanical components.
4. Product visualization, rendering, and engineering drawing generation.
5. Introduction to Computer-Aided Manufacturing (CAM) and CNC toolpath generation.
6. Design optimization using digital simulation and finite element analysis.
7. Preparation of models for additive manufacturing and 3D printing.
8. Demonstration of CNC machining, additive manufacturing, and hybrid manufacturing technologies.
9. Development of a digital twin model and its application in product lifecycle management.
10. Mini project involving digital design, simulation, manufacturing planning, and presentation of a digitally manufactured product.

LEARNING RESOURCES

TEXTBOOKS

1. "Designing Smart Manufacturing Systems" by Daniel Rossit, Chaudhery Mustansar Hussain, 1st Edition, Elsevier, 2023.
2. "Practical Guide to Digital Manufacturing: First-Time-Right for Design of Products, Machines, Processes and System Integration" by Zhuming Bi and Wen-Jun Chris Zhang, Springer, 2021.

REFERENCE BOOKS

1. Handbook of Manufacturing Systems and Design: An Industry 4.0 Perspective by Uzair Khaleeq uz Zaman, CRC press, 2023

COURSES FOR MINORS IN SMART MANUFACTURING

SEMESTER - III

(25MEC302MN401) INTRODUCTION TO DIGITAL MANUFACTURING AND DESIGN			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Digital Manufacturing & Design

1. Introduction to Digital Manufacturing & Design Technology - Definition, evolution, and key concepts.
2. Impact on Manufacturing Careers - How digital transformation is changing job roles.
3. Advantages of Digital Manufacturing and Design - Benefits such as efficiency, cost reduction, and innovation.
4. Information Sharing in the Digital Thread - Concept and significance of the digital thread.
5. Multiple Organizations in the Manufacturing Process - Collaboration across the supply chain.
6. Transition to Digital Manufacturing and Design - Steps and challenges in the transition process.

UNIT II: Digital Manufacturing Components

7. Digital Manufacturing Components - Overview of key components and their roles.
8. Closed Loop Approach - How feedback loops optimize manufacturing.
9. Integrated Information Systems in the Product Lifecycle - PLM, CAD, CAM, and their integration.
10. Protecting Your Organization - Cybersecurity challenges and best practices.

UNIT III: Digital Thread

11. Introduction to Digital Thread - Definition and significance.
12. Components of the Digital Thread - Key elements and their roles.
13. The Vision of Digital Manufacturing and Design - Future trends and technological advancements.
14. The Diffusion of Innovation - How new technologies spread across industries.
15. Motivating Factors for Digital Thread Implementation - Business and technical drivers.
16. Data Storage in Digital Thread - Strategies for efficient and secure storage.
17. Data Singularity and Version Control - Ensuring data integrity and consistency.
18. Data Security and Disaster Recovery - Safeguarding digital assets.

UNIT IV: Data Sharing and Cyberinfrastructure

19. Data Sharing in the Digital Thread - Importance and methods.
20. Interoperability in Digital Manufacturing - Challenges and solutions.
21. Semantic Data in Digital Manufacturing - Standardization and its impact.
22. Strategic Issues in Implementing the Digital Thread - Organizational and technical hurdles.
23. Implementation of the Digital Thread - Steps and methodologies.
24. A Business Case for the Digital Thread - Cost-benefit analysis and ROI.

36. Demonstration of Simapro Software – Project Setup, Analysis
37. Final Review, Applications, Mini Projects and Future Trends in SM

LIST OF EXPERIMENTS

1. Study of sustainable manufacturing practices and identification of opportunities for waste reduction in manufacturing processes.
2. Development of a simple manufacturing simulation model to analyze process flow and resource utilization.
3. Introduction to Digital Twin concepts through simulation of a basic manufacturing system.
4. Life Cycle Assessment (LCA) of a selected product using standard LCA methodology.
5. Estimation of carbon footprint and environmental impact for a simple manufacturing process.
6. Energy audit of laboratory equipment or a small manufacturing setup to identify energy-saving opportunities.
7. Study of renewable energy applications for manufacturing through case studies and demonstrations.
8. Evaluation of lean manufacturing techniques for improving productivity and reducing waste.
9. Assessment of sustainability performance using basic environmental and energy efficiency indicators.
10. Mini project on designing a simple green manufacturing system or sustainable production process.

LEARNING RESOURCES

TEXT BOOKS

1. G. Seliger, 2012, Sustainable Manufacturing: Shaping Global Value Creation, Springer-Verlag, Berlin.
2. **Gaha, M. W., & Ben Amor, M.** (2022). Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives. Wiley-ISTE.

REFERENCE BOOKS

1. **Hirsch, M., & Baumann, M.** (2021). Sustainable Manufacturing: An Overview. Springer Vieweg. https://doi.org/10.1007/978-3-658-31856-7
2. **Charpentier, J. C., Aïssiou, D., & Bouvier, J. M.** (Eds.). (2017). Modern Sustainable Manufacturing Principles and Applications. Wiley-ISTE.

1. Kothandaraman, C. P., and Subramanyan, S., "**Heat and Mass Transfer Data Book**", New Age International Publishers, 2022.

SEMESTER – VI

(25MEC302HN404) SUSTAINABLE MANUFACTURING			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Fundamentals of Sustainable Manufacturing

1. Introduction to Sustainable Manufacturing – Need & Importance
2. Definitions and Related Terms (Sustainable, Green, Lean Manufacturing)
3. Sustainability in the Manufacturing Context
4. Evolution of Manufacturing – Traditional to Smart & Sustainable
5. Lean to Green to Sustainable Manufacturing – Integration & Shift
6. Tools & Techniques of Sustainable Manufacturing
7. Total Materials Cycle – Resource Flow & Optimization
8. WEEE Directive – Introduction and Industrial Relevance

UNIT II: Life Cycle Engineering and Management

9. Life Cycle Thinking / Approach
10. Checklist Method in Life Cycle Engineering
11. MET Matrix – Concept, Use & Case Study
12. Life Cycle Assessment (LCA) – Concepts & Steps
13. Background and Philosophy of LCA Indicators
14. Modular Life Cycle Assessment (MLCA)
15. Pros and Cons of Abridged LCA
16. Industrial Applications and Discussion on LCE & LCA
17. UNIT III: Sustainable Production and Consumption (Lectures 17–23)
18. Waste Reduction in Manufacturing – Principles
19. Pollution Prevention and Control Strategies
20. Waste Reduction & Pollution Prevention Assessment Techniques
21. Green Products – Definition, Lifecycle and Demand
22. Environmental Load and Impact Analysis
23. xR Approaches: Reduce, Reuse, Recycle, Remanufacture, etc.
24. Case Studies in Sustainable Production and Consumption

UNIT IV: Sustainable Product Design and Development

25. Design for Environment (DfE): Principles, Strategies
26. Design for Sustainability (DfS): Tools and Integration
27. Case Studies: Products with Environmental Consideration
28. Best Practices in Sustainable Product Development

UNIT V: Decision-Making Tools and LCA Software Applications

29. Introduction to Multi-Criteria Decision Making (MCDM)
30. SAW Method: Process & Example
31. AHP Method: Hierarchy Building & Weightage
32. TOPSIS Method: Ideal Solution-Based Ranking
33. Interpretive Structural Modeling (ISM)
34. Preference Value Analysis (PVA)
35. Introduction to LCA Software Tools

UNIT V: Numerical & Advanced Topics in Heat and Mass Transfer

31. Numerical Techniques – Finite Difference Method for Heat Conduction
32. Finite Volume & Finite Element Methods for Heat Transfer Problems
33. Computational Methods for Convection & Radiation Problems
34. Combined Heat and Mass Transfer – Applications in Evaporation & Drying
35. Heat and Mass Transfer in Cooling Towers & Industrial Dryers
36. Course Review & Problem-Solving Session

LIST OF EXPERIMENTS

1. Experimental determination of the thermal conductivity of metallic rods under steady-state heat conduction conditions.
2. Experimental analysis of one-dimensional heat conduction through composite walls and evaluation of overall thermal resistance.
3. Investigation of heat transfer through cylindrical systems and determination of the critical radius of insulation.
4. Experimental determination of heat transfer characteristics of extended surfaces (fins) and evaluation of fin efficiency and effectiveness.
5. Study of transient (unsteady-state) heat conduction and estimation of thermal diffusivity using the lumped capacitance method.
6. Experimental investigation of forced convection heat transfer over flat plates and inside pipes, and determination of convective heat transfer coefficients.
7. Experimental study of natural convection from vertical and horizontal surfaces and comparison with empirical correlations.
8. Measurement of emissivity of different engineering surfaces and experimental evaluation of radiation heat transfer between surfaces.
9. Performance analysis of shell-and-tube or double-pipe heat exchangers under parallel-flow and counter-flow arrangements, including determination of overall heat transfer coefficient, LMTD, and effectiveness.
10. Experimental investigation of phase change heat transfer through boiling and condensation experiments, including determination of heat transfer coefficients and comparison with theoretical correlations.

TEXTBOOKS

1. Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, “Incropera’s Principle of Heat and Mass Transfer” Wiley India Edition, 2018
2. Yunus A. Cengel, Afshin J. Ghajar, “Heat and Mass Transfer: Fundamentals and Applications”, McGraw-Hill, 6th Edition, 2020.

REFERENCE BOOKS

1. Lienhard, J.H., and Lienhard, J. H., “A Heat Transfer Text Book”, Phlogiston Press, 6th Edition, 2024.
2. Sachdeva, R.C., “Fundamentals of Engineering Heat and Mass Transfer”, New Age International Publishers, 5th edition, 2018.

DATA BOOK

SEMESTER – V

(25MEC302HN403) **ADVANCED HEAT AND MASS TRANSFER**			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Fundamentals of Heat and Mass Transfer

1. Introduction to Heat Transfer – Conduction, Convection, Radiation
2. Transient Conduction – Lumped Capacitance Method
3. Transient Conduction – Semi-infinite Solids & Heisler Charts
4. Extended Surface Heat Transfer – Fins, Fin Efficiency & Effectiveness
5. Heat Transfer in Composite Walls & Contact Resistance
6. Introduction to Mass Transfer – Fick's Law, Analogy with Heat Transfer
7. Steady-State Diffusion Mass Transfer in Different Geometries
8. Convective Mass Transfer – Sherwood Number, Mass Transfer Coefficients

UNIT II: Convection Heat Transfer

9. Review of Laminar and Turbulent Heat Transfer in External Flows
10. Steady-State Laminar Flow Heat Transfer in Internal Channels
11. Turbulent Flow Heat Transfer in Internal Channels – Empirical Relations
12. Heat Transfer at High Speeds – Compressible Flows & Reynolds Analogy
13. Unsteady Forced Convection – Governing Equations & Solutions
14. Heat Transfer in Ducts & Plates – Entrance Length & Flow Development
15. Convection with Body Forces – Natural Convection Fundamentals
16. Mixed Convection – Governing Equations & Applications
17. Natural & Forced Convection Combined – Heat Transfer in Complex Systems

UNIT III: Advanced Convective Heat Transfer & Two-Phase Flow

18. Two-Phase Flow – Introduction to Boiling & Condensation
19. Boiling Heat Transfer – Nucleate, Transition, & Film Boiling
20. Condensation Heat Transfer – Dropwise & Filmwise Condensation
21. Two-Phase Flow Correlations – Heat Transfer Coefficients & Modeling
22. Heat and Mass Transfer in Porous Media – Governing Equations
23. Applications of Two-Phase Flow – Heat Pipes, Phase Change Materials
24. Applications of Heat & Mass Transfer in Industrial Processes

UNIT IV: Radiative Heat Transfer

25. Basics of Radiation – Planck's Law, Stefan-Boltzmann Law, Kirchhoff's Law
26. Radiation Properties of Surfaces – Emissivity & Absorptivity
27. Radiation Exchange Between Surfaces – View Factors & Shape Factors
28. Radiation in Enclosures – Gray & Non-Gray Surfaces
29. Gas Radiation – Emission, Absorption & Scattering in Participating Media
30. Radiation in Engineering Applications – Solar Radiation & Industrial Heating

34. Automation in Precision Manufacturing
35. Robotics Applications in Precision Production
36. Future Trends and Industry 4.0 in Precision Manufacturing

LIST OF EXPERIMENTS

1. Study of precision manufacturing systems, machine tool components, and process parameters used in precision machining.
2. Measurement and calibration of precision engineering components using Vernier calipers, micrometers, dial indicators, and gauge blocks.
3. Evaluation of dimensional accuracy and geometric tolerances of machined components using Coordinate Measuring Machine (CMM).
4. Measurement of surface roughness and assessment of surface quality using a surface roughness tester.
5. Experimental study on precision turning by analyzing the effect of cutting speed, feed, and depth of cut on dimensional accuracy and surface finish.
6. Experimental investigation of precision milling and grinding processes to evaluate machining accuracy and surface integrity.
7. Study of Electrical Discharge Machining (EDM) process parameters and their influence on material removal rate, tool wear, and surface finish through experimentation or simulation.
8. Investigation of machining errors due to thermal effects, machine tool inaccuracies, and geometric deviations, and their influence on precision manufacturing.
9. Statistical quality control of precision-manufactured components using process capability analysis, control charts, and basic quality improvement tools.
10. Mini project involving the design, manufacturing, inspection, and quality evaluation of a precision component using suitable machining, metrology, and process optimization techniques.

LEARNING RESOURCES

TEXT BOOKS

1. **Leach, R., & Smith, S. T.** (Eds.). (2018). Basics of Precision Engineering. CRC Press. ISBN: 978-1498760850.
2. **Yeh, C. H., & Chen, H. T.** (Eds.). (2022). Handbook of Precision Engineering: Fundamentals and Applications. Springer.

REFERENCE BOOKS

1. **Dornfeld, D. A.** (Ed.). (2012). Green Manufacturing: Fundamentals and Applications (Part of the Springer Series in Advanced Manufacturing). Springer.
2. **Kalpakjian, S., & Schmid, S. R.** (2014). Manufacturing Engineering and Technology (7th ed.). Pearson Education. (Often used as a reference handbook in manufacturing courses.)

SEMESTER – IV

(25MEC302HN402) PRECISION MANUFACTURING			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Precision Manufacturing
1. Introduction, Definition and Importance of Precision Manufacturing
2. History and Evolution of Precision Manufacturing
3. Principles and Fundamentals of Precision Manufacturing
4. Overview of Precision Machining Processes
5. Sensors for Process Monitoring and Control
6. Introduction to Metrology and Actuators in Precision Manufacturing

UNIT II: Machine Tool Elements and Structure
7. Introduction to Machine Tool Elements and Functions
8. Machine Tool Components: Bed, Guideways, Spindle, etc.
9. Kinematics of Machine Tools
10. Dynamics of Machine Tools
11. Accuracy and Precision of Machine Tools
12. Machine Tool Maintenance Techniques
13. Troubleshooting and Failure Diagnosis in Machine Tools

UNIT III: Sources of Error & Precision Machining Processes
14. Introduction to Sources of Error in Precision Manufacturing
15. Thermal and Mechanical Errors
16. Geometric and Process Errors
17. Measurement Errors and Their Effects
18. Introduction to Precision Machining Processes
19. Precision Turning and Milling: Principles and Applications
20. Precision Grinding and EDM
21. Ultraprecision Machining Techniques
22. Micromachining: Tools and Challenges

UNIT IV: Metrology and Quality Control
23. Measurement Techniques for Precision Components
24. Working Principle and Applications of CMM
25. Laser Interferometry: Principle and Use in Precision Manufacturing
26. Optical Measurement Techniques
27. Introduction to Statistical Quality Control
28. Statistical Tools for Process Control (SPC, Control Charts)
29. Case Studies on Process Improvement and Quality Assurance

UNIT V: Advanced Topics in Precision Manufacturing
30. Introduction to Advanced Topics in Precision Manufacturing
31. Basics of Nanomanufacturing
32. Nanotechnology Applications in Precision Engineering
33. Additive Manufacturing for Precision Components

LIST OF EXPERIMENTS

1. Determination of the mechanical properties of engineering materials, including Young's modulus, yield strength, ultimate tensile strength, and ductility, through uniaxial tensile testing using a Universal Testing Machine (UTM).
2. Evaluation of the modulus of rigidity and torsional behavior of circular shafts by performing torsion tests under static loading conditions.
3. Measurement and comparison of the hardness of engineering materials using the Rockwell hardness testing method.
4. Determination of the Brinell hardness number (BHN) for metallic specimens and comparison of hardness characteristics of different materials.
5. Experimental determination of the stiffness and modulus of rigidity of helical springs subjected to compressive loading.
6. Determination of the Young's modulus of engineering materials under compressive loading using a Universal Testing Machine.
7. Evaluation of the toughness and energy absorption characteristics of engineering materials using the Charpy impact test.
8. Assessment of impact strength and fracture behavior of materials through the Izod impact test.
9. Determination of the shear strength of engineering materials using the punch shear test on a Universal Testing Machine.
10. Experimental investigation of the deflection behavior of simply supported beams subjected to concentrated loads and comparison with theoretical predictions.
11. Analysis of the deflection of simply supported beams under uniformly distributed load (UDL) and uniformly varying load (UVL), and verification using Euler–Bernoulli beam theory.
12. Investigation of the flexural behavior and bending strength of engineering materials using bending tests on a Universal Testing Machine.

TEXTBOOKS

1. L. S. Srinath, Advanced mechanics of solids, 7th Edition, McGraw-Hill, 2021.
2. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 10th Edition, John Willey and Sons, 2022.

REFERENCEBOOKS

1. Lester W. Schmerr Jr. “Advanced Mechanics of Solids” Cambridge University Press. 2021
2. S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, 7th Edition, McGraw Hill, 2024

19. Linear Stress-Strain Relations: Isotropic and Orthotropic Cases – Material behavior under elasticity assumptions.
20. Relationship Between Material Constants (Young's Modulus, Poisson's Ratio, Shear Modulus, Bulk Modulus) – Derivations and significance.
21. General Hooke's Law for Isotropic Materials – Mathematical formulation and engineering applications.
22. Reduction of Hooke's Law for Orthotropic Materials – Understanding material anisotropy.
23. Applications of Stress-Strain Relations in Engineering Design – Case studies on practical material selection.
24. Advanced Problems on Stress-Strain Relations – Solving complex numerical problems.

UNIT IV: Theories of Failure or Yield Criteria

25. Introduction to Theories of Failure and Their Importance – Need for failure theories in engineering.
26. Maximum Normal Stress Theory and Maximum Shear Stress Theory – Failure conditions under different loading conditions.
27. Distortion Energy Theory (Von Mises) and Strain Energy Theory – Advanced failure criteria and applications.
28. Comparison of Theories of Failure and Their Applications – Selection of appropriate failure theories.
29. Factor of Safety in Design and Its Significance – Engineering design considerations.
30. Case Studies and Practical Applications of Failure Theories – Real-world applications in mechanical and structural design.
31. Numerical Problems on Failure Theories – Solving problems on different failure criteria.

UNIT V: Deflection and Bending of Non-Symmetric Cross Section of Beams

32. Overview of Deflection and Bending of Symmetric Beams – Basic bending equations and theory.
33. Euler–Bernoulli Hypothesis and Its Assumptions – Classical beam theory.
34. Symmetric and Axisymmetric Deformations in Beams – Concept and examples.
35. Bending Analysis of Beams with Non-Symmetric Cross-Sections – Stress and strain distribution.
36. Stresses and Strains in Non-Symmetric Cross-Section Beams – Practical considerations in design.

36. The Role of Governments and Institutions in Robot Ethics

COURSES FOR HONORS IN MECHANICAL ENGINEERING

SEMESTER - III

(25MEC302HN401) **ADVANCED SOLID MECHANICS**			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Analysis of Stresses

1. Introduction to Stress Tensor and Cartesian Representation – Concept of stress, stress tensor, Cartesian components.
2. Traction Vectors and Stress Tensors – Definition, derivation, and significance in mechanics.
3. Normal and Shear Stresses: Definition and Applications – Understanding stress components in 2D and 3D states.
4. Principal Stresses and Principal Directions – Eigenvalues, eigenvectors of the stress tensor, Mohr's Circle for 2D.
5. Stresses in the Octahedral Plane – Octahedral normal and shear stresses, significance in material failure.
6. Symmetry of Stress Tensor and Transformation of Stress Matrix – Stress transformation equations, Mohr's Circle in 3D.
7. Equilibrium Equations in Cartesian Coordinates – Derivation and physical significance.
8. Equilibrium Equations in Cylindrical Polar Coordinates – Application to cylindrical structures, stress distribution.

UNIT II: Analysis of Strains

9. Concept of Strain and Strain Tensor – Definition, small strain approximation, and representation.
10. Longitudinal, Shear, and Volumetric Strains – Analysis of strain components.
11. State of Strain at a Point and Interpretation of Shear Strain Components – Understanding shear strain, practical applications.
12. Strain Compatibility Condition and Its Importance – Mathematical derivation and real-world relevance.
13. Strain Measurement Techniques – Use of strain gauges, optical methods, Moiré methods.
14. Strain Transformation and Mohr's Circle for Strain – Application of Mohr's Circle to strain analysis.
15. Practical Applications of Strain Analysis – Case studies from industry applications.
16. Numerical Problems on Strain Analysis – Problem-solving session on strain calculations.

UNIT III: Stress-Strain Relations for Linear Elastic Materials

17. State of Strain in Simple Cases (Axial, Shear, and Combined Loadings) – Material response under different loads.
18. Strain Compatibility Condition and Its Role in Elasticity – Importance in structural mechanics.

(25MEC300SE404) MACHINE VISION AND SAFETY			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Robot Safety and Ethics

1. Importance of Safety in Robotics
2. Types of Safety Hazards in Robotics
3. Safety Standards and Regulations Overview
4. Hierarchy of Safety Measures
5. Ethics of Autonomous Decision-Making in Robots
6. Human-Robot Interaction (HRI) Ethical Considerations
7. Legal and Ethical Issues in Robot-Assisted Workplaces
8. Emergency stop systems and fail-safe protocols

UNIT II: Safety Standards in Robotics

9. Safety protocols in robotics
10. Industrial and collaborative robots (Cobots)
11. Global Safety Standards Overview (ISO, ANSI, OSHA, etc)
12. ANSI/RIA R15.06: U.S. Industrial Robot Safety Standard
13. IEC 61508: Functional Safety of Electrical/Electronic Systems
14. OSHA Guidelines for Workplace Robot Safety
15. Cybersecurity and Data Protection in Robot Systems

UNIT III: Risk Assessment in Robotics

16. Risk assessment methods: Failure Modes and Effects Analysis (FMEA)
17. Risk assessment methods:Fault Tree Analysis (FTA)
18. Implementing risk mitigation strategies
19. Redundancy and fault tolerance in robot systems
20. Safe physical design: Collision avoidance, sensor integration
21. Vision-based safety systems for navigation
22. Robotic safety in smart manufacturing
23. Human-centric safety protocols for collaborative robots

UNIT IV: Safety Technologies

24. Safety Sensors and Vision-Based Safety Systems
25. AI and Machine Learning for Risk Detection in Robotics
26. Safe Speed, Power, and Force Monitoring for Robots
27. Collaborative Robot (Cobot) Safety Considerations
28. Protective Barriers, Light Curtains, and Safety Mats
29. Human Factors and Ergonomic Design for Robot Safety
30. Bias and Fairness in AI-Driven Robotic Systems

UNIT V: Social, Legal, and Future Considerations

31. Responsibility and Accountability in Robot Failures
32. Ethical Challenges in Military and Defense Robotics
33. Privacy Concerns in Data-Driven Robotic Systems
34. Regulatory Challenges in Robotics and AI Development
35. Human Augmentation and Ethical Considerations in Cyborg Technologies

UNIT V: Advanced Topics and Applications

32. Advanced Control: Trajectory planning and inverse kinematics.
33. ROS-Industrial: ROS for industrial robots
34. Manufacturing.
35. Multi-Robot Systems: ROS for swarm robotics.

TEXTBOOKS:

1. Morgan Quigley, Programming Robots with ROS: A Practical Introduction to the Robot Operating System. O'Reilly Media, 2025.
2. Brian Gerkey, ROS Robotics by Example: Learning ROS Through Real-World Projects. Packt54 Publishing, 2023.

REFERENCE BOOKS:

1. R. Vijaykumar, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy. Apress, 2022.

SPECIALIZATION ELECTIVE - II (Robotics and Automation)

(25MEC300SE403) ROBOTICS OPERATING SYSTEM			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Fundamentals of ROS and Operating Systems

1. Fundamentals of Operating Systems: Role in robotics, overview of real-time operating systems (RTOS).
2. Introduction to ROS: History, evolution, and key features of ROS.
3. Architecture of ROS: Nodes, topics, services,
4. Architecture of ROS: actions, and parameters.
5. ROS File System: Packages, workspaces.
6. ROS Communication: Publisher-subscriber model, message passing,
7. ROS Communication: data types.
8. Comparison of ROS 1 vs. ROS 2: Key differences in architecture and features.

UNIT II: ROS System Design and Middleware

9. Distributed ROS Architecture: Master node,
10. multi-robot systems, and communication.
11. Middleware & Communication Protocols: TCPROS, UDPROS (ROS 1), and
12. Middleware & Communication Protocols :DDS (ROS 2).
13. ROS Launch Files: Writing and managing launch files, launching multiple nodes and parameters.
14. ROS Launch Files: Writing and managing launch files, launching multiple nodes and parameters.
15. Parameter Server: Storing and retrieving parameters, dynamic reconfigure for runtime changes.
16. Robot Modeling with URDF: Basics of Unified Robot Description Format (URDF).

UNIT III: Robot Simulation and Sensor Integration

17. Robot Simulation with Gazebo: Integrating URDF with Gazebo.
18. Gazebo Plugins: Adding sensors (e.g., cameras, LIDAR) in Gazebo.
19. ROS Control: Configuring controllers for simulated robots.
20. Advanced Simulation: Multi-robot simulation and environment modeling.
21. Advanced Simulation: Multi-robot simulation and environment modeling.
22. ROS for Camera Integration: Using OpenCV with ROS.
23. ROS for Camera Integration: Using OpenCV with ROS.
24. Point Cloud Data (PCL): Processing LIDAR data in ROS.
25. Sensor Fusion: Combining data from multiple sensors.

UNIT IV: Robot Perception and Navigation

26. Object Detection and Tracking: Integrating machine learning models (e.g., YOLO).
27. Advanced Perception: SLAM and ROS navigation stack.
28. Introduction to Robot Control: PID control in ROS.
29. ROS Navigation Stack: Overview and configuration of the navigation stack.
30. Path Planning: Global and local planners
31. Autonomous Navigation: Implementing obstacle avoidance.

31. Edge AI and Cloud Computing for Real-Time Robotic Control
32. Leveraging Edge AI and Cloud computing for real time processing
33. IoT-Enabled Robots and Smart Automation
34. Generative AI's Impact on Robotics
35. Human-Centric Safety Protocols for Collaborative Robots
36. Risk Assessment Methods: FMEA, FTA

TEXTBOOKS:

1. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in Python. Springer, 2023.
2. Anirudh Koul, Siddha Ganju, and Meher Kasam, Deep Learning for Robotics: Design and Deployment. O'Reilly Media, 2022.

REFERENCE BOOKS:

1. Carlos Martín and Luis Montesano, Sensor Fusion and Robotics Perception: A Hands-On Approach. CRC Press, 2023.
2. Lentin Joseph and Jonathan Cacace, ROS 2 and AI-Driven Robotics: Advanced Motion Planning and Control. Packt Publishing, 2023.

(25MEC300SE304) AI in ROBOTICS			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Data analytics in AI and Robotics

1. Overview of AI and Robotics.
2. Fundamentals of Machine Learning (ML) in Robotic
3. Data Collection and Preprocessing for Robotics
4. Image Acquisition Techniques
5. Image Processing: Filtering, Segmentation,
6. Edge Detection
7. Object Recognition and Feature Extraction (SIFT, SURF, ORB)
8. Role of Big Data in Robotics

UNIT II: Machine Learning and Deep Learning in Robotics

9. Supervised Learning for Robot Perception
10. Unsupervised Learning in Robotics
11. Reinforcement Learning (RL) for Robot Control: Concepts
12. Reinforcement Learning (RL) for Robot Control: Algorithms and Applications
13. Computer Vision and Deep Learning: CNN
14. Computer Vision and Deep Learning: RNN
15. Implementing Deep Learning for Robotics Vision
16. Robot Perception and Sensor Fusion

UNIT III: Robotic Perception and Sensor Integration

17. Processing Data from LiDAR.
18. Processing Data from Proximity Sensors
19. Object Detection algorithm
20. Object Detection and Tracking in Robotics
21. AI-Powered Gesture and Voice Recognition
22. Safety Sensors: Proximity Sensors, Force Sensors, LiDAR
23. Vision-Based Safety Systems for Navigation

UNIT IV: AI-based Motion Planning and Control in Robotics

24. AI-Based Path Planning Algorithms
25. Multi Agent path planning and coordination in robotics
26. AI-Powered Robotic Manipulation and Grasping
27. ROS for AI Motion Control-Architectures, Algorithms
28. ROS : A Comprehensive approach for autonomous system
29. Real-Time Motion Execution with AI

UNIT V: Advanced Applications and Ethical Considerations

30. AI-Driven Predictive Maintenance in Robotics

33. IoT Integration for Sensor-based Smart Control
34. Use case in Industrial and Service Robotics
35. Cobots and multi-tasking robots
36. Industrial robots in smart factory

TEXTBOOKS:

1. Nikolaus Correll, Bradley Hayes, Volkan Isler "Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms", 3rd Edition (2022), MIT Press
2. Kevin M. Lynch, Frank C. Park, "Modern Robotics: Mechanics, Planning, and Control" , 2nd Edition (2023), Cambridge University Press

REFERENCE BOOKS:

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, "Robotics: Modelling, Planning and Control", Revised Edition (2021), Springer,
2. Xiao-Yun Lu, Kun Zhou, Thomas Stricker, "Sensor and Data Fusion for Intelligent Transportation Systems", 1st Edition (2020), Elsevier

SPECIALIZATION ELECTIVE - I (Robotics and Automation)

(25MEC300SE303) SENSORS AND CONTROL FOR ROBOTICS			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Sensors in Robotics & Data Acquisition

1. Introduction to Robotic Sensors: Types & Applications
2. Classification of Sensors: Proximity, Vision, Force, Motion
3. Proximity Sensors: Infrared, Ultrasonic, Lidar
4. Position & Motion Sensors: Encoders, IMUs, Gyroscopes
5. Multisensor Fusion: Combining Multiple Sensor Data for Enhanced Perception
6. Environmental Sensors: Temperature, Pressure, Humidity Sensors
7. Strain Gauges, Capacitive & Resistive Touch Sensors
8. Data Acquisition: Signal conditioning circuits

UNIT II: Sensor Calibration and data processing

9. Sensor Integration with Robotic Systems
10. Vision Sensors: Camera Systems, Depth Sensors, 3D Scanners
11. Force & Tactile Sensors for Human-Robot Interaction
12. Sensor Calibration & Noise Reduction
13. Sensor Data Processing using AI & Machine Learning
14. Real-time Sensor Communication Protocols (I2C, SPI, CAN)

UNIT III: Actuators in Robotics

15. Role of Actuators in Robot Motion & Manipulation
16. Classification of Actuators: Electric, Hydraulic, Pneumatic
17. Electric Actuators: DC Motors, Servo Motors, Stepper Motors
18. Hydraulic & Pneumatic Actuators: Working Principles & Applications
19. Soft Actuators & Artificial Muscles: Emerging Trends in Robotics
20. Smart Actuators with AI-based Adaptation

Unit IV: Control Systems & Feedback Mechanisms in Robotics

21. Need for Advanced Control in Autonomous & Industrial Robots
22. Feedback Mechanisms: Sensors in Closed-Loop Control
23. Advance Control System concepts
24. Force Control for Safe Human-Robot Collaboration
25. Compliance Control in Soft Robotics
26. Hierarchical Control Architectures
27. Communication Protocols for Control (CAN, ROS, EtherCAT)

Unit V: AI-Enabled Sensing and Smart Control in Robotics

28. Machine Learning for Sensor Data Processing
29. Deep Learning for Computer Vision in Robotics
30. Hierarchical planning in robot navigation
31. Obstacle Avoidance using Sensor Data
32. Integration of Digital Twins with Robotics

35. Real-Time Systems and Embedded Robotics
36. Uncertainty Handling in Autonomous Systems

LAB SESSIONS

1. Use **RoboAnalyzer** to model a 2-DOF or 3-DOF robotic arm. Perform forward and inverse kinematics analysis and analyze the robot's motion.
2. Use **ANSYS** or **SolidWorks Simulation** to analyze stress and deformation on robot components made of different materials (e.g., aluminum, plastic). Compare the results and select the best material for a given application.
3. Use **MATLAB** or **Simulink** to simulate the performance of electric, hydraulic, and pneumatic actuators. Analyze speed, torque, and power requirements for a specific robotic task.
4. Simulate a PID controller for a DC motor in **MATLAB/Simulink**. Tune the PID gains to achieve optimal performance and analyze the system's response to step inputs.
5. Use **ROS** to plan and simulate trajectories for a robotic arm. Visualize the motion in **RViz** and analyze the smoothness and accuracy of the trajectory.
6. Model a simple robotic system (e.g., inverted pendulum) using state-space representation in **MATLAB**. Implement a state feedback controller and simulate the system's response.
7. Set up a teleoperation system in **ROS** to control a robot in **Gazebo**. Use a joystick or keyboard to control the robot and analyze the latency and accuracy of the system.
8. Simulate a force control system for a robotic arm in **MATLAB/Simulink**. Test the system's ability to interact with objects of varying stiffness.
9. Implement a Kalman filter in **MATLAB** to estimate the position and velocity of a mobile robot using noisy sensor data. Compare the filtered data with raw sensor data.
10. Write a simple ROS node to control a robot in **Gazebo** or a physical robot. Implement basic movements (e.g., forward, backward, turn) and test the program.
11. Interface a DC motor with an **Arduino** and control it using ROS. Implement PWM-based speed control and direction control using an H-bridge motor driver.
12. Implement a basic SLAM algorithm using **ROS** and **Gazebo**. Use a simulated LiDAR or camera to map an environment and navigate autonomously. Visualize the map and robot's path in **RViz**.

TEXTBOOKS:

1. Nikolaus Correll, Bradley Hayes, Volkan Isler, **"Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms"**,3rd Edition (2022), MIT Press
2. Kevin M. Lynch, Frank C. Park, **"Modern Robotics: Mechanics, Planning, and Control"**, 2nd Edition (2023), Cambridge University Press

REFERENCE BOOKS:

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, **"Robotics: Modelling, Planning and Control"**, Revised Edition (2021), Springer
2. Joe Jones, Daniel Roth, **"Robot Programming: A Guide to Controlling Autonomous Robots"**, 1st Edition (2020), McGraw-Hill

(25MEC302SC302) ROBOTIC SYSTEM DESIGN			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Design and Actuation

1. Design Principles for Robots
2. Materials Selection for Robot Components
3. Actuators: Electric, Hydraulic, and Pneumatic Systems
4. Robot Specifications: Payload, Speed, Accuracy, and Repeatability
5. End-Effectors: Grippers, Tools, and Custom Attachments
6. Sensors for Mechanical Feedback: Encoders, Force/Torque Sensors
7. Design for Stability and Load Distribution

UNIT II: Control Systems

8. Control System Basics: Open-Loop vs. Closed-Loop Control
9. PID Control for Robotic Systems
10. Motion Control: Velocity, Acceleration, and Torque Control
11. Microcontrollers for Robotics
12. State-Space Representation and Feeback control
13. Robot Programming: Teach Pendant, Scripting, and Simulation
14. Control strategies for multi-robot systems

UNIT III: **Human-Robot Interaction (HRI) and Control**

15. Human-Robot Interaction (HRI)
16. Natural language processing (NLP) for HRI
17. Types of HRI: Teleoperation, Assistive, Collaborative Robotics
18. Control Strategies: Adaptive, Impedance & Force Control
19. Tracking Algorithms in Robotics – Kalman filters, optical flow
20. Experimental Evaluation of Control Algorithms
21. Safety Considerations in HRI Experiments,
22. Case Studies: Exoskeletons, Service Robots, & Social Robots

UNIT IV: Robot Programming

23. Robot Programming – Different programming paradigms.
24. Types of Robot Programming – Online vs. offline programming, teach pendants.
25. Writing Simple Programs for Robot Movement – Hands-on implementation.
26. Programming for Robots using Arduino or Raspberry Pi.
27. Motor Control Using Microcontrollers – PWM, motor drivers, and interfacing.
28. Advanced Motion Control Techniques – Trajectory generation and smooth motion.
29. Debugging & Testing Robot Programs – Identifying and fixing errors.

UNIT V: Autonomous Robotic Systems

30. Levels of Autonomy in Robotics
31. Real-time control and Decision-Making in Autonomous Robots
32. Autonomous Navigation & Motion Planning
33. Types of Path Planning Algorithms
34. Navigation in Dynamic Environments

33. PLCs in Robotics
34. Ladder Logic Programming
35. Industrial Robot Programming
36. Integration of Robotics with Automation
37. Use cases & Case Study Analysis

LAB Experiments:

1. Simulate different robot parts: base, links, joints, actuators using RoboAnalyzer
2. Demonstrate movement using different coordinate reference frames using RoboAnalyzer
3. Simulate different configurations and analyze workspace differences using RoboAnalyzer / RoboDK
4. Simulate a 3-link robotic arm and observe its kinematic chain using **CoppeliaSim**
5. Analyze the effect on different coordinate frames using homogeneous transformations to a robot manipulator in RoboAnalyzer
6. Demonstrate a 3-DOF manipulator using D-H parameters using RoboAnalyzer / RoboDK
7. Compute inverse kinematics for a 2-link robot RoboAnalyzer & CoppeliaSim
8. Simulate singularities & Redundancy in a robotic manipulator using CoppeliaSim / RoboAnalyzer
9. Apply forces and torques to a robotic arm and observe behavior in Robotic Systems CoppeliaSim / RoboAnalyzer.
10. Generate a trajectory for a robotic arm moving between two points using RoboDK.
11. Implement a pick-and-place task with optimized trajectory.
    Using CoppeliaSim / RoboDK.
12. PLC-Based Conveyor Belt System Simulation

TEXT BOOKS:

1. Mikell P. Groover, Nicholas G. Odrey, Ashish D. Kaparthi, and Mitchel Weiss, Industrial Robotics: Technology, Programming, and Applications, Tata McGraw-Hill Education, 4th Edition, 2022.
2. Nikolaus Correll, Bradley Hayes, and Samuel Paivinen, "Introduction to Autonomous Robots", MIT Press, 2nd Edition, (2022).

REFERENCE BOOKS:

1. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, TRobotics: Control, Sensing, Vision, and Intelligence", McGraw-Hill, 2021.
2. Bruno Siciliano, Oussama Khatib, "Springer Handbook of Robotics", Springer, 2019.

ROBOTICS AND AUTOMATION SPECIALIZATION

SPECIALIZATION CORE

(25MEC302SC202) ROBOTICS AND AUTOMATION			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Robotics

1. Overview & classification of Robotics
2. Robot Components, Mechanical Configurations
3. Degrees of Freedom
4. Joints of Robots
5. Coordinate Frames & Transformations

UNIT II: Robot Kinematics

6. Kinematic Chains & Robotic Mechanisms
7. Forward Kinematics -Formulation and their physical significance
8. Forward Kinematics - Application on different configurations
9. Homogeneous Transformation Matrices
10. Denavit-Hartenberg (D-H) Convention
12. Application of D-H Conventions
13. Inverse Kinematics - Formulation and their physical significance
14. Inverse Kinematics - Application on different configurations
15. Jacobian Matrix for forward and reverse kinematics
16. Velocity Kinematics of robot configuration

UNIT III: Robot Dynamics

17. Difference Between Kinematics and Dynamics
18. Robot Dynamics and orientations of end-effector
19. Equations of Motion in Robotics
20. Forces and Torques in Robotic Systems
21. Newton-Euler Formulation
22. Lagrangian Formulation
23. Task-Space vs. Joint-Space Dynamics

UNIT IV: Trajectory Planning and Motion Control

24. Concepts of Trajectory Planning
25. Cubic and Quintic Polynomials
26. Velocity and Acceleration Profiles
27. Trajectory Generation in Joint Space
28. Trajectory Generation in Task Space
29. Motion Control Strategies
30. Feedback and Feedforward Control

UNIT V: Automation Systems in Robotics

31. Automation in industries
32. Types of Automation

19. AI-driven supply chain management, integration of smart robotics and automation, and cybersecurity resilience in interconnected systems.

UNIT V: Future Trends in IIoT and Capstone Project

20. Forecasting Future Trends in IIoT: Emerging technologies, digital transformation roadmap, and sustainable smart factories.
21. Anticipated Developments in the Next Decade: Role of quantum computing, hybrid manufacturing systems, and AI-driven digital factories.
22. Capstone Project: Application of IIoT concepts in a practical manufacturing challenge.
23. AI-powered predictive maintenance, quantum computing impact on manufacturing, and advanced digital materials manufacturing.

LIST OF EXPERIMENTS

1. Introduction to digital manufacturing technologies and Industry 4.0 concepts using simulation and visualization tools.
2. Interfacing industrial sensors for data acquisition and real-time monitoring in manufacturing systems.
3. Development of an Industrial Internet of Things (IIoT) system for machine condition monitoring using embedded platforms.
4. Collection, visualization, and analysis of manufacturing data using cloud-based IoT platforms.
5. Configuration of cloud services for remote monitoring and storage of manufacturing process data.
6. Integration of multiple sensors and devices to develop a connected manufacturing environment.
7. Development of a digital twin model for a manufacturing process or production system using simulation software.
8. Analysis of manufacturing performance using digital twin models and real-time operational data.
9. Implementation of predictive maintenance concepts using sensor data and cloud analytics.
10. Mini project involving the design, implementation, and demonstration of an Industry 4.0-enabled manufacturing system integrating IIoT, cloud computing, sensors, and digital twin technologies.

LEARNING RESOURCES

TEXTBOOKS

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2019.
2. Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, PHI, 1st edition, 2013.

REFERENCEBOOKS

1. Zhihan Lv, Elena Fersman, Digital Twins: Basics and Applications, Springer, 2022.
2. Bruce Sinclair, IoT Inc: How Your Company Can Use the Internet of Things to Win in the Outcome Economy, McGraw-Hill, 2017.

(25MEC202SE402) ADVANCED DIGITAL TECHNOLOGY IN MANUFACTURING			L	R	P	C
			2	0	2	3
Course type	Program Core	Pre-requisite	Knowledge of basic manufacturing techniques and digital systems			

UNIT I: Introduction to Digital Transformations in Manufacturing

1. Overview of Digital Transformation: Definition and scope of digital transformations.
2. Key Components and Technologies: Overview of Industry 4.0, smart manufacturing, cyber-physical systems, and digital twins.
3. Evolution of Digital Technologies in Manufacturing: Historical perspective, key technological advancements, and the role of automation.
4. Drivers and Challenges: Factors motivating digital transformation in manufacturing, common challenges, and strategies to overcome them.
5. Incorporation of sustainability in digital transformation, human-robot collaboration, and role of AI in digitalization.

UNIT II: IIoT and Sensor Technology in Manufacturing

6. Industrial Internet of Things (IIoT): Definition, core principles, and use cases in manufacturing.
7. Sensor Technology in Manufacturing: Types of sensors and their applications in smart factories.
8. Sensor Networks and Data Collection: Integration of IIoT and sensors to create a connected manufacturing environment.
9. Data Analytics for Improved Efficiency: Use of real-time data for predictive maintenance, quality control, and energy management.
10. Edge computing in IIoT, digital twin integration with sensor technology, and role of blockchain in secure data management.

UNIT III: Cloud Computing and AI in Manufacturing

11. Fundamentals of Cloud Computing: Cloud architecture, deployment models, and cloud-based manufacturing solutions.
12. Cloud-based Tools and Platforms: Use of cloud computing for digital manufacturing, case studies of successful cloud adoption.
13. Security and Privacy in Cloud Adoption: Best practices for data security, compliance considerations, and cybersecurity frameworks.
14. Artificial Intelligence and Machine Learning in Manufacturing: AI-driven process optimization, generative design, and automation.
15. AI-driven digital twins, federated learning in manufacturing, and cloud-integrated additive manufacturing.

UNIT IV: Systems and Partners in IIoT

16. IoT Ecosystem: Stakeholders and their roles, interoperability, and standardization.
17. Interconnected Systems in IIoT: Strategies for effective integration, cybersecurity measures, and digital manufacturing supply chains.
18. Case Studies in Collaboration: Real-world examples of successful industry collaborations, challenges, and best practices.

STUDIO WORK / LABORATORY EXPERIMENTS / HANDS ON ACTIVITY:

1. Introduction to Statistical Analysis and Data Visualization Tools
2. Getting Started with MySQL: Accessing and Managing Databases
3. Basic MySQL Operations: SELECT, UPDATE, DELETE Commands
4. Creating and Managing Databases in MySQL
5. Set Operations in MySQL: Union, Intersection, and Difference
6. Introduction to Python Programming for Data Analysis
7. File Handling in Python: Reading and Writing Data
8. Data Visualization with Matplotlib: Creating Graphs and Charts
9. Using Built-in Functions in Python for Data Manipulation
10. Introduction to Python Modules: Importing and Using Libraries
11. Integrating MySQL with Python for Data Retrieval and Analysis
12. Project Lab: Applying Statistical Analysis and Visualization to a Real-world Dataset

LEARNING RESOURCES

TEXT BOOKS

1. **White, T.** (2015). Hadoop: The Definitive Guide (4th ed.). O'Reilly Media. ISBN: 978-1491901632.
2. **EMC Education Services** (Ed.). (2015). Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. Wiley. ISBN: 978-1118876138.

REFERENCE BOOKS

1. **O'Reilly Media.** (2016). Big Data Now: 2016 Edition – Current Perspectives from O'Reilly Media. O'Reilly Media. ISBN: 978-1491957684.
2. **Khanna, S.** (2017). BIG DATA IN MANUFACTURING: A Practical Introductory Guide to Starting Your Big Data Journey. Self-published. ISBN: 978-1521227285.

SPECIALIZATION ELECTIVE - II (Smart Manufacturing)

(25MEC202SE401) **DATA ANALYTICS IN MANUFACTURING**			**L**	**R**	**P**	**C**
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I:

1. Introduction to Manufacturing Industry
2. Key Aspects of Manufacturing
3. Manufacturing Challenges
4. Types of Data in Manufacturing
5. Introduction to Big Data in Manufacturing
6. The Five V's of Big Data in Manufacturing

UNIT II:

7. Introduction to HDFS
8. Working Principle of HDFS
9. Introduction to MAPREDUCE
10. Need for MAPREDUCE
11. Working Principle of MAPREDUCE
12. Comparison of HDFS and MAPREDUCE in Big Data Processing

UNIT III:

13. Introduction to Apache Pig and Its Need
14. Working of Apache Pig and Pig Creation
15. Components of Pig and Pig Latin
16. Basic Types of Data Models in Pig

UNIT-IV

17. Introduction to Hive and Its Working
18. Hive QL: Data Types, Operators, and Functions
19. Partitions, Buckets, and Storage Formats in Hive
20. Managing Data in Hive: Importing, Altering, and Dropping Tables

UNIT V:

21. Querying Data in Hive QL: Sorting, Aggregating, and Joins
22. Advanced Hive QL: Subqueries and Optimization
23. Introduction to HBase: Definition and Key Concepts
24. Using HBase with Pig for Big Data Processing

STUDIO WORK / LABORATORY EXPERIMENTS / HANDS-ON ACTIVITY:

LABORATORY EXPERIMENTS:

1. Study the piezoelectricity in cigarette lighters working principle and list out the parts
2. Dissection and Analysis of a Piezoelectric Igniter
3. Practical Applications and Performance Evaluation: Testing the igniter under different loading conditions
4. Investigate the shape memory effect by deforming and then recovering the shape of an SMA wire.
5. Characterization of Shape Memory Effect
6. Observe the bending of an EAP material in response to an electric field.
7. Observe the deformation of an EAP material in response to an electric field.
8. Explore the electrical conductivity of conductive polymers under different conditions.
9. Setup circuits and measure the efficiency of Piezoelectric energy harvesting mechanisms
10. Setup circuits and measure the efficiency of thermoelectric energy harvesting mechanisms
11. Setup circuits and measure the efficiency of electromagnetic energy harvesting mechanisms
12. Performance Evaluation and Optimization: comparing efficiency of different materials

LEARNING RESOURCES

TEXTBOOKS:

1. Fundamentals of Smart Materials, Mohsen Shahinpoor, Royal Society of Chemistry, 1st edition, 2020
2. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006.

REFERENCE BOOKS:

1. Smart Structures, P. Gauenzi, Wiley, 2009.
2. Handbook of Smart Materials, Technologies, and Devices, Chaudhery Mustansar Hussain, Paolo Di Sia, Springer, 1st Edition, 2022

(25MEC202SE302) SMART MATERIALS			L	R	P	C
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Smart Materials

1. Introduction to Material Classes: Characteristics of metals, polymers, and ceramics, Introduction to smart materials, properties, and classification.
2. Components of a Smart System: Elements and mechanisms of smart responses.
3. Types of Smart Materials: Piezoelectric materials, Electrostrictive materials, Magnetostrictive materials, Magnetoelectric materials
4. Magneto-rheological fluids, Electro-rheological fluids and Shape Memory materials.
5. Applications of Smart Materials: Industry and research-based case studies.
6. Smart materials in architectural design (photochromics, thermochromics, electroluminescents), symmetry-breaking phase transformations, and multifunctional structures.

UNIT II: Processing of Smart Materials

7. Processing Techniques: Semiconductor fabrication,
8. Metal metallization techniques, Ceramic processing methods,
9. Polymer synthesis (UV Radiation Curing of Polymers: Mechanisms and applications.)
10. Multiscale processing and microstructural control, Composite material fabrication techniques.

UNIT III: Smart Sensors

11. Introduction to Sensors: Definition, characteristics, and classification.
12. Types of Sensors: Conductometric, Capacitive and Piezoelectric
13. Magnetostrictive, Piezoresistive and Optical and Resonant
14. Semiconductor-based and Acoustic, Polymer-based and Carbon nanotube sensors.
15. New sensors Ferroelectric sensors, Liquid crystal elastomer-based sensors, Integrated multifunctional sensors.

UNIT IV: Smart Actuators

16. Introduction to Actuation Mechanisms: Basics and working principles.
17. Types of Actuators: Electrostatic transducers, Electromagnetic transducers, Electrodynamic transducers, Piezoelectric transducers,
18. Electrostrictive transducers, Magnetostrictive transducers and Electrothermal actuators.
19. Comparison of Actuation Mechanisms: Performance metrics and applications.
20. Multiferroic actuators, Micro and nanoscale actuators, Soft actuators for adaptive structures.

UNIT V: Internet of Things (IoT) in Smart Composites

21. Integration of Smart Materials into IoT Systems: Role of embedded sensors and actuators.
22. Wireless Communication and Data Transmission: Protocols and implementation.
23. Real-time Monitoring and Control: Applications in adaptive structures, healthcare, and industrial automation.
24. Machine learning for smart material behavior prediction, Digital twins in smart material applications.

35. Best Practices for IIoT Security Implementation
36. Future Security Trends and Research Directions in IIoT

LABORATORY EXPERIMENTS

1. Study of Industrial IoT architecture and configuration of an IIoT development environment.
2. Interfacing industrial sensors (temperature, pressure, proximity, humidity, vibration) with microcontroller/edge devices for real-time data acquisition.
3. Interfacing actuators and implementing basic industrial automation using embedded controllers.
4. Implementation of MQTT protocol for transmitting sensor data between edge devices and cloud platforms.
5. Configuration and testing of OPC-UA communication for secure industrial data exchange.
6. Development of an IIoT-based remote monitoring system using cloud platforms such as AWS IoT, Microsoft Azure IoT, or similar open-source platforms.
7. Real-time data visualization and dashboard development for industrial process monitoring.
8. Edge computing implementation for local data processing and comparison with cloud-based analytics.
9. Implementation of predictive maintenance using sensor data and machine learning techniques for condition monitoring.
10. Mini project involving the design and implementation of an Industrial IoT system integrating sensors, edge devices, cloud services, and industrial analytics for a smart manufacturing application.

LEARNING RESOURCES

TEXTBOOKS

1. Geng Geng, "Industrial IoT: Challenges, Design Principles, Applications, and Security",Springer, 2021.
2. Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0", Packt Publishing, 2018.

REFERENCEBOOKS

1. Perry Lea, IoT and Edge Computing for Architects, Packt Publishing, 2020
2. Sam Goundar (Editor), J. Avanija (Editor), Gurram Sunitha (Editor), K. Reddy Madhavi (Editor), S. Bharath Bhushan (Editor), " Innovations in the Industrial Internet of Things (IIoT) and Smart Factory (Advances in Computer and Electrical Engineering)"

SPECIALIZATION ELECTIVE - I (Smart Manufacturing)

(25MEC202SE301) INDUSTRIAL IoT			L	R	P	C
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Industrial IoT

1. IoT Background: Definition, Evolution, and Enabling Technologies
2. Industry 4.0 and IIoT: Differences and Similarities
3. IIoT Use Cases: Manufacturing, Healthcare, Smart Cities, Logistics
4. Key Challenges in Implementing IIoT
5. Role of Data and Connectivity in IIoT
6. Business Benefits and return on investment of IIoT Adoption

UNIT II: Industrial Processes and IIoT Devices

7. Automation in Industry & Industrial Control Systems
8. Types of Industrial Processes: Batch, Continuous, and Discrete
9. Role of Sensors and Actuators in IIoT
10. Overview of Industrial Edge Devices
11. The CIM Pyramid & ISA-95 Equipment Hierarchy
12. Integration of IIoT Devices with Existing Infrastructure

UNIT III: Industrial IoT Networking and Communication

13. Data Flow in Industrial IoT: Sensors → Edge → Cloud → Analytics
14. Edge Computing vs Cloud Computing for IIoT
15. IIoT Protocols: MQTT, OPC-UA, Modbus, Profibus
16. IIoT Communication Networks: Fieldbus, SCADA, MES, ERP
17. Industrial Protocols: OPC-UA, DDS, LoRaWAN, Ethernet/IP
18. Real-time Data Processing with Edge Gateways
19. Industrial Communication Challenges & Solutions
20. Case Studies on IIoT Networking Implementation
21. Future Trends in IIoT Communication

UNIT IV: IIoT Cloud Platforms & Industrial Analytics

22. IIoT Cloud Providers: AWS IoT, Microsoft Azure IoT, Google Cloud IoT
23. Introduction to Time-Series Databases for IIoT: InfluxDB, OSIsoft PI
24. Importance of Data Storage & Retrieval in IIoT
25. Industrial Data Analytics & AI for IIoT
26. Predictive Maintenance Using IIoT Data
27. Role of Machine Learning in Industrial Automation

UNIT V: IIoT Security & Cyber security

28. IIoT Security & Cyber security Challenges
29. Industrial Network Security Standards & Compliance
30. Risk Assessment and Threat Modeling in IIoT
31. Firewalls, DMZ, VPNs in Industrial Networks
32. IDS/IPS for Industrial Networks
33. Case Studies on IIoT Security Breaches
34. Securing IIoT Data Flow with TLS/SSL

34. ERP
35. MES
36. Implementing Digital Manufacturing in a Real-world Scenario

LAB PLAN

1. Introduction to Molecular Dynamics and parametric design of an Alloy
2. Designing an Alloy and Simulating its Thermal Properties.
3. Introduction to Computational Fluid Dynamics (CFD) Using Open Source Software
4. Demonstration of a Real-Time Computational Fluid Dynamics (CFD) Model (fluid passing through cutting tool)
5. Explanation and Demonstration of a Component Using a 3D Printer (FDM Technology)
6. Demonstration and construction of partial build body using 3D scanner
7. Explain a ERP system showing a real time software package
8. Demonstration of Material Management ERP package working procedure
9. Design CAD model and import into Unity
10. Access CAD from Unity using Vuforia Augmented Reality
11. Demonstrate Condition Monitoring technique for Fault diagnosis of Bearing
12. Demonstrate Condition Monitoring technique for Fault diagnosis of Bearing using Vibration or sound sensor

(25MEC302SC301) DIGITAL MANUFACTURING SYSTEM DESIGN			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Digital Manufacturing & Design

1. Overview of Digital Manufacturing & Design Technology
2. Impact on Manufacturing Careers & Advantages of Digital Manufacturing
3. Information Sharing in the Digital Thread & Multiple Organizations in Manufacturing Session 1
4. Information Sharing in the Digital Thread & Multiple Organizations in Manufacturing session 2
5. Transition to Digital Manufacturing and Design - Case Studies

UNIT II: Digital Manufacturing Components & Digital Thread

6. Digital Manufacturing Components
7. Closed Loop Approach
8. Integrated Information Systems in Product Lifecycle & Organizational Protection
9. Introduction to Digital Thread: Vision, Innovation Diffusion & Motivating Factors
10. Data Storage in Digital Thread: Data Singularity, Version Control, Security & Recovery
11. Implementing a Digital Thread in a Manufacturing Enterprise Case Study Discussion

UNIT III: Data Sharing, Cyberinfrastructure & Digital Thread Implementation

12. Data Sharing
13. Interoperability Semantic Data in Digital Thread
14. Strategic Issues in Implementing the Digital Thread
15. Transitioning to the Digital Thread: Business Cases, Challenges & Benefits
16. Cyberinfrastructure Components: IT & Computing Resources
17. Cloud-based Computing
18. Virtualization for Digital Manufacturing

UNIT IV: CNC Machine Tools, FMS & Automation in Manufacturing

19. 19. Flexible Manufacturing Systems (FMS) & Automated Machine Systems
20. Overview of CNC Machine Tools, Types, and Benefits of Multi-Axis Machines
21. Tooling, Sensing
22. Automated Methods of Loading in CNC Systems
23. Hands-on Demonstration of CNC Programming and Toolpath Optimization
24. Short test & discussion on automation technologies

UNIT V: Design Process Technologies & Digital Manufacturing Applications

25. Technologies in Design Process: FEA,
26. CFD
27. Mold Design, Verification & Validation
28. Digital Thread on Shop Floor: Additive Manufacturing
29. Digital Work Instructions & Metrology
30. Digital Manufacturing Enterprise
31. IIOT
32. 32.Factory Simulation Tools,
33. MRP

UNIT 5: Cybersecurity and Smart Manufacturing Platforms

21. **Cybersecurity in Smart Manufacturing -** Importance, threats, and countermeasures.
22. **Security Measures and Best Practices -** Implementing robust security frameworks.
23. **Smart Manufacturing Platforms and Standards -** Overview and applications.
24. **Future Trends in Smart Manufacturing -** Emerging technologies and innovations.

LABORATORY EXPERIMENTS

1. Introduction to CAD Modeling - Creating 3D models using CAD software.
2. Finite Element Analysis (FEA) Simulation - Stress analysis of a mechanical component.
3. Computational Fluid Dynamics (CFD) Simulation - Analyzing fluid flow through a pipe.
4. Additive Manufacturing Process Demonstration – Fabricating part using 3D printing.
5. Digital Twin Implementation - Creating and analyzing a digital twin model.
6. Big Data Analytics for Smart Manufacturing - Using historical and real-time data for process optimization.
7. AI-based Predictive Maintenance - Implementing machine learning for fault detection and prediction.
8. Cybersecurity in Manufacturing - Simulating a cybersecurity breach and mitigation strategies.
9. Internet of Things (IoT) and Smart Sensors - Real-time data collection and analysis from sensors.
10. Virtual Factory Simulation - Simulating a production line using digital tools.
11. Human-Robot Collaboration Experiment - Testing collaborative robots in a manufacturing setup.
12. Cloud-Based Design Collaboration - Collaborative CAD modeling using cloud platforms.

LEARNING RESOURCES

TEXT BOOKS:

1. Handbook of Smart Manufacturing: Forecasting the Future of Industry 4.0, by Ajay Hari Singh, Parveen Kumar, Bandar AlMangour, Routledge, 2023.
2. Smart Manufacturing: The Lean Six Sigma Way by Anthony Tarantino, Wiley, 2022

REFERENCE BOOKS

1. Advances in Manufacturing Processes and Smart Manufacturing by R. Venkata Rao, K. Narasimhan, V. N. Gaitonde, et al., Springer, 2024.
2. Soft Computing in Smart Manufacturing and Materials by Rupesh Kumar Jha, Elsevier, 2024.

SMART MANUFACTURING SPECIALIZATION CORE

SPECIALIZATION CORE

(25MEC302SC201) SMART MANUFACTURING			**L**	**R**	**P**	**C**
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT 1: Introduction to Smart Manufacturing

1. **Overview of Smart Manufacturing -** Definition, key principles, and significance.
2. **Evolution of Manufacturing Paradigms -** From traditional to Industry 4.0.
3. **Impact of Industry 4.0 on Manufacturing -** Technological and economic shifts.
4. **Benefits of Smart Manufacturing -** Efficiency, cost reduction, flexibility, and sustainability.
5. **Key Challenges in Implementing Smart Manufacturing -** Barriers and potential solutions.

UNIT 2: Foundations of Industry 4.0

6. **Cyber-Physical Systems (CPS) in Manufacturing -** Integration of digital and physical systems.
7. **Interoperability and Connectivity -** Communication between machines, people, and processes.
8. **Information Transparency and Data-Driven Manufacturing -** Real-time data collection and analysis.
9. **Decentralized Decision-Making in Smart Factories -** AI-driven autonomous production systems.
10. **Technologies Enabling Industry 4.0 -** IoT, Big Data, Cloud Computing, and Edge Computing.

UNIT 3: Digital Twins and Advanced Automation

11. **Concept and Significance of Digital Twins -** Virtual modeling of physical systems.
12. **Applications and Use Cases of Digital Twins -** Process optimization and predictive maintenance.
13. **Automated Manufacturing Processes -** Role of automation in smart factories.
14. **Robotics and Collaborative Robots (Cobots) -** Integration in manufacturing environments.
15. **Integration of Automation with Smart Technologies -** AI, IoT, and cloud computing.

UNIT 4: Artificial Intelligence (AI) in Manufacturing

16. **Basics of AI and Machine Learning in Manufacturing -** Fundamentals and use cases.
17. **AI Applications in Manufacturing -** Predictive maintenance, quality control, and adaptive systems.
18. **AI-Driven Process Optimization -** Enhancing manufacturing efficiency.
19. **Decision Support Systems in Smart Manufacturing -** AI for strategic decision-making.
20. **Case Studies of AI Implementation in Manufacturing -** Real-world examples and best practices.

LABORATORY EXPERIMENTS

1. Introduction to CFD Software & Interface
2. Finite Difference Discretization of 1D Heat Conduction (MATLAB/Python)
3. Simulation of 2D Laminar Flow Over a Flat Plate
4. Grid Independence Study Using a CFD Tool
5. Implementation of SIMPLE Algorithm in MATLAB/Python
6. RANS Turbulence Model for Flow Over a Cylinder
7. Conjugate Heat Transfer Analysis in a Pipe Flow
8. Simulation of Flow Over an Airfoil (Lift & Drag Calculation)
9. Transient Heat Conduction Simulation in a Solid
10. Flow Through a Sudden Expansion Pipe (Separation & Recirculation)
11. Multi-Phase Flow Simulation Using VOF Model
12. Project Work – Final Report & Presentation

TEXTBOOKS

1. **J. D. Anderson**, Computational Fluid Dynamics: The Basics with Applications, McGraw Hills Education, Indian Edition, 2017.
2. **Joel H. Ferzige, Milovan Perić, Robert L. Street**, Computational Methods for Fluid Dynamics, Springer, 4th ed, 2020.

REFERENCE BOOKS

1. **H. Versteeg & W. Malalasekera**, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, PHI Publishing, 2nd ed, 2007.
2. **T. J. Chung,** Computational Fluid Dynamics**,** Cambridge University Press, 2nd ed. 2014.

1.

(25MEC202PE408) COMPUTATIONAL FLUID DYNAMICS			L	R	P	C
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I – Introduction to CFD & Governing Equations

1. Basics of Computational Fluid Dynamics, Applications & Importance
2. Governing Equations of Fluid Flow: Conservation of Mass, Momentum & Energy
3. Classification of Partial Differential Equations (PDEs)
4. Well-posed & Ill-posed Problems, Initial & Boundary Conditions
5. Analytical vs Numerical Solutions

UNIT II – Discretization Techniques & Numerical Methods

6. Introduction to Finite Difference Method (FDM) & Finite Volume Method (FVM)
7. Discretization of Diffusion & Convection Terms
8. Implicit vs Explicit Methods, Stability & Convergence Criteria
9. Solution of Linear Systems: Gauss-Seidel, Jacobi, Successive Over-Relaxation (SOR)
10. Error Analysis & Grid Independence Study

UNIT III – Grid Generation & Solution Algorithms

11. Types of Grids: Structured, Unstructured & Hybrid Meshes
12. Mesh Quality Parameters: Skewness, Aspect Ratio, Orthogonality
13. Pressure-Velocity Coupling: SIMPLE & PISO Algorithms
14. Application of Boundary Conditions in CFD Simulations
15. Post-Processing & Result Interpretation

UNIT IV – Turbulence Modeling & Heat Transfer in CFD

16. Introduction to Turbulence & Need for Modeling
17. Reynolds-Averaged Navier-Stokes (RANS) Models
18. Large Eddy Simulation (LES) – Basic Concept
19. Heat Transfer in CFD: Conduction & Convection Models
20. Industrial Applications: Heat Exchangers, Cooling Systems

UNIT V – CFD Applications & Case Studies

21. Introduction to CFD Software (ANSYS Fluent, OpenFOAM, etc.)
22. External Flow Simulations: Airfoil, Cylinder
23. Internal Flow Simulations: Pipe, Duct
24. Multiphase & Reactive Flow Overview

LABS

1. Introduction Session
2. Design of tool electrodes to perform Electrochemical Machining
3. Tool Design for Micromachining Processes
4. Demo of COMSOL Multiphysics and Hands-on Session
5. Demo of COMSOL Multiphysics and Hands-on Session
6. Modelling and simulation for Electrochemical Machining, polishing to estimate MRR and Surface finish.
7. Lab Exam
8. Modelling and simulation for Electro discharge Machining to estimate MRR and Surface finish.
9. Modelling and simulation of Laser Beam Machining to estimate MRR.
10. Experimental study on ultrasonic cleaning for removal of foreign contaminants from surfaces.
11. Lab Exam
12. Buffer Class

TEXTBOOKS

1. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Publications, eighth edition,2020.
2. Pandey P C and Shah H S, "Modern Machining Process", 2008, 1st Edition, TMH, Sixth edition, 2022.

REFERENCE BOOKS

1. V K Jain, Advanced Manufacturing Process, Allied publishers, 12th edition, 2022.
2. Kapil Gupta, Advanced Manufacturing Technologies: Modern Machining, Advanced Joining, Sustainable Manufacturing (Materials Forming, Machining and Tribology), Sprinzer, First edition, 2017.

PROGRAM ELECTIVE – IV

(25MEC202PE407) UNCONVENTIONAL MACHINING PROCESS			**L**	**R**	**P**	**C**
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT-I

1. Introduction to Non-Traditional Machining Methods
2. Classification of Modern Machining Processes
3. Process Selection Based on Material and Application
4. Elements of Ultrasonic Machining
5. Mechanics of Material Removal
6. Applications and Limitations of Ultrasonic Machining

UNIT-II

7. Basics of Abrasive Jet Machining, Mechanics of Material Removal in Abrasive Jet Machining
8. Understanding Water and Abrasive Water Jet Machining
9. Applications and Constraints of Abrasive Jet Machining, WJM, and AWJM
10. Basics of Electro-Chemical Machining, Material Removal Rate in Electro-Chemical Machining
11. Design Considerations for ECM Tools
12. Surface Finish and Applications of ECM

UNIT-III

13. Basics of Electric Discharge Machining
14. Material Removal in EDM
15. Parameters Affecting EDM Performance
16. Wire EDM Fundamentals

UNIT-IV

17. Electron Beam Machining Fundamentals
18. Applications of Electron Beam Machining
19. Basics of Laser Beam Machining
20. Performance Parameters of LBM

UNIT-V

21. Basics of Plasma Machining
22. Performance Analysis of Plasma Machining
23. Micromachining for difficult to cut materials
24. Industry lecture on applications of unconventional machining processes for Dies and fixtures manufacturing

35. Effluents from Power Plants, Pollution Standards, and Pollution Control Methods

TEXTBOOKS

1. Farshid Zabihian, "Power Plant Engineering", CRC Press, 1st edition, 2021.
2. R. K. Rajput, "A Textbook of Power Plant Engineering", Laxmi Publications, 5th edition, 2016.

REFERENCE BOOKS

1. Sudipta De, "Nag's Power Plant Engineering", McGraw Hill, 5th edition, 2021.
2. P. K. Nag, "Power Plant Engineering", McGraw Hill Education, 4th edition, 2017.

(25MEC300PE406) POWER PLANT ENGINEERING			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Power Plants

1. Introduction to the Sources of Energy
2. Resources and Development of Power in India
3. Steam Power Plant: Plant Layout
4. Working of Different Circuits in a Steam Power Plant
5. Fuel and Handling Equipment: Types of Coal and Storage Methods
6. Ash Handling Systems

UNIT II: Steam & Gas Turbine Power Plants

7. Combustion Process & Properties of Coal
8. Overfeed and Underfeed Fuel Beds
9. Travelling Grate, Spreader, and Retort Stokers
10. Pulverized Fuel Burning System and Its Components
11. Combustion Needs and Draught System
12. Cyclone Furnace: Design and Construction
13. Dust Collectors and Cooling Towers in Power Plants
14. Introduction to Gas Turbine Plants: Classification & Construction
15. Layout and Working of Open and Closed Cycle Gas Turbines

UNIT III: IC Engines & Hydro Power Plants

16. Introduction to Diesel Power Plants & IC Engines
17. Types of IC Engines and Their Construction
18. Diesel Power Plant Layout with Auxiliaries
19. Water Power and the Hydrological Cycle
20. Flow Measurement and Drainage Area Characteristics
21. Hydrographs, Storage, and Pondage
22. Classification of Dams and Spillways
23. Hydro Power Plant Layout and Operation

UNIT IV: Nuclear Power Plants

24. Nuclear Fuels: Breeding and Fertile Materials
25. Nuclear Reactor and Reactor Operation
26. Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR)
27. Sodium-Graphite Reactor and Fast Breeder Reactor (FBR)
28. Homogeneous Reactor and Gas-Cooled Reactor
29. Radiation Hazards and Shielding Methods
30. Radioactive Waste Disposal and Environmental Concerns

UNIT V: Power Plant Economics & Environmental Considerations Capital Cost, Fixed Charges, and Operating Costs

31. General Arrangement of Power Distribution
32. Load Curves and Load Duration Curve
33. Key Load Parameters: Connected Load, Maximum Demand, Demand Factor
34. Load Factor and Diversity Factor: Related Exercises

EXPERIMENTS:

1. Model in-line automated flow lines by using FlexSim software
2. Model rotary automated flow lines by using FlexSim software
3. Model Partial automated flow lines by using FlexSim software
4. Model in-line automated flow lines with buffer Storage by using FlexSim software
5. Model rotary automated flow lines with buffer Storage by using FlexSim software
6. Model Partial automated flow lines by using FlexSim software
7. Model automated transfer lines with conveyor systems by using FlexSim software
8. Model automated transfer lines with AGV by using FlexSim software
9. Model automated Storage/Retrieval Systems in manufacturing industry
10. Identify product with Barcode, RFID etc.by using Flexsim software
11. Model partially automated flow line with AGV by using Flexsim software
12. Model fully automated flow line with AGV by using Flexsim software

PROGRAM ELECTIVE – III

(25MEC202PE405) FACTORY AUTOMATION			**L**	**R**	**P**	**C**
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction

1. Automation in Production System
2. Principles and Strategies of Automation
3. Basic Elements of an Automated System
4. Advanced Automation Functions
5. Levels of Automation, Cost of Manufacturing Lead Time

UNIT II: Automated Flow Lines

6. Transfer Mechanism
7. Buffer Storage
8. Control Functions
9. Automation for Machining Operations

UNIT III: Material Handling

10. Types of Material Handling Equipment
11. Analysis for Material Handling Systems
12. Conveyor Systems and Automated Guided Vehicles
13. Automated Storage Systems and Automated Storage/Retrieval Systems (AS/RS)
14. Conveyor Systems and Automated Guided Vehicle (AGV) Systems

UNIT IV: Identification Technologies

15. Barcode, RFID
16. Automated Assembly Systems, Design for Automated Assembly
17. Automated Assembly Systems-Types
18. Part Feeding Devices
19. Analysis of a Single Station and Multi Station Assembly Machines.

UNIT V: Control Technologies in Automation

20. Industrial Control Systems
21. Process Industries Versus Discrete Manufacturing Industries
22. Continuous Verses Discrete Control
23. Computer Process Control and its Forms
24. Construction Automation, autonomous systems

33. Filters, Grills and registers, fans and blowers.
34. Working of humidifier and dehumidifiers.
35. Heat pump and classification.
36. Different heat pump circuits.

TEXTBOOKS

1. C P Arora, "Refrigeration and Air Conditioning", TMH, 5th Edition, 2021.
2. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 3rd Edition, 2021.

REFERENCE BOOKS

1. Tomczyk J. A., "Refrigeration and Air Conditioning Technology", Cengage Learning Exclusive, 8th Edition, 2020.
2. R.S.Khurmi and J.K.Gupta, "Refrigeration and Air conditioning", S.Chand, Eurasia Publishing House (P) Ltd, 1st Edition, 2019.

(25MEC300PE404) REFRIGERATION AND AIR CONDITIONING			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Refrigeration and Air Refrigeration

1. Introduction to Refrigeration, Necessity and Applications.
2. Unit of refrigeration and C.O.P, Mechanical refrigeration
3. Types of Ideal cycles of refrigeration
4. Calculation of COP of refrigeration cycle
5. Need of Air Refrigeration, Explanation of Bell Coleman cycle
6. Open Vs Dense air systems, Actual air refrigeration system
7. Need of Refrigeration in Air Crafts

UNIT II: Vapour Compression Refrigeration, Refrigerants

8. Working principle and essential components of the plant
9. Simple vapour compression refrigeration cycle
10. COP - Representation of cycle on T-S and p-h charts , Effect of subcooling and super heating - cycle analysis
11. Effect of subcooling and super heating - cycle analysis
12. Actual cycle Influence of various parameters on system performance ,Use of p-h charts - numerical problems
13. Principles of Evaporators, Classification, Working principles of expansion devices
14. Refrigerants, desirable properties, classification refrigerants used.
15. Nomenclature of refrigerants.

UNIT III: Vapour Absorption Refrigeration System

16. Vapour Absorption Refrigeration System, Calculation of max COP
17. Working of NH_3 - water system and Li Br - water (Four shell) System
18. Working principle of Li Br – water (Two shell)
19. Principle of operation Three Fluid absorption system
20. Working of Steam Jet refrigeration
21. Thermoelectric refrigerator and Vortex tube or Hilsch tube

UNIT IV: Introduction to Air Conditioning

22. Introduction to Air Conditioning, Psychometric Properties
23. Psychometric Processes
24. Calculation of Psychrometric properties
25. Sensible and latent heat loads, Need for Ventilation, infiltration
26. Load concepts of RSHF, GSHF, Numerical problems on RSHF,
27. Concept of ESHF and ADP
28. Numerical problems on SHF, ADP
29. Requirements of human comfort and concept of effective temperature, Comfort chart and Comfort Air conditioning
30. Requirements of Industrial air conditioning and Load calculations.

UNIT V: Air Conditioning Systems

31. Air Conditioning Systems , Classification of equipment.
32. Cooling, heating humidification and dehumidification 3

LAB

1. Predict future demand using moving averages, exponential smoothing, and regression analysis.
2. Calculate and visualize the break-even point using cost and revenue data.
3. Optimize inventory levels using EOQ, safety stock calculations, and ABC analysis.
4. Create production schedules and visualize them using Gantt charts.
5. Simulate dispatching processes using job priorities and due dates.
6. Simulate production system behaviours under varying conditions.

TEXTBOOKS

1. Samuel Eilon, "Elements of Production Planning and Control", Universal Book Corporation, 2015.
2. M. Mahajan, "Production Planning and Control", Dhanpat Rai & Co, 2018.

REFERENCE BOOKS

1. **Panneerselvam, R.** (2012). *Production and Operations Management* (3rd ed.). PHI Learning. ISBN: 978-8120345553.
2. **Mukhopadhyay, S.K.** (2015). *Production Planning and Control: Text and Cases* (3rd ed.). PHI Learning. ISBN: 978-8120350847.

USEFUL LINKS

1. Excel Time Series Models for Business Forecasting
   https://www.coursera.org/learn/excel-business-forecasting-time-series
2. Inventory Management
   https://www.coursera.org/learn/inventory-management

PROGRAM ELECTIVE – II

(25MEC202PE403) PRODUCTION PLANNING AND CONTROL			**L**	**R**	**P**	**C**
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT-I

1. Introduction to Production Planning and Control
2. Types of Production Environments and Organization of Production Planning
3. Break-even Analysis and Work Study Basics
4. Applications of Computers in Production Planning and Recap of Unit-I

UNIT-II

5. Introduction to Forecasting: Importance, Principles, and Factors
6. Demand Variations and Time Frames in Forecasting
7. Qualitative Forecasting Techniques
8. Quantitative Forecasting Techniques
9. Forecasting Errors and Recap of Techniques

UNIT-III

10. Introduction to Inventory Management: Functions and Costs
11. Inventory Classification and Deterministic Models
12. Inventory Control Systems: Perpetual, Periodic, and Safety Stock
13. Inventory Classification Techniques: ABC and VED Analysis
14. Operations Planning: MRP, MRP-II, ERP, and JIT Systems

UNIT-IV

15. Introduction to Aggregate Planning and Strategies
16. Aggregate Planning Methods
17. Introduction to Line Balancing: Terminology and Methods
18. Advanced Line Balancing Techniques
19. Routing Procedure and Route Sheet

UNIT-V

20. Introduction to Scheduling: Definition and Policies
21. Types of Scheduling Methods: Flow Shop and Job Shop
22. Dispatching: Definition, Activities, and Procedures
23. Follow-Up: Definition, Types, and Expediting Procedures
24. Integrating Scheduling, Dispatching, and Follow-Up

LIST OF EXPERIMENTS:

1. Study of free vibration characteristics of a single-degree-of-freedom (SDOF) system and determination of its natural frequency.
2. Experimental determination of damping coefficient and damping ratio using the logarithmic decrement method.
3. Investigation of forced vibration response of an SDOF system under harmonic excitation and resonance conditions.
4. Study of vibration isolation and determination of transmissibility for different excitation frequencies.
5. Measurement and analysis of vibration signals using accelerometers, vibration sensors, and data acquisition systems.
6. Experimental determination of the critical speed of a rotating shaft and observation of resonance phenomena.
7. Analysis of free vibration characteristics of a two-degree-of-freedom (2DOF) system and determination of mode shapes and natural frequencies.
8. Demonstration of vibration absorber performance for reducing the amplitude of forced vibrations.
9. Modal analysis of beam or shaft vibration using simulation software and comparison with analytical solutions.
10. Mini project involving vibration measurement, analysis, and control of a mechanical system using experimental or simulation techniques.

TEXTBOOKS

1. S. S. Rao. Mechanical Vibrations, 4th Edition, and Pearson India: New Delhi.
2. W. T. Thomson, M. D. Dahleh and C. Padmanabhan. Theory of Vibration with Applications, Pearson Education India: New Delhi.
3. L. Meirovitch. Elements of Vibration Analysis, Tata McGraw-Hill: New Delhi.

REFERENCEBOOKS

1. B. Ramachandran, E. B. Magrab. Fundamentals of Vibrations, Cengage Engineering: New Delhi.
2. V. Ramamurti. Mechanical Vibration Practice and Noise Control, Narosa: New Delhi.
3. S. J. P. Den Hartog. Mechanical Vibrations. McGraw-Hill.

(25MEC202PE402) MECHANICAL VIBRATIONS			L	R	P	C
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction of vibration models

1. Introduction to Vibration
2. Applications of Vibration
2. Basic Concept on Vibration Models
3. Mechanical System Vibration Models
4. Deriving Equations of Motion
5. Implement boundary conditions

UNIT II: Single degree of freedom systems vibration

6. Introduction to SDOF Systems & Free Vibration
7. Damped Free Vibration
8. Forced Vibration – Harmonic Excitation
9. Rotating Unbalance & Support Excitation
10. Transmissibility & Vibration Isolation
11. Case Studies & Problem Solving

UNIT III: Advanced vibration analysis and measurement techniques

12. Vibration Measuring Instruments
13. Response to Periodic and Arbitrary Excitation
14. Critical Speed of Rotors
15. Energy Method & Rayleigh's Method
16. Equivalent Viscous Damping
17. Laplace Transform &
18. Fourier Transform Methods

UNIT IV: 2-DOF systems and Multi-DOF Systems

19. Introduction to Two-DOF Systems & Free Vibration
20. Matrix Formulation of Two-DOF Systems
21. Beat Phenomenon in Two-DOF Systems
22. Forced Vibration in Two-DOF Systems
23. Principle of Vibration Absorbers
24. Introduction to Multi-DOF Systems & Matrix Formulation
25. Eigenvalue Problem, Normal Modes, & Influence Coefficients
26. Applications of Lagrange's Equation in Vibration Problems

UNIT V: Continuous system models vibration analysis (8 sessions)

27. Introduction to Continuous System Models
28. Transverse Vibration of Strings
29. Torsional Vibration of Shafts
30. Axial and Beam Bending Vibrations
31. Forced Vibration of Continuous Systems using Modal Superposition
32. Introduction to Approximation Methods
33. Rayleigh-Ritz Method for Vibration Analysis
34. Galerkin Method & Comparative Analysis

LAB EXPERIMENTS

1. Using ProjectLibre, determine the critical path of various activities of the given project and project completion time.
2. Find the total slack and free slack of each activity of the given project.
3. Create a project plan that includes various tasks and sub-tasks of the production of a new high-efficiency lathe machine for a manufacturing company and find the total duration required to manufacture the lathe machine.
4. Identify various tasks and sub-tasks of the production of a new industrial pump. Determine the critical path for this project and calculate the total duration required to manufacture the pump.
5. Create a Work Breakdown Structure (WBS) for establishing a thermal power plant. Assign the relevant resources and identity the project completion time.
6. Show Work breakdown structure (WBS), Resource breakdown structure (RBS) and Resource Usage while completing various tasks and sub-tasks of the given project activities.

TEXTBOOKS

1. S.N Chary, Production and Operations Management, Tata McGraw-Hill, 6th Edition, 2019
2. Lee J. Krajewski, Manoj K. Malhotra, Samir K. Srivastava and Larry P. Ritzman, Operations Management: Processes and Supply Chains, Pearson Education, 12e Edition, 2018

REFERENCE BOOKS

1. R. Pannerselvam, Production and Operations Management, PHI Learning Pvt. Ltd, 3rd Edition, 2012
2. E.S Buffa, Modern Production/ Operations Management, John Wiley & Sons, 8th Edition, 2007

PROGRAM ELECTIVE

PROGRAM ELECTIVE – I

(25MEC202PE401) PRODUCTION AND OPERATIONS MANAGEMENT			**L**	**R**	**P**	**C**
			2	0	2	3
Course type	Program Core	Pre-requisite				

UNIT I - Operations Management and Product Design
Introduction Operations Management and Strategy.

1. Tools for Implementation of Operations, Industry Best Practices.
2. Requirements of good product design, product development approaches
3. Concepts in product development – standardization, simplification
4. Speed to market - Introduction to concurrent engineering.

UNIT II - Value Engineering, Facility location and layout

5. Objectives of value engineering, Types of values, Function & cost
6. Product life cycle, Steps in value engineering
7. Methodology in value engineering, FAST Diagram, Cost – Function matrix.
8. Facility location and layout - Factors considerations in plant location, Comparative study of rural and urban sites

UNIT III - Quality Management

9. Basic quality management principles - Total quality management (TQM),
10. Kaizen (Continuous improvement), Lean thinking and six sigma,
11. ISO 9001 and Quality standards; Quality control (QC) vs. Quality assurance (QA).
12. Quality tools and techniques - Control charts and Statistical process control (SPC),
13. Pareto charts and Fishbone diagrams.
14. Cost of quality (COQ) - Prevention, Appraisal, and Failure costs, Impact of poor quality on business.

UNIT IV - Supply Chain Management

15. Introduction to Supply chain management,
16. Domain applications and Views on supply chain.
17. Collaborative supply chain, Inventory management in supply chain
18. Financial supply chain – A new revolution within the SCM fold

UNIT V - Project Management

19. Programming Evaluation Review Techniques (PERT), Three times estimation
20. Critical path and Practice problems
21. Probability of completion of project and Practice problems
22. Critical path method and Practice problems
23. Crashing of simple nature and Practice problems

36. Applications of Heat Transfer in Engineering Systems

LABS

1. Determination of thermal conductivity of a metal rod
2. Determination of overall heat transfer coefficient of a composite slab
3. Determination of thermal conductivity of insulation materials using a lagged pipe apparatus
4. Determination of thermal conductivity of insulating powder using a concentric sphere apparatus
5. Determination of natural and forced convective heat transfer coefficient for a pin-fin
6. Determination of transient/unsteady temperature profile
7. Determination of natural heat transfer coefficient
8. Determination of forced heat transfer coefficient
9. Critical heat flux apparatus
10. Comparison of parallel and counter-flow heat exchangers
11. Determination of Stefan Boltzmann constant
12. Determination of emissivity of a polished plate

TEXTBOOKS

1. Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, "Incropera's Principle of Heat and Mass Transfer" Wiley India Edition, 2018
2. Yunus A. Cengel, Afshin J. Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", McGraw-Hill, 6th Edition, 2020.

REFERENCE BOOKS

1. Lienhard, J.H., and Lienhard, J. H., "A Heat Transfer Text Book", Phlogiston Press, 6th Edition, 2024.
2. Sachdeva, R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, 5th edition, 2018.

DATA BOOK

1. Kothandaraman, C. P., and Subramanyan, S., "Heat and Mass Transfer Data Book", New Age International Publishers, 2022.

(25MEC302PC306) HEAT TRANSFER			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I – Fundamentals & Heat Conduction

1. Introduction to Heat Transfer
2. Basic Laws of Heat Transfer
3. General Heat Conduction Equation
4. Boundary & Initial Conditions
5. Simplification of the General Heat Conduction Equation
6. Physical Interpretation of Conduction & Thermal Conductivity

UNIT II – One-Dimensional Steady-State Conduction

7. Steady-State Conduction in Homogeneous Slabs
8. Conduction in Cylindrical & Spherical Coordinates
9. Overall Heat Transfer Coefficient & Electrical Analogy
10. Critical Radius of Insulation
11. Extended Surfaces (Fins)
12. Analysis of Infinitely Long Fin & Fin with Insulated Tip
13. Heat Transfer Enhancement Using Fins

UNIT III – Transient Conduction & Dimensional Analysis

14. Introduction to Transient Conduction
15. Lumped Capacitance Model
16. Dimensional Analysis in Heat Transfer
17. Key Non-Dimensional Numbers in Heat Transfer
18. Development of Empirical Correlations for Heat Transfer

UNIT IV – Convection & Phase Change

19. Introduction to Convective Heat Transfer
20. Forced vs. Free Convection
21. Free Convection
22. Empirical Relations for Free Convection
23. Forced Convection
24. Internal Flow Heat Transfer
25. Heat Transfer in Turbulent & Laminar Flow
26. Boiling Heat Transfer
27. Types of Boiling
28. Condensation Mechanisms

UNIT V: Heat Exchangers & Radiation

29. Introduction to Heat Exchangers
30. Overall Heat Transfer Coefficient in Heat Exchangers
31. Effectiveness-NTU Method
32. Introduction to Radiation Heat Transfer
33. Radiation Laws
34. Radiative Heat Exchange Between Surfaces
35. Gray Body Radiation & Radiation Shielding Concepts

LABORATORY

1. Importing and exporting the CAD models to analysis software
2. Mesh generation of various types of elements
3. Analysis of stress distribution in a simple bar with different cross-section areas and different loading conditions.
4. Analysis of the deformation in a simple bar with different cross-section areas and different loading conditions.
5. Analysis of stress distribution in a stepped bar with different cross-section areas and different loading conditions.
6. Analysis of the deformation in a stepped bar with different cross-section areas and different loading conditions.
7. Analysis of stress distribution in a 2-D truss structure for different loading conditions.
8. Analysis of the deformation in a 2-D truss structure for different loading conditions.
9. Analysis of stress distribution in a 3-D truss structure for different loading conditions.
10. Analysis of the deformation in a 3-D truss structure for different loading conditions.
11. Analysis of beam deflection under Point loading conditions.
12. Analysis of beam deflection under uniformly distributed loading conditions.
13. Analysis of stress on a flat plate with a hole at its center.
14. Analysis of 1D Steady-State Heat Conduction in a Rod.
15. Analysis of 2D Transient Heat Conduction in a Plate.
16. Analysis of 3D Heat Transfer in a Cubic Solid.
17. Analysis of Heat Transfer with Radiation in a Thin Fin.
18. Analysis of Heat Flow in a Composite Wall.
19. Analysis of 1D Fluid Flow in a Pipe.
20. Analysis of 2D Incompressible Flow Over a Flat.
21. Analysis of 3D Flow Over a Sphere or Cylinder.
22. Analysis of Flow Through a Sudden Contraction in a Channel.
23. Analysis of Conjugate Heat Transfer in a Heat Exchanger.
24. Steady and unsteady linear viscous flow analysis.

TEXTBOOKS

1. S. S. Rao. “The Finite Element Methods in Engineering”, Elsevier, 8th edition, 2022.
2. O.C. Zienkiewicz, R.L. Tayylor, D.D. Fox ."The Finite Element Method: Its Basis and Fundamentals". Butterworth-Heinemann Ltd; 10th edition, 2023.

REFERENCE BOOKS

1. J.N.Reddy, “An Introduction to Finite Element Methods”, McGraw Hill, 7th Ed., 2022.
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom. “The Finite Element Method for Engineers". Wiley-Interscience; 8th edition 2021.

(25MEC204PC305) FINITE ELEMENT METHOD			L	R	P	C
			2	0	4	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to FEM

1. Fundamentals of FEM
2. Comparison of FEM with Other Methods and Basic Concepts
3. Meshing in FEM
4. FEM Formulation and Errors

UNIT II: Methods of finite element analysis

5. Introduction to Variational Methods
6. Rayleigh-Ritz Method
7. Method of Weighted Residuals (MWR) - Basics
8. Method of Weighted Residuals (MWR) - Detailed Study
9. Assembly Process in FEM
10. Implementation of Boundary Conditions for 1D/2D/3D elements

UNIT III: One-dimensional problems of FEM

11. Introduction to 1D Finite Element Problems
12. Finite Element Analysis of Bars
13. Plane Trusses – Fundamentals, Displacement & Stress Analysis
14. Buckling Analysis using FEM
15. Analysis of Thin Plates & Composite Slabs
16. 1D Heat Conduction Problems

UNIT IV: 2-D and 3D problems of FEM

17. Introduction to 2D and 3D FEM Problems
18. Stress Computation in Axisymmetric Loading
19. FEM Applications in Fluid Mechanics
20. 2D and 3D Heat Conduction Problems

UNIT V: Advanced topics of FEM

21. Failure Analysis Using FEM
22. Time Integration Methods
23. Nonlinear FEM Formulations
24. Multi-Physics Coupling in FEM

35. Buckling Analysis of Slender Components under Load
36. Structural and Thermal Analysis of an Exhaust Manifold

TEXTBOOKS

1. P.N. Rao "CAD/CAM: Principles and Applications" McGraw Hill India, 2010 (3rd Edition).
2. David C. Planchard "Engineering Design with SolidWorks" Schroff Development Corporation, 2023.

REFERENCE BOOKS

1. Fundamentals of CNC Machining" – Autodesk Manufacturing Academy, Autodesk, Inc. 2016.
2. "SolidWorks 2023: A Power Guide for Beginners and Intermediate Users" – CADArtifex, CreateSpace Independent Publishing Platform, 2023

(25MEC006PC304) CAD/CAM			L	R	P	C
			0	0	6	3
Course type	Program Core	Pre-requisite				

LAB

MODULE 1: Fusion 360

1. Fusion 360 Interface and Basic Sketching
2. Creating 3D Models Using Extrude, Revolve, and Loft
3. Parametric Modeling and Design Modifications in Fusion 360
4. Surface Modeling and Freeform Design in Fusion 360
5. Assembly Modeling and Applying Joints in Fusion 360
6. CAM in Fusion 360 for CNC Machining

MODULE 2: Solid Works

7. SolidWorks and Basic Sketching Techniques
8. 3D Feature-Based Modeling: Extrude, Revolve, Loft, and Sweep
9. Applying Fillet, Chamfer, Draft, and Shell Features
10. Sheet Metal Design: Bending, Hemming, and Flattening
11. Surface Modeling: Lofted and Boundary Surfaces
12. Assembly Modeling and Standard Mates
13. Advanced Mating Conditions and Motion Simulation
14. Interference Detection and Exploded View Creation
15. Design Table and Configuration Management in Assembly
16. Top-Down and Bottom-Up Assembly Modeling
17. Design and Optimization of a Gearbox Housing
18. Reverse Engineering and Design for Additive Manufacturing
19. Design and Fabrication of a Sheet Metal Bracket
20. Kinematic Simulation of Mechanisms in SolidWorks

MODULE 3: CNC Programming

21. CNC Milling and Machine Setup
22. Toolpath Generation for Face Milling and Pocketing
23. Hole-Making Operations: Drilling, Boring, and Reaming
24. Toolpath Simulation and Verification for Milling
25. Post-Processing and NC Code Generation
26. CNC Turning and Workpiece Setup
27. Facing, Profiling, and Grooving Operations in CNC Turning
28. Thread Cutting and Parting Off in CNC Turning
29. Generating G-Code for CNC Lathe Operations
30. CNC Machining of a Custom Part using Turning and Milling

MODULE 4: ANSYS Analysis

31. Ansys Workbench and Static Structural Analysis
32. Stress Analysis of a Cantilever Beam under Load
33. Thermal Conductivity and Heat Transfer Analysis
34. Temperature Distribution in a Metal Plate with Heat Sources

33. Dynamic Response Analysis introduction
34. Dynamic response requirements of proposed machine designs for safety and effective operations

TEXT BOOKS

1. Sadhu Singh, "Machine Design", Khanna Publishing House, 2022
2. Pandya and Shah, "Machine Design", Charotar Publishing House, 2022

REFERENCE BOOKS

1. Sundararajamoorthy TV and Shanmugam N, "Machine Design", Anuradha Publications, 2018
2. V.B.Bandari, "Design of Machine Machine ", Laxmi Publications, 2020.

DESIGN DATA HANDBOOK

1. S. Md. Jalaluddin, Design Data Handbook, Anuradha Publications, 2014
2. Kalaikathir Achchagam, Design Data Handbook, PSG College of Engineering,2020

1.

(25MEC300PC303) DESIGN OF POWER TRANSMISSION ELEMENTS			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite	Engineering mechanics, Mechanics of solids, Machine design.			

UNIT I: Bearings:

1. Types of Journal bearings, Lubrication ,Bearing Modulus
2. Full and partial bearings – Clearance ratio
3. Bearing Characteristic Number, Heat dissipation of bearings, bearing materials
4. Journal bearing design
5. Ball and roller bearings
6. Static of ball and roller bearings

UNIT II: Mechanical Springs:

7. Stresses and deflections of helical springs
8. Extension and compression springs
9. Design of springs for fatigue loading
10. Natural frequency of helical springs
11. Energy storage capacity – helical torsion springs
12. Design of co-axial springs
13. Design of leaf springs

UNIT III: Design of Gears

14. Gears: Introduction
15. Gears – Load concentration factor
16. Dynamic load factor
17. Surface compressive strength
18. Bending strength
19. Spur Gear -Estimation of centre distance, module and face width
20. Helical Gear – Problems

UNIT IV: Transmission of power by Belt and Rope drives & Dynamic Response Analysis

21. Transmission of power by Belt and Rope drives
22. Transmission efficiencies- Belts
23. Flat Belts Introduction, Problems
24. V type Belts
25. Rope drives
26. 27.Transmission efficiencies

UNIT V: **Brakes & Clutches**

27. Clutches
28. Single disc clutch
29. Multiple disc clutch,cone clutch
30. Brakes-Block brake
31. Band brake
32. Internal expanding shoe brake

36. Machine Learning for Condition Monitoring

LAB

1. Predicting the Weight of a Material Based on Density and Volume (Simple Linear Regression)
2. Predicting Machine Failure (Classification Problem)
3. Clustering for Quality Control (K-Means Clustering)
4. Handling Missing Data in Sensor Readings
5. Optimizing a Mechanical Design (Gradient Descent)
6. K-Means Clustering for Manufacturing Data
7. Predicting Fuel Consumption (Multiple Linear Regression)
8. Polynomial Regression for Stress-Strain Curve
9. Regression Tree for Predicting Material Properties
10. Classifying Engine Condition (Decision Tree Classifier)
11. Predicting Failure Based on Machine Parameters (Random Forest)
12. Predicting Faults in Bearings (Support Vector Machine)
13. Inverse Heat Transfer Problem (Machine Learning)
14. Predicting Fuel Properties (Regression Model)
15. Predicting Equipment Lifetime (Survival Analysis)
16. Condition Monitoring with Time Series Data.

LEARNING RESOURCES

TEXTBOOKS

1. Ms. M. Thenmozhi, "Machine learning for mechanical engineering", Notion Press, 2023.
2. S Sridhar., "Machine Learning", Oxford University press, 4th Ed., 2021

REFERENCEBOOKS

1. ESCOBAR, CARLOS A, "Machine Learning In Manufacturing", Elsvier, 1st Ed., 2024.
2. Oliver Theobald, "Machine Learning for Absolute Beginners", Scatterplot Press 3rd Ed., 2020

(25MEC302ES301) AI for MECHANICAL ENGINEERING			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT1:
1. Introduction to Python
2. Data Visualization
3. Introduction to AI & Machine Learning
4. Classification in Machine Learning
5. Error Metrics - MSE, RMSE, MAE
6. Data Processing
7. Categorical Variables
8. Introduction to Optimization
9. Gradient Descent Algorithm (GDA)

UNIT II:
10. Identifying & Formulating Supervised Learning Problems
11. inputs and outputs to learning algorithms
12. Performance Metrics for Learning Algorithms
13. Clustering Algorithms
14. Introduction to Regression Models
15. Simple Linear Regression Model
16. Multi-Variable (Multiple) Regression Model

UNIT III:
17. Introduction to Classification Models
18. Logistic Regression
19. Decision Tree Classifier
20. Random Forest Classifier
21. Support Vector Machine (SVM) – Theory & Concepts
22. Implementing SVM & Model Comparison

UNIT IV:
23. Neural networks
24. The analogy between the human brain and artificial neural nets
25. Fine tuning-1
26. Fine tuning-2
27. Convolutional neural network (CNN)
28. The architecture of a multilayer perception
29. Loss functions and the back propagation algorithm
30. Training neural network

UNIT V:
31. Introduction to Applications of Machine Learning in Engineering
32. Inverse Heat Transfer – Fundamentals & Applications
33. Implementing Machine Learning for Inverse Heat Transfer
34. Condition Monitoring – Concepts & Importance
35. Implementing Machine Learning for Condition Monitoring

36. Dynamic response requirements of proposed machine designs for safety and effective operations.

RECITATION

1. Theories of failures-problems
2. Theories of failures-problems
3. Theories of fatigue failures-problems
4. Theories of fatigue failures-problems
5. Riveted Joints-Problems
6. Bolted Joints Joints-Problems
7. Welded Joint Joints-Problems
8. Keys-Problems
9. Cotter Joints-Problems
10. Knuckle Joints-Problems
11. Shafts-Problems
12. Shaft couplings-Problems

TEXTBOOKS

1. Sadhu Singh, "Machine Design", Khanna Publishing House, 2022
2. Pandya and Shah, "Machine Design", Charotar Publishing House, 2022

REFERENCE BOOKS

1. Sundararajamoorthy TV and Shanmugam N, "Machine Design", Anuradha Publications, 2018
2. V.B.Bandari, "Design of Machine Machine ", Laxmi Publications.2020

(25MEC310PC302) MACHINE DESIGN			L	R	P	C
			3	1	0	3.5
Course type	Program Core	Pre-requisite				

UNIT I: Failure Theories

1. Types of design
2. Design procedure
3. Design phases
4. Factor of Safety
5. Selection of Material for design
6. Various theories of failure,
7. Design for static stresses

UNIT II Fatigue Failure Theories

8. Stress concentration
9. Theoretical stress Concentration factor
10. Fatigue stress concentration factor
11. Design for fluctuating stresses
12. Soderberg Line
13. Endurance limit
14. Estimation of Endurance strength – Goodman's line – Soderberg's line-problems

UNIT III: Design of Fasteners

15. Riveted joints - definition, Introduction
16. Axial Loading of simple joints
17. Axial loading of lozenge joints
18. Eccentric loading
19. Design of Bolted joints
20. Axial Loading
21. Eccentric loading
22. Design of Welded joints
23. Eccentric loading

UNIT IV:Design of Keys, Cotters and Knuckle Joints

24. Design of keys-stresses in keys
25. Cottered joints
26. Sleeve and cotter
27. Spigot and socket,
28. Gib and cotter joints
29. Knuckle joints

UNIT V: Design of Shafts and Shaft Couplings

30. **Shafts-**Introduction
31. Design of solid shafts for strength and rigidity -Problems
32. Rigid couplings Introduction
33. Muff couplings & Split muff coupling
34. Flange couplings
35. Dynamic Response Analysis,

UNIT V: Surface Roughness Measurement

31. Tool maker's microscope and its uses, Collimators.
32. Optical flats and their uses, Interferometer
33. Measurement of flat surfaces – instruments used, Straight edges surface plates, Optical flat and auto collimator.
34. Differences between Surface Roughness and surface waviness.
35. Numerical assessment of surface finish – CLA, R.M.S.
36. Surface measurement using Talysurf, ISI symbols for indication of surface finish

LAB

1. Perform step turning and taper turning operation on a given cylindrical work piece by using Lathe machine.
2. Perform thread cutting and diamond knurling operation on a given cylindrical work piece by using lathe machine.
3. Make drilling operation on a given work piece by using Radial drilling machine and perform taping operation.
4. Make square block on a given cylindrical work piece by using shaping machine.
5. Make surface finishing of given work piece by using surface grinding machine.
6. Prepare tool angles on a given work piece by using tool and cutter grinding machine.
7. Prepare an internal key way on given work piece by using slotting machine
8. Cut spur gear on a given work piece by using milling machine.
9. Measure different dimensions of a given specimen such as length, height, diameter and depth by using vernier calipers, inside and outside micrometer.
10. Measure the chordal addendum and chordal height of spur gear by using gear teeth vernier calipers
11. Determine the angle of taper using Bevel Protractor, sign bar.
12. Measure the dimensions of a given work piece such as angle, diameter, length by using tool maker's microscope.
13. Measure the error in the spindle by using machine tool alignment test on lathe and milling machine

TEXTBOOKS

1. P.N.Rao, "Manufacturing Technology" Vol.2, "Metal Cutting and Machine Tools", 4th Ed., TMH, 2018.
2. Mahajan M, "A Text Book of Metrology", Dhanpat Rai and Co. Pvt. Ltd, 2023

REFERENCE BOOKS

1. P.C. Sharma, "A Text Book of Manufacturing Technology – II", S. Chand, 2018.
2. Serope Kalpak jian and Steven R. Schmid, "Manufacturing Engineering and Technology". 2018

(25MEC302PC301) MACHINE TOOLS AND METROLOGY			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Elementary Treatment of Metal Cutting Theory

1. Importance of Machine tools and metrology, Overview of different machines.
2. Introduction to machining, Elements of cutting process
3. Geometry of single point tool and angles
4. Mechanism of chip formation, Types of chips
5. Built up edge formation , Effects of chip breakers
6. Mechanics of orthogonal cutting, Merchant's Force diagram
7. Effect of cutting forces – cutting speeds, feed, depth of cut
8. Problems on cutting forces. Analysis of tool life, Problems on Tool life
9. Coolants and its types. Tool materials

UNIT II: Machining

10. Engine Lathe: Principle of working, Parts, Specification of lathe, different lathe operations
11. Shaping: Principles of working, Principal parts –specification
12. Classification, operations performed.
13. Slotting: Principles of working, Principal parts –specification, Classification, operations performed.
14. Planning Machines: Principles of working, Principal parts –specification, Classification, operations performed.
15. Drilling: Principles of working, specifications, types, operations performed, Tool holding devices – twist drill
16. Boring Machines: Principles of working, Specifications, types, operations performed

UNIT III: Milling and Grinding Machine

17. Milling Machine, Principles of working – specifications,
18. Classifications of milling machines, machining operations,
19. Types of geometry of milling cutters
20. Methods of indexing: Simple, Compound Indexing
21. Differential Indexing
22. Theory of grinding, Classification of grinding, Types of grinding machines
23. Selection of a grinding wheel

UNIT IV: System of Limits and Fits

24. System of Limits and Fits, normal size, tolerance limits, deviations, allowance,
25. Fits and their types – unilateral and bilateral tolerance system.
26. Hole and shaft basis systems, Interchange ability and selective assembly.
27. Length standard, line and end standard slip gauges, Calibration of the slip gauges Dial indicator, micrometers.
28. Bevel protractor – angle slip gauges, Spirit levels – sine bar – Sine plate, rollers.
29. Taylors principle – Design of go and No-go gauges, Plug, ring, snap, gap, taper, profile and position gauges.
30. Start-ups related to talk on measurement of different instruments

21. Selective Laser Melting (SLM) – Principle & Process Parameters – Differences between SLS and SLM.
22. SLM Components & Post-Processing Techniques – Residual stress management, support removal.
23. Comparison of SLS and SLM – Strengths, weaknesses, and application differences.
24. Topology Optimization & Simulation in Powder-Based AM – Using Ansys Additive for brake and throttle pedal optimization.

LABORATORY EXPERIMENTS

List of simulation experiments: Software Tool used: CAD Software, UltimakerCura, Ansys Additive

1. Preparation of 3D printing Design (3D Modelling using any CAD software Creo, Inventor, Solid works, Catia, Fusion 360).
2. Assembly and Simulation
3. Processing the CAD data in Catalyst software (Selection of Orientation, supports generation, Slicing, Tool path generation) using Cura Software

List of experiments: Equipment/Tool used: 3D Printing Machine (FDM/SLA)

4. Sending the tool path data to FDM RP machine
5. Fabricating the physical part on FDM/SLA machine
6. Post-processing of Fabricated metal parts by Shot-peening, polishing, etc., to improve the surface quality of the produced parts.
7. Topology optimization of Brake Pedal using Ansys Additive Suite
8. Topology optimization of Throttle Pedal using Ansys Additive Suite
9. Modelling and Simulation of Powder bed system.
10. Modelling and Simulation of FDM
11. Modelling and Simulation of SLA

LEARNING RESOURCES

TEX BOOKS

1. Gibson, I., Rosen, D. W., & Stucker, B. (2015). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (2nd ed.). Springer. ISBN: 978-1-4939-2113-3.
2. **Horvath, J.** (2020). Mastering 3D Printing: A Guide to Modeling, Printing, and Prototyping (2nd ed.). Apress. ISBN: 978-1484258415.

REFERENCES BOOKS

1. Liou LW and Liou FW, “Rapid Prototyping and Engineering Applications: A tool box for Prototype Development”, CRC Press, 2011.
2. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications (3rd ed.). World Scientific Publishing Company. ISBN: 978-9812778970.

(25MEC302PC208) ADDITIVE MANUFACTURING			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Additive Manufacturing

1. Introduction to Additive Manufacturing – Need, evolution, and impact on product development.
2. AM Process Chain – Steps from CAD model to final product, virtual prototyping, and rapid tooling.
3. Classification of AM Processes – Liquid-based, solid-based, and powder-based techniques.
4. Benefits and Applications of AM – Industry-specific applications (Aerospace, Automotive, Medical, etc.).

UNIT II: Reverse Engineering & CAD Modelling

5. Reverse Engineering in AM – Model reconstruction techniques and applications.
6. Data Processing for AM – CAD model preparation, data formats, and geometric modeling techniques (Wireframe, Surface, Solid).
7. Support Structure Design & Part Orientation – Importance in AM, optimization strategies.
8. Slicing and Tool Path Generation in AM – Software tools, slicing strategies, and tool path optimization (Cura, Ansys Additive).

UNIT III: Liquid-Based Additive Manufacturing Systems

9. Stereolithography Apparatus (SLA) – Principles & Pre-Build Process – Photo-polymerization and material selection.
10. SLA Part Building & Post-Processing – Recoating issues, quality control, and case studies.
11. Process Planning for SLA – Layer thickness, resolution, and curing time impact.
12. Applications of SLA in Industries – Medical implants, prototypes, and customized parts.

UNIT IV: Solid-Based Additive Manufacturing Systems

13. Fused Deposition Modeling (FDM) – Principle & Process Variables – Material extrusion, deposition paths.
14. Materials for FDM & Process Optimization – PLA, ABS, PETG, flexible and composite materials.
15. Challenges & Limitations in FDM – Warping, surface roughness, mechanical strength improvements.
16. Case Studies of FDM in Real-World Applications – Engineering and consumer product applications.

UNIT V: Powder-Based Additive Manufacturing Systems

17. Selective Laser Sintering (SLS) – Principle & Process Parameters – Powder bed fusion, thermal considerations.
18. SLS Material Selection & Powder Structures – Polymer, metal, ceramic powders, and their characteristics.
19. Post-Processing in SLS & Surface Quality Control – Shot-peening, polishing, heat treatment.
20. Industrial Applications of SLS – Aerospace, medical, and automotive case studies.

34. Parameters of performance, Cycle with inter cooling and reheating
35. Cycle with regeneration.
36. Closed and open cycles ,merits and demerits

LAB

1. I.C. Engines Valve and Port Timing Diagrams.
2. I.C. Engines Performance Test on 4-Stroke Diesel Engine.
3. I.C. Engines Performance Test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke Multi-cylinder Petrol Engine.
5. Evaluation of engine friction by conducting retardation test on 4-stroke diesel engine.
6. Heat balance on IC engines.
7. Determination of A/F Ratio and Volumetric Efficiency on IC engines.
8. Determination of economical speed for fixed load on 4-stroke engine.
9. Performance test on Variable compression ratio engine.
10. Dis-assembly/ Assembly of engines.
11. Performance test on Reciprocating Air-compressor unit.
12. Study of Boilers.

TEXTBOOKS

1. R. K. Rajput, "Thermal Engineering", Laxmi Publications, 10th Edition, 2020.
2. Ganesan V, "Internal Combustion Engines", McGraw Hill, 4th Edition, 2017.

REFERENCE BOOKS

1. Dr. N Krishnamurthy, "Applied Thermodynamics", Sunstar publisher, 2nd Edition, 2020.
2. P.K.Nag, "Basics and Applied Thermodynamics", McGraw Hill, 2nd Edition, 2017.

(25MEC302PC207) APPLIED THERMODYNAMICS			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Compressors

1. Compressors, classification of compressors
2. Principle of operation of Reciprocating compressor
3. Work required, Isothermal efficiency
4. Volumetric efficiency and effect of clearance
5. Stage compression, undercooling, saving of work
6. Minimum work condition for stage compression

UNIT II: IC engines and Combustion in IC engines

7. IC engines classification
8. Working of Four Stroke and Two stroke engines
9. Valve and Port Timing Diagrams
10. Stages of combustion in S.I Engines, Normal and abnormal combustion.
11. Importance of flame speed and effect of engine variables.
12. Stages of Combustion in C.I Engines, delay period and its importance.
13. Effect of engine variables and diesel knock.

UNIT III: Testing and Performance of IC engines and Rankine cycle

14. Performance parameters of IC engines
15. Measurement of cylinder pressure, fuel consumption and air intake
16. Exhaust gas composition, Measurement of Brakepower and Frictional power
17. Heat balance sheet
18. Schematic layout of Rankine cycle
19. Thermodynamic analysis, concept of mean temperature of heat addition,
20. Methods to improve cycle performance, Reheat Rankine cycle
21. Rankine cycle with regeneration.

UNIT IV: Steam Turbines

22. Steam turbines classification, Mechanical details of Impulse turbine.
23. Velocity diagram, power developed, axial thrust, and blade or diagram efficiency
24. Condition for maximum efficiency of Impulse turbine
25. Mechanical details of Reaction turbine.
26. Degree of reaction, Parson's reaction turbine.
27. Velocity diagram of Reaction turbine
28. Condition for maximum efficiency

UNIT V: Steam Nozzles and Gas Turbines

29. Function of nozzle, types and applications, Flow through nozzles.
30. Thermodynamic analysis and assumptions, velocity of nozzle at exit.
31. Ideal and actual expansion in nozzle, velocity coefficient
32. Condition for maximum discharge and critical pressure ratio
33. Simple gas turbine plant , Ideal cycle, essential components.

UNIT V: Performance of Hydraulic Machines

29. Geometric Similarity
30. Unit and Specific Quantities
31. Centrifugal Pumps
32. Manometric Head, Losses, Efficiencies, and Specific Speed.
33. Reciprocating Pumps
34. Performance Characteristics

LABS

1. Verification of Bernoulli's Theorem.
2. Calibration of Venturi Meter.
3. Calibration of Orifice Meter.
4. Determination of friction factor for a given pipe line.
5. Determination of loss of head due to sudden expansion and sudden contraction.
6. Impact of jet on Vanes.
7. Performance Test on Pelton Wheel.
8. Performance Test on Francis Turbine.
9. Performance Test on Kaplan Turbine.
10. Performance Test on Single Stage Centrifugal Pump.
11. Performance Test on Multi Stage Centrifugal Pump.
12. Performance Test on Reciprocating Pump.

TEXT BOOKS:

1. F. M. White, "Fluid mechanics", 9th edition, Tata McGraw Hills, 2022.
2. Y .A. Cengel, J.M. Cimbala, "Fluid Mechanics: Fundamentals and Applications", 4th edition, Tata McGraw Hills, 2019.

REFERENCE BOOKS

1. S. K. Som, G. Biswas, S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", 3rd edition, Tata McGraw Hills, 2017.
2. G. K. Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press, 2nd edition, 2000.

(25MEC302PC206) FLUID MECHANICS			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Fluid Statics

1. Dimensions, and Units
2. Properties of Fluids
3. Vapor Pressure
4. Pressure
5. Piezometer and U-tube Manometer
6. Concepts and Applications

UNIT II: Fluid Kinematics and Dynamics

7. Basics of Vectors
8. Divergence operator, Gradient Operator, Curl Operator, Green's Theorem, Stokes' Theorem
9. Fluid Kinematics
10. Classification of Flows and Equation of Continuity
11. Surface and Body Forces
12. Euler's Equation
13. Bernoulli's Equation
14. Pitot Tube and Venturimeter
15. Orificemeter

UNIT III: Closed Conduit Flow and Boundary Layer Concepts

16. Reynold's Experiment and Introduction to Pipe Flow
17. Darcy-Weisbach Equation
18. Minor Losses in Pipes
19. Pipes in Series and Parallel, Energy Line and Hydraulic Gradient Line.
20. Boundary Layer Concepts
21. Boundary Layer Separation

UNIT IV: Basics of Turbo Machinery and Hydraulic Turbines

22. Forces on Jets and Work Done
23. Velocity Diagrams and Efficiency
24. Flow Over Radial Vanes
25. Hydraulic Turbines
26. Impulse Turbines: Pelton Wheel
27. Reaction Turbines: Francis Turbine
28. Kaplan Turbine, and Draft Tube

35. Joining Techniques for Multi-Material Manufacturing
36. Sustainable Manufacturing and Eco-Design

STUDIO WORK / LABORATORY EXPERIMENTS / HANDS-ON ACTIVITY:

In the lab component of the " Manufacturing Technology " course, students will engage in hands-on experiments and demonstrations to reinforce the theoretical knowledge gained during the lectures.

The lab work includes:

List of Experiments

1. Preparation of pattern, mould, Performing design and functionality of gating systems.
2. Pattern Design and making – for one casting drawing
3. Sand properties testing – strengths and permeability.
4. Moulding, Melting and Casting
5. Study the arc characteristics of the arc welding process and calculate the power requirements to join the two plates.
6. Compare and observe the properties of the welded joints in ARC Welding process for Lap and Butt Joints
7. Determine the hardness of the Spot Welded Joints
8. Determine the weld strength of the butt joint using TIG Welding Process
9. Study the difference between Gas welding and Brazing Process to join the steel pipes
10. Calculate the cutting and bending forces of sheet metal using a Hydraulic press
11. Calculate the forces required to design the blank and washer using Blanking and Piercing operations
12. Experimenting with various plastic processing methods such as extrusion and injection molding, observing how different plastics respond to these processes.
    1. Injection Moulding
    2. Blow Moulding

LEARNING RESOURCES

TEXTBOOKS

1. Serope Kalpakjian and Steven R Schmid, “Manufacturing Processes for Engineering Materials”, Pearson Publications, 8th edition, 2022.
2. P.N.Rao, “Manufacturing Technology”, TMH, 5th edition, 2018.

REFERENCEBOOKS

1. R.K.Jain, “Production Technology”, Khanna Publishers, 19th edition,2021
2. Sharma PC, “A Text Book of Production Technology”, S.Chand Publishers., 8th edition 2022

(25MEC302PC205) MANUFACTURING TECHNOLOGY			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite				

UNIT I: Casting and Solidification Processing

1. Fundamentals of Casting: Steps involved, advantages, and applications
2. Moulding: Sand properties, types of moulds
3. Pattern Making: Types, materials, and allowances
4. Design of Gating and Riser Systems
5. Special Casting Techniques: Investment casting, centrifugal casting, die casting
6. Casting Defects: Identification, causes, and remedies
7. Advanced Solidification Processing: Control of microstructure, grain refinement techniques
8. Methods of Metal Melting
9. Digital Twin in Casting: Simulation and optimization of casting defects using AI

UNIT II: Metal Forming Processes

10. Hot and Cold Working: Strain hardening, recovery, recrystallization
11. Rolling: Types of rolling mills, forces in rolling
12. Forging: Smith forging, drop forging, rotary forging, defects in forging
13. Extrusion: Hot and cold extrusion, hydrostatic extrusion, impact extrusion
14. Drawing and Bending Processes
15. Blanking and Piercing in Sheet Metal Processing
16. Micro and Nano-Forming: Deformation mechanisms at the micro/nanoscale
17. Forging Defects and Prevention Techniques

UNIT III: Material Removal and Machining

18. Traditional Machining: Turning, milling, drilling, grinding, tool wear mechanisms
19. Advanced Machining: EDM, ECM, ultrasonic machining, laser beam machining
20. Metal Cutting: Cutting tool technology, tool wear, cutting fluids
21. Hybrid Machining: Combining conventional and non-conventional techniques
22. CNC Machining and Automated Manufacturing
23. Sustainable and Green Machining

UNIT IV: Joining Processes and Additive Manufacturing

24. Welding: Types, design of welded joints, welding defects
25. Advanced Welding: TIG, MIG, Friction Stir Welding, Plasma Arc Welding,
26. Gas Welding and Arc Welding
27. Resistance and Thermit Welding
28. Metal Cutting: Oxy-acetylene cutting, cutting of ferrous and non-ferrous metals
29. Role of Robotics in Welding and Assembly
30. Additive Manufacturing (AM) for Metal and Polymer Components

UNIT V: Processing of Plastics and Composites

31. Polymer Processing: Injection moulding, blow moulding, extrusion
32. Composite Manufacturing: Resin transfer moulding, automated fibre placement
33. Smart Manufacturing for Polymers and Composites
34. Biodegradable Polymers and Sustainability in Plastic Processing

(25CAI214ES210) PROBLEM SOLVING USING PYTHON			L	R	P	C
			2	1	4	4.5
Course type	Program Core	**Pre-requisite**	**NA**			

COURSE OUTCOMES:

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

1. Implement a given algorithm in Python by using standard programming constructs.
2. Identify and correct errors in a given Python program.
3. Apply the appropriate concepts to develop real time applications.
4. Discuss object-oriented programming features.

UNIT I

Introduction: Algorithms and Flowcharts; The process of Computational Problem Solving; Introduction to Python programming language; Data and Expressions: Literals; Variables and Identifiers; Operators; Expressions and Data Types; Control Structures: Boolean Expressions.

UNIT II

Selection Control; Iterative Control; Functions: Program routes; Calling Value Returning Functions; Calling Non-value Returning Functions; Parameter Passing; Keyword and Default Arguments in Python; Variable Scope.

String Processing, Lists: List Structures; Lists in Python; Iterating over Lists in Python.

UNIT III

Dictionaries and Sets: Dictionary Type in Python; Set Data Type in Python.

Python Modules (random, math, os, time, sys) and Packages; File Handling: Opening, Reading and Writing Text Files; Command Line Arguments; Exception Handling;

UNIT IV

Graphics Programming: Graphics Programming, Using Graphical Objects, Interactive Graphics, Graphic Objects, Entry Objects, Displaying Images, Generating Colours.

UNIT V

Object-Oriented Programming: Introduction to Object Oriented Programming; Encapsulation; Inheritance; Polymorphism;

TEXT BOOKS:

1. C. Dierbach, Introduction to Computer Science Using PYTHON: A Computational Problem-Solving Focus (1st ed.), Wiley, 2015. ISBN 978-0370555156.
2. Yashavant Kanetkar, Let Us Python (1st ed.), BPB Publishers, 2019. ISBN 978-9388511568.

REFERENCE BOOKS:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist (2nd ed.), O'Reilly, 2015. ISBN 978-9352133755.
2. Martin C. Brown, Python: The Complete Reference (1st ed.), McGraw-Hill, 2001. ISBN 978-9387572932

33. Forced Vibrations with Viscous Damping
34. Vibration Isolation and Transmissibility
35. Whirling of Shafts
36. Free Torsional Vibrations

TEXTBOOKS

1. S S Ratan, “Theory of Machines”, Mc Graw Hill, 5th edition, 2019.
2. R.S.Khurmi and J.K.Gupta, “Theory of Machines”, Eurasia Publishing House 2020.

REFERENCE BOOKS

1. Sadhu Singh, “Theory of Machines”, Pearson Education India, 2016..
2. R.L. Norton, “Kinematics and Dynamics of Machinery”, Mc. Graw Hill, 2009.

(25MEC300PC204) MACHINES AND MECHANISMS			L	R	P	C
			3	0	0	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction and Kinematic Chains
1. Introduction to Machines and Mechanisms
2. Types of Constrained Motion
3. Links, Joints, and Kinematic Pairs
4. Degrees of Freedom & Grubler's Criterion
5. Kinematic Chains and Inversions
6. Slider Crank Mechanism

UNIT II: Velocity and Acceleration Analysis
7. Plane Motion of a Body
8. Instantaneous Centre of Rotation
9. Velocity of Rubbing & Angular Velocity Ratio
10. Determination of Velocity in Mechanisms
11. Linear & Angular Acceleration
12. Acceleration Analysis of Four-Bar Mechanisms
13. Acceleration Analysis of Single-Slider Crank Mechanisms
14. Coriolis Acceleration
15. Determination of Coriolis Component of Acceleration

UNIT III: Flywheels and Governors
16. Introduction to Flywheels & Governors
17. Types of Governors
18. Governor Performance Parameters
19. Effort and Power of a Governor
20. Flywheels
21. Turning Moment Diagrams
22. Torque Analysis
23. Crank Effort and Flywheel Design

UNIT IV: Gears and Gear Trains
24. Introduction to Gears
25. Gear Tooth Profiles & Velocity Ratio
26. Gear Trains
27. Simple and Compound Gear Trains
28. Reverted Gear Trains
29. Epicyclic Gear Trains
30. Number of Teeth in Gear Trains

UNIT V: Vibrations (6 Sessions)
31. Introduction to Vibrations
32. Free Undamped and Damped Vibrations

30. Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys.
31. Crystalline ceramics, glasses, cermets, abrasive materials,
32. Ceramics and Cermets, Advanced Ceramics and Polymers
33. Nanomaterials – definition, properties, and applications.
34. High and low-temperature materials and their applications.
35. Introduction to sustainability and materials in engineering.
36. Exploration of electrical properties of materials.

LABORATORY EXPERIMENTS:

1. Preparation and study of the Microstructure for the ferrous material.
2. Preparation and study of the Microstructure for the Non-Ferrous material.
3. Calculate the crystal structure of SC, BCC, FCC and HCP the help of ball models (Marbles).
4. Calculate the total free energy required to form a solid for pure metal and draw the solidification curve.
5. Study the hardenability of steel by Jominy End Quest Test.
6. To study of the properties of various types of Plastics.
7. Study the Microstructure and amount of phases present in a given Ferrous alloys using Lever rule.
8. Study the microstructure and amount of phases present in a given Non-Ferrous alloys using Lever rule.
9. To analyze the hardness of various ferrous metals at different temperatures and different cooling rates.
10. To analyze the hardness of various non-ferrous metals at different temperatures and different cooling rates.
11. To study the properties and applications of Composites.
12. To study the properties and applications of ceramics.

LEARNING RESOURCES

TEXTBOOKS

1. William and Callister, “Materials Science and Engineering”, Wiley, 10th edition, 2018
2. Kodgire, “Material Science and Metallurgy”, Everest Publishing House, 46th edition, 2022

REFERENCE BOOKS

1. Dieter, George.E, “Mechanical Metallurgy”, TMH., 3rd edition 1988
2. Sidney H.Avener, “Introduction to Physical Metallurgy”, Tata McGraw Hill Education, 2nd edition, 2017

(25MEC302PC203) MATERIAL SCIENCE ENGINEERING			L	R	P	C
			3	0	2	4
Course type	Program Core	Pre-requisite	None			

UNIT I: Fundamentals of Material Structure

1. Crystallization of metals, crystal structure, atomic packing factor, grain and grain boundaries.
2. Effect of grain boundaries on the properties of metals/alloys, determination of grain size.
3. Introduction to bonding and structure in materials science.
4. Point, line, and surface imperfections in materials.
5. Diffraction and structure determination techniques.
6. Molecular geometry and structure levels in biological materials.

UNIT II: Constitution of Alloys and Phase Equilibria

7. Necessity and effects of alloying, types of solid solutions, Hume-Rothery's rules,
8. Intermediate alloy phases, and electron compounds.
9. Phase Diagrams.
10. Lever rule, coring, miscibility gaps, eutectic systems, congruent melting, intermediate phases, peritectic reactions.
11. Isomorphous alloy systems, equilibrium cooling and heating of alloys
12. Solid-State Transformations
13. Study of important binary phase diagrams (Cu-Ni, Al-Cu, Bi-Cd, Cu-An, Cu-Si)
14. Phase diagram Fe-Fe3C.
15. Eutectic and Peritectic Systems
16. Transformation Kinetics and Microstructure
17. Thermodynamics and the Phase Rule
18. Transformations in the solid state: allotropy, eutectoid, peritectoid reactions, phase rule, and the relationship between equilibrium diagrams and alloy properties.

UNIT III: Heat Treatment and Microstructure Optimization

19. Effect of alloying elements on Fe-Fe3C system.
20. Heat Treatment Basics: Annealing, normalizing, quenching
21. TTT diagrams and Phase Transformation Kinetics, tempering,
22. Hardening, hardenability,
23. Surface-hardening methods.
24. Age hardening, cryogenic treatment of alloys.
25. Microstructure optimization for engineering applications.

UNIT IV: Engineering Metals and Alloys

26. Structure and properties of White Cast Iron, Malleable Cast Iron, Grey Cast Iron, Spheroidal Graphite Cast Iron, and Alloy Cast Irons.
27. Classification, structure, and properties of plain carbon steels, low alloy steels, Hadfield manganese steels, tool and die steels.
28. Introduction to ferrous and non-ferrous metallic alloys.
29. Overview of carbon steels and sustainability in material selection.

UNIT V: Non-Ferrous Metals and Advanced Materials

32. slope and deflection for cantilever subjected to point loads or UDL, Combination of point load and UDL.
33. slope and deflection for simply supported beams subjected to point loads or UDL, Combination of point load and UDL.
34. Classification and behaviour of columns,
35. crippling load Euler's theory of column
36. crippling load for different end conditions.

STUDIO WORK / LABORATORY EXPERIMENTS / HANDS ON ACTIVITY:

1. Determine the material properties by direct tension test using UTM.
2. To determine modulus of rigidity and tortional tensile strength of given specimen by torsion test.
3. Evaluate hardness value for various materials using Rockwell hardness test.
4. Measurements of micro hardness value for various materials using Brinell's hardness test.
5. Determine the stiffness and modulus of rigidity by compression test on springs.
6. Determination of Young's modulus of given specimen by compression loading using UTM.
7. Determine the Impact strength for given specimen by Charpy test.
8. Evaluate the Impact energy for given specimen by Izod test.
9. To determine the shear strength of given specimen by Punch shear test using UTM.
10. Deflection test on simply supported beam with point load.
11. Deflection test on simply supported beam with UDL & UVL.
12. Bending test of a given specimen using UTM.

LEARNING RESOURCES

TEXTBOOKS

1. S S Bhavikatti., "Strength of Materials", Vikas Publishing. Vikas Publishing, India, 2023.
2. S.Timoshenko, "Strength of Materials", CBS Publishers and Distributors Pvt. Ltd., New Delhi, 3rd Edition, 2021.

REFERENCE BOOKS

1. Ramamrutham, "Strength of Materials". Dhanpat Rai Publication Ltd., 20th edition, 2022.
2. Popov Egor P, "Engineering Mechanics of Solids", Prentice Hall 3rd edition 2019.

(25MEC312PC202) MECHANICS OF SOLIDS			L	R	P	C
			3	1	2	4.5
Course type	Program Core	Pre-requisite	Engineering Mechanics			

UNIT I: Simple stresses and strains

1. Simple stress and strain, Types of stresses and strains
2. Hooke's Law, Stress-strain relations,
3. Material properties, Poission's ratio
4. Stress-strain curves
5. Volumetric stress, strains
6. Modulus of elasticity, Modulus of rigidity, Bulk modulus, and Relation between them.
7. Thermal stress and strains
8. Torsions of shaft

UNIT II: Principal Stresses and Strains &Thin Cylinders:

9. Principle stresses and principal planes,
10. Compound Stress – Normal and tangential stresses on an inclined plane for biaxial stress
11. Relationships between normal and shear stress,
12. Maximum shear stress and corresponding plane,
13. Mohr's stress circle method.
14. Hoop, longitudinal and circumferential stresses of Thin seamless cylindrical shells
15. Hoop, longitudinal and volumetric strains

UNIT III: Shear Force and Bending Moment:

16. Definition of beam & Types of beams
17. Concept of shear force and bending moment
18. Relation between S.F., B.M. and rate of loading at a section of a beam.
19. S.F. and B.M. diagrams for cantilever,
20. Simply supported and overhanging beams subjected to point loads, Points of contra flexure
21. Simply supported and overhanging beams UDL, uniformly varying loads and combination of these loads

UNIT IV: Flexural Stresses:

22. Theory of simple bending –
23. Assumptions, bending equation,
24. Neutral axis, formulation of bending stresses,
25. Section modulus. Design of simple beam sections.
26. Formulation of shear stresses
27. Shear stress distribution across various beam sections
28. Design of simple beam sections.

UNIT V: Deflection of Beams &Columns and Struts

29. Definitions of slope, deflection,
30. Elastic curve-derivation of differential equation of flexure,
31. Sign convention, Slope and deflection for standard loading classes using Macaulay's method,

UNIT V: Power Cycles

30. Otto cycle description and representation on P-V and T-S diagram, Thermal efficiency, Mean effective pressures
31. Diesel cycle description and representation on P-V and T-S diagram, Thermal efficiency, Mean effective pressures.
32. Calculation of the efficiency of Otto and diesel cycles.
33. Dual combustion cycles description and representation on P-V and T-S diagram, Thermal efficiency, Mean effective pressures.
34. Calculation of the efficiency of dual cycle
35. Comparison of Otto, Diesel and Dual cycles , Brayton and Rankine cycles
36. Calculation of the efficiency of Brayton and Rankine cycles.

RECITATION

1. Numerical problems to calculate work transfer of various thermodynamic processes.
2. Determine heat transfer of various thermodynamic processes.
3. Apply first law of thermodynamics to determine energy transfer.
4. Solve problems using Steady flow energy equation.
5. Calculate efficiency of the heat engine using second law of thermodynamics.
6. Solve problems to calculate the efficiency of Carnot engine.
7. Make use of Mollier chart to calculate the properties of pure substance.
8. Make use of Steam tables data to calculate the properties of pure substance.
9. Determine the properties of ideal gas.
10. Calculate the properties of ideal gases for various thermodynamic processes.
11. Numerical problems to determine properties of gas mixtures.
12. Determine the efficiency of various thermodynamic cycles.

TEXTBOOKS

1. PK Nag, “Engineering Thermodynamics”, McGraw Hill, 6th Edition, 2022.
2. Yunus A. Cengel, Michael A. Boles, “Thermodynamics- An Engineering Approach”, McGraw Hill, 8th Edition, 2017.

REFERENCE BOOKS

1. Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen, “Fundamentals of Thermodynamics”, John Wiley & Sons, 6th Edition, 2020.
2. R. K. Rajput, “Engineering Thermodynamics”, Laxmi Publications, 5th Edition, 2020.

(25MEC310PC201) THERMODYNAMICS			L	R	P	C
			3	1	0	3.5
Course type	Program Core	Pre-requisite				

UNIT I: Introduction & First Law of Thermodynamics

1. System, Control Volume, Surrounding, Boundaries, Universe
2. Thermodynamic Equilibrium, State, Property, Process, Cycle, Quasi–static process.
3. Reversible and Irreversible Process
4. Point and Path Function, Zeroth Law of Thermodynamics
5. Calculation of work and heat transfer
6. Joule's experiments and Corollaries, First law of thermodynamics
7. Steady Flow Energy Equation
8. PMM-I, Limitations of First law of thermodynamics

UNIT II: Second Law of Thermodynamics

9. Second law of thermodynamics
10. Kelvin-Planck and Clausius Statements
11. Efficiency of reversible engine
12. PMM-II, Carnot principle.
13. Carnot cycle and its specialties.
14. Third law of thermodynamics and Free energy.
15. Entropy
16. Thermodynamic scale of temperature, Principle of Entropy Increase.

Unit III: Pure Substances

17. P-V-T surfaces, P-V and P-T diagrams of Pure substance
18. T-S and h-s diagrams of pure substance, Triple Point, and critical state properties during change of phase.
19. Dryness fraction, Property tables, and Mollier charts
20. Thermodynamic processes and energy transfer
21. Properties of pure substance using steam tables data
22. Properties using Mollier chart

UNIT IV: Perfect Gas Laws & Mixtures of Perfect Gases

23. Equation of state, specific and universal gas constants, various Non-flow processes, properties, end states
24. Heat and work transfer, changes in Internal energy, Throttling, and free expansion processes
25. Calculation of properties of ideal gases
26. Mole fraction, Mass fraction, gravimetric, and volumetric analysis
27. Dalton's Law, Avogadro's Law, Equivalent gas constant, and Molecular internal energy.
28. Enthalpy, specific Heats and Entropy of Mixture of perfect gases and vapour.
29. Determination of properties of gas mixtures.

22. Design
23. Testing
24. Refine the design

TEXTBOOKS

1. R. Barnwal, *Arduino Programming Projects: Learn How to Build Cool, Fun, and Easy Arduino Projects*, New Delhi, India: BPB Publications, 2023.
2. S. Monk, *Programming Arduino: Getting Started with Sketches*, 3rd ed., New York, NY, USA: McGraw-Hill, 2022.

REFERENCE BOOK

1. M. Banzi and M. Shiloh, *Getting Started with Arduino: The Open Source Electronics Prototyping Platform*, Make Community, LLC, 2022.

(25ECE104ES102) SMART PRODUCT DESIGN			L	R	P	C
			1	0	4	3
Course type	Program Core	Pre-requisite				

UNIT I : Arduino Programming
1. Arduino uno pin functions
2. Switch and LED

UNIT II : Sensors
3. Digital sensors
4. Analog sensors

UNIT III : Actuators
5. Relays
6. DC motor

UNIT IV : Wireless Connectivity
7. Bluetooth
8. Wi-Fi

UNIT V : Course Project
9. Identify real-world problems
10. Ideation
11. Concept development
12. Final design and testing

LAB:
1. Interfacing of input devices
2. Interfacing of output devices
3. Serial communication
4. Liquid crystal display
5. PIR sensor to Arduino
6. Object detection using IR sensor
7. Temperature monitoring
8. Automatic streetlight system
9. Distance measurement
10. Relay-based switching and control systems
11. Speed control of DC motors
12. Direction control of DC motors
13. Precision control with servo motors
14. Wireless connectivity
15. Wireless communication with bluetooth
16. Sending data using wi-fi
17. Receiving data using wi-fi
18. Identify real-world problems
19. Ideation
20. Concept development
21. Prototype development

35. Material Behavior Under Various Loading Conditions
36. Case study

TEXT BOOKS

1. Fedinand. L. Singer, "Engineering Mechanics", Harper Collins.
2. S.S Bhavikatti and J.G Rajasekharappa, "Engineering Mechanics", New Age International.

REFERENCE BOOKS

1. Tayal AK, "Engineering Mechanics -Statics and Dynamics", Umesh Publications.
2. Timoshenko and Young, "Engineering Mechanics", TMH.

(25MEC310PC102) MECHANICS FOR ENGINEERS			L	R	P	C
			3	1	0	3.5
Course type	Program Core	Pre-requisite	Applied Physics			

UNIT I: Equilibrium of a Particle

1. Fundamental Concepts of Mechanics
2. Force Vectors – Scalar & Vector Formulation
3. Force Vector Along a Line & Reduction of a Simple Distributed Loading
4. System of Coplanar Forces
5. Coplanar concurrent force system
6. Equilibrium of a Particle & Condition for Equilibrium-Problems

UNIT II: Equilibrium Of A Rigid Body

7. Introduction to Rigid Body Equilibrium & Moments of a Force
8. Moment About a Specified Axis
9. Couples and Their Effects
10. Simplification of a Force and Couple System
11. Conditions for Rigid-Body Equilibrium & Free-Body Diagram
12. Two- and Three-Force Members & Equations of Equilibrium
13. Types of Beams, Support Reactions-Problems

UNIT III: Analysis of Trusses

14. Introduction to Trusses & Simple Trusses
15. The Method of Joints
16. The Method of Joints –Zero-Force Members
17. The Method of Sections
18. The Method of Sections –Problems

UNIT IV-Centroid & Moment of Inertia

19. Introduction to Center of Gravity & Centroid of a Body
20. Centroid of Composite Bodies
21. Introduction to Moments of Inertia
22. Parallel-Axis Theorem for an Area
23. Moments of Inertia for Composite Areas
24. Radius of Gyration
25. Mass moment of inertia of simple bodies
26. Mass moment of inertia of composite bodies
27. Applications

UNIT V-Kinetics, Kinematics & Materials Properties

28. Introduction to Kinematics – Motion of a Particle
29. Rectilinear Motion – Velocity & Acceleration
30. Curvilinear Motion – Velocity & Acceleration
31. Motion of a Rigid Body – Types of Planar Motion
32. D'Alembert's Principle & Rigid Body Motion in Translation
33. Equations of Plane Motion & Applications
34. Material Properties – Understanding Stress & Strain

LABORATORY / STUDIO WORK

1. Freehand Sketching – Lines, shapes, perspectives, and object drawing.
2. Storyboard Development and Shading Techniques.
3. Introduction to Woodworking Tools and Basic Joints.
4. Surface Finishing and Simple Wooden Prototype Development.
5. Introduction to Breadboards and Electronic Components.
6. Electrical Measurements Using Multimeters.
7. LED and Sensor-Based Circuits Using Microcontrollers.
8. DC Motor Control Using Breadboard and Power Supply.
9. Basic 2D Sketching and 3D Modeling in CAD Software.
10. Surface Development, Rendering, and Material Application in CAD.
11. Generation of Technical Drawings from 3D Models.
12. Mock-up Materials, Tools, and 3D Printing Techniques.

TEXT BOOKS

1. Cagan, J. & Vogel, C. M., Creating Breakthrough Products, Pearson, 2002.
2. Programming and Interfacing with Arduino, CRC Press, 2021.
3. Arduino Programming Projects, BPB Online LLP, 2023.

REFERENCE BOOKS

1. Ulrich, K. T., & Eppinger, S. D., Product Design and Development, 7th Edition, McGraw-Hill, 2023.
2. Pahl, G. et al., Engineering Design: A Systematic Approach, Springer, 2007.
3. Dym, C. L., & Little, P., Engineering Design: A Project-Based Introduction, Wiley, 2021.
4. Dick, J. et al., Requirements Engineering, Springer, 2017.
5. Bolton, W., Mechatronics, Pearson, 2023.

SYLLABUS REFERENCE

Adapted from Purdue University – ME588: Design Thinking Studio.

(25MEC104ES104) PRODUCT DESIGN STUDIO			L	R	P	C
			1	0	4	3
Course type	Program Core	Pre-requisite				

UNIT I: Introduction to Design (5 sessions)

1.Difference between Art, Design, and Engineering
2.Evolution of Design
3.Design, Society, Culture, and Environment
4.Introduction to Design Thinking
5.Design Artifacts

UNIT II: Design Research (5 sessions)

6.Exploring the Design Space
7.Identifying Research Gaps
8.User Study and Ethnographic Research
9.A.E.I.O.U Framework
10.Market Study and Prior Art Search

UNIT III: Design Issues and Problem Identification (5 sessions)

11.Identifying User Needs
12.Painstorming
13.Jobs To Be Done (JTBD)
14.Opportunity Identification
15.Problem Definition and Need Hierarchy

UNIT IV: Concept Generation and Selection (5 sessions)

16.Creative Thinking
17.Ideation Methods
18.Brainstorming, SCAMPER, and Lateral Thinking
20.Concept Visualization and Idea Sketching
21.Concept Evaluation and Selection

UNIT V: Prototyping (6 sessions)

22.Prototyping Fundamentals
23.Materials and Manufacturing Processes
24.Bill of Materials (BOM)
25.Low-Fidelity and High-Fidelity Prototypes
26.Functional Prototypes
27.Introduction to 3D Printing and CAD File Preparation

14. Hands-on Practice on Advanced Projection Problems
15. Creating 3D Models of Simple Components using Extrude and Revolve
16. Practicing 3D Modelling using Sweep, Loft, and Press-Pull Features
17. Designing Mechanical Components – Pulley, Spring, Bracket
18. Projecting Auxiliary Views from Principal Views, Drawing Partial Auxiliary Views
19. Creating Isometric Projections as Auxiliary Views, Hands-on Practice
20. Drawing Sectional Views of Mechanical Components
21. Working with Special Rules for Sectioning Thin Materials
22. Demonstration of a Simple Team Design Project – Model Creation and Analysis
23. Creating 3D Wireframe, Shaded Solids, and Meshed Topologies for Engineering Analysis
24. Solid Modelling for Creating Associative Models at the Component Level

TEXTBOOKS

1. N.D.Bhatt, "Engineering Drawing", 52th Edition Charotar Publishers, 2019.
2. Dhananjay A Jolhe, "Engineering Drawing with an introduction to AutoCAD", Tata McGraw-Hill Publishing company limited, 2017.

REFERENCE BOOKS

1. M. Kulkarni, A.P. Rastogi and A. K. Sarkar; "Engineering Graphics with AutoCAD", PHI Learning Private Limited, New Delhi.
2. Venugopal. K, "Engineering Drawing and Graphics AutoCAD", New Age International.

DETAILED SYLLABUS

(25MEC104PC101) GRAPHICS DESIGN AND MODELING			**L**	**R**	**P**	**C**
			1	0	4	3
Course type	Program Core	**Pre-requisite**				

UNIT I: Introduction to Engineering Graphics

1. Introduction to Engineering Graphics,
2. Introduction to Computer-Aided Drafting, Overview of AutoCAD, Importance in Engineering

UNIT II: Projection of Solids

3. Types of Solids and Their Classifications.
4. Concept of Projection in First-Angle Projection and Third Angle Projection
5. Projection of Solids in Simple Position and with Axis Inclined to One Reference Plane

UNIT III: Conversion of Pictorial Views into Orthographic Views and Vice-Versa

6. Introduction to Orthographic Projections
7. Isometric Views from Orthographic Projections (Basic Shapes)
8. Creating Isometric Views from Orthographic Projections (Complex Shapes)

UNIT IV: 3-D Modelling using AutoCAD

9. Introduction to 3D Modelling, Geometric Primitives, Extrude, Revolve, Sweep, Loft
10. Boolean Operations in 3D Modelling, Press-Pull, Creating Assemblies.

UNIT V: Sectioning

11. Sectioning – Importance, Presentation of Hidden Details, Offset, Partial, and Revolved Sections
12. Combining Auxiliary and Sectional Views, Drawing Sections in Isometric Views.

LAB

1. Introduction to AutoCAD Interface, Setting Up Drawing Page, Printer Settings, and Scale Adjustment.
2. Projection of Points/ Lines/ planes in AutoCAD, Dimensioning Methods
3. Projection of Lines in AutoCAD, Dimensioning Methods
4. Hands-on Practice with Basic Drawing and Modification Tools
5. Projection of Solids with Axis Inclined to One Reference Plane (Prism, Pyramid)
6. Projection of Solids with Axis Inclined to One Reference Plane (Cylinder, Cone)
7. Projection of Complex Solids (Combination of Different Solids)
8. Projection of Complex Solids (Two Reference Plane)
9. Hands-on Practice and Assignment on Solid Projections
10. Construction of Orthographic Views from Pictorial Views (Basic Shapes)
11. Construction of Orthographic Views from Pictorial Views (Intermediate Shapes)
12. Creating Isometric Views from Orthographic Projections (Basic Shapes)
13. Creating Isometric Views from Orthographic Projections (Complex Shapes)

		Farm to Fork					
33	25AGR300OE433	Socio-Economic Transformations in Indian Agriculture	3	0	0	3	
34	25AGR300OE434	Smart Farming Technologies for Doubling the Farmer Income	3	0	0	3	
35	25AGR300OE435	Sky Farming and Urban Horticulture Systems	3	0	0	3	

Flexible Courses for Open Electives and Professional Electives						
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25HUM202CR401	Industry Certification	2	0	2	3
2	25HUM300CR402	Professional Skill Development	3	0	0	3
3	25HUM300CR403	Self-Paced Learning	3	0	0	3
In Special Cases Open Electives may be considered as Program Electives						
In Special Cases Program Electives may be considered as Open Electives						
In Special Cases Program Electives may be considered as Specialization Electives						
In Special Cases Specialization Electives may be considered as Program Electives						
In Special Cases Specialization Electives may be considered as Open Electives						
In Special Cases Open Electives may be considered as Specialization Electives						
In Special Cases Open Electives may be considered as LHS Electives						
In Special Cases LHS Electives may be considered as Open Electives						

Minor Courses offered by NEST						
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25BUS400MN401	Startup Garage	4	0	0	4
2	25BUS400MN402	Startup Launch and Business Operation	4	0	0	4
3	25BUS400MN403	Digital Marketing Strategy	4	0	0	4
4	25BUS400MN404	Growth Hacking	4	0	0	4

Open Electives							
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**	
1	25CAI202OE401	Fundamentals of Database Management Systems	2	0	2	3	CSE
2	25CAI202OE402	Fundamentals of Data Structures	2	0	2	3	
3	25CAI202OE403	Analysis and Design of Algorithms	2	0	2	3	
4	25ECE300OE404	Principles of Communication	3	0	0	3	ECE
5	25ECE300OE405	Sensors and Transducers	3	0	0	3	
6	25ECE300OE406	Design for Social Impact	3	0	0	3	
7	25EEE300OE407	Introduction to Electric Vehicle Technologies	3	0	0	3	EEE
8	25EEE202OE408	Introduction to PLC Programming	2	0	2	3	
9	25MEC300OE409	Operations Research	3	0	0	3	ME
10	25MEC300OE410	3D Printing	3	0	0	3	
11	25MEC300OE411	Renewable Energy Resources	3	0	0	3	
12	25MEC104OE412	Workshop Practices	1	0	4	3	
13	25CIV300OE413	Disaster Management	3	0	0	3	CE
14	25CIV300OE414	Pollution and Control Engineering	3	0	0	3	
15	25CIV300OE415	Smart Cities	3	0	0	3	
16	25BUS300OE416	Digital Marketing	3	0	0	3	SoB
17	25BUS300OE417	Startup Launch and Ecosystems	3	0	0	3	
18	25BUS300OE418	Finance for Engineers	3	0	0	3	
19	25SCI202OE419	Space Physics	2	0	2	3	Basic Science
20	25SCI202OE420	Nanomaterials and Technology	2	0	2	3	
21	25SCI202OE421	AI for Drug Discovery	2	0	2	3	
22	25MAT300OE422	Integral Transforms and Partial Differential Equations	3	0	0	3	Math
23	25MAT300OE423	Optimization Techniques	3	0	0	3	
24	25HUM202OE424	LSRW Language Skills	2	0	2	3	English
25	25HUM300OE425	Learning How to Learn	3	0	0	3	
26	25HUM300OE426	German for Professionals	3	0	0	3	
27	25HUM300OE427	Japanese Language and Culture	3	0	0	3	
28	25HUM300OE428	Spanish for Global Work Place	3	0	0	3	
29	25NCC300OE429	NCC Foundation course	3	0	0	3	NCC
30	25NCC300OE430	NCC Basic course	3	0	0	3	
31	25NCC300OE431	NCC Advanced Course	3	0	0	3	
32	25AGR300OE432	Food Safety and Quality Management from	3	0	0	3	AGRI

Courses for Honors in Mechanical Engineering						
Semester - III						
1	25MEC302HN401	Advanced Solid Mechanics	3	0	2	4
Semester - IV						
2	25MEC302HN402	Precision Manufacturing	3	0	2	4
Semester - V						
3	25MEC302HN403	Advanced Heat and Mass Transfer	3	0	2	4
Semester - VI						
4	25MEC302HN404	Sustainable Manufacturing	3	0	2	4

Courses for Minors in Smart Manufacturing						
Semester III						
1	25MEC302MN401	Introduction to Digital Manufacturing and Design	3	0	2	4
Semester IV						
2	25MEC302MN402	Foundations of Smart Manufacturing	3	0	2	4
Semester V						
3	25MEC302MN403	3D Printing	3	0	2	4
Semester VI						
4	25MEC302MN404	Mechatronics	3	0	2	4

Hobbies, Co-Curricular and Extra-Curricular (HCE) Electives						
S.No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25HUM002AU401	Community Engagement and Social Responsibility through NSS	0	0	2	1
2	25HUM002AU402	Leadership and Collaboration through Student Clubs	0	0	2	1
3	25HUM002AU403	Physical Education and Sports for Holistic Development	0	0	2	1
4	25HUM002AU404	Experiential Learning through Internships	0	0	2	1
5	25HUM002AU405	Skill Enrichment and Creativity through Hobby Activities	0	0	2	1
6	25HUM002AU406	Visual Storytelling and Documentation through Photography	0	0	2	1
7	25HUM002AU407	Skill Acceleration and Applied Learning through Boot Camps	0	0	2	1
8	25HUM002AU408	Indian Classical Music	0	0	2	1
9	25HUM002AU409	Classical and Folk Dance Traditions of India	0	0	2	1
10	25HUM002AU410	Traditional Indian Culinary Practices	0	0	2	1

In Special Cases Open Electives, Program Electives, Specialization Electives may be considered interchangeably.

Program Electives						
Program Elective - I						
1	25MEC202PE401	Production and Operations Management	2	0	2	3
2	25MEC202PE402	Mechanical Vibrations	2	0	2	3
		Program Elective - II				
1	25MEC202PE403	Production Planning and Control	2	0	2	3
2	25MEC300PE404	Refrigeration and Air Conditioning	3	0	0	3
		Program Elective - III				
1	25MEC202PE405	Factory Automation	2	0	2	3
2	25MEC300PE406	Power Plant Engineering	3	0	0	3
		Program Elective - IV				
1	25MEC202PE407	Unconventional Machining Process	2	0	2	3
2	25MEC202PE408	Computational Fluid Dynamics	2	0	2	3

Smart Manufacturing Specialization Core						
Specialization Core						
1	25MEC302SC201	Smart Manufacturing	3	0	2	4
2	25MEC302SC301	Digital Manufacturing System Design	3	0	2	4
Specialization Elective - I (Smart Manufacturing)						
1	25MEC202SE301	Industrial IoT	2	0	2	3
2	25MEC202SE302	Smart Materials	2	0	2	3
Specialization Elective - II (Smart Manufacturing)						
1	25MEC202SE401	Data Analytics in Manufacturing	2	0	2	3
2	25MEC202SE402	Advanced Digital Technology in Manufacturing	2	0	2	3

Robotics and Automation Specialization						
Specialization Core						
1	25MEC302SC202	Robotics and Automation	3	0	2	4
2	25MEC302SC302	Robotic System Design	3	0	2	4
Specialization Elective - I (Robotics and Automation)						
1	25MEC300SE303	Sensors and Control for Robotics	3	0	0	3
2	25MEC300SE304	AI in Robotics	3	0	0	3
Specialization Elective - II (Robotics and Automation)						
1	25MEC300SE403	Robotics Operating System	3	0	0	3
2	25MEC300SE404	Machine Vision and Safety	3	0	0	3

VI SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC300PC303	Design of Power Transmission Elements	3	0	0	3
2	25MEC006PC304	CAD-CAM	0	0	6	3
3	25MEC204PC305	Finite Element Method	2	0	4	4
4	25HUM104HS201	Critical Thinking and Interpersonal Skills	1	0	4	3
5	25MEC302PC306	Heat Transfer	3	0	2	4
6		Specialization Elective - I	2	0	2	3
Total			**11**	**0**	**18**	**20**

VII SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1		Open Elective - II	2	0	2	3
2		Program Elective - II	2	0	2	3
3		Program Elective - III	2	0	2	3
4		Program Elective - IV	2	0	2	3
5		Specialization Elective - II	2	0	2	3
6	25MEC010PR401	Capstone Project	0	0	10	5
		Total	**10**	**0**	**20**	**20**
Or						
1	25MEC040PR402	Industrial Project/ R&D Project/ Industry Internship/Start-up/Externship	0	0	40	20
		Total	**0**	**0**	**40**	**20**

VIII SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC040PR403	Major Project/Industrial Project/ R&D Project/ Industry Internship/Start-up/Externship	0	0	40	20
		Total	**0**	**0**	**40**	**20**
		Total Credits	**170**			

III SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC310PC201	Thermodynamics	3	1	0	3.5
2	25MEC312PC202	Mechanics of Solids	3	1	2	4.5
3	25MEC302PC203	Material Science Engineering	3	0	2	4
4	25MEC300PC204	Machines and Mechanisms	3	0	0	3
5	25CAI214ES210	Problem Solving Using Python	2	1	4	4.5
6	25MEC302PC205	Manufacturing Technology	3	0	2	4
		Total	**17**	**3**	**10**	**23.5**

IV SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC302PC206	Fluid Mechanics	3	0	2	4
2	25MEC302PC207	Applied Thermodynamics	3	0	2	4
3		Program Elective - I	2	0	2	3
4		Specialization Core - I	3	0	2	4
5	25MEC302PC208	Additive Manufacturing	3	0	2	4
6		Open Elective - I	3	0	0	3
7	25MAT310BS109	Probability and Statistics	3	1	0	3.5
		Total	**20**	**1**	**10**	**25.5**

V SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC302PC301	Machine Tools and Metrology	3	0	2	4
2	25MEC310PC302	Machine Design	3	1	0	3.5
3	25HUM006HS202	Quantitative Aptitude and Logical Reasoning	0	0	6	3
4	25MEC302ES301	AI for Mechanical Engineering	3	0	2	4
5	25CIV200HS301	Sustainability and Ethical Innovation	2	0	0	2
6	25MEC002PR301	Undergraduate Research in Mechanical Engineering	0	0	2	1
7		Specialization Core - II	3	0	2	4
		Total	**14**	**1**	**14**	**21.5**

(R25) COURSE STRUCTURE

B. TECH. MECHANICAL ENGINEERING

(Applicable from the batch admitted during 2025-26 Academic Year and onwards)

L: Theory T: Tutorial P/D: Practical/Drawing J: Course Project C: Credits

CIE: Continuous Internal Evaluation SEE: Semester End Examination

I SEM						
Sl. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC104PC101	Graphics Design and Modeling	1	0	4	3
2	25MEC104ES104	Product Design Studio	1	0	4	3
3	25EEE312ES103	Electrical and Electronics Engineering	3	1	2	4.5
4	25MAT310BS101	Calculus and Differential Equations	3	1	0	3.5
5	25SCI312BS105	Applied Physics & Chemistry for Mechanical Engineering	3	1	2	4.5
		Total	**11**	**3**	**12**	**18.5**

II SEM						
S. No.	**Course Code**	**Course**	**L**	**R**	**P**	**C**
1	25MEC310PC102	Mechanics for Engineers	3	1	0	3.5
2	25ECE104ES102	Smart Product Design	1	0	4	3
3	25MAT310BS108	Linear Algebra and Numerical Methods	3	1	0	3.5
4	25HUM204HS101	Life Skills: Enterpreneurship, Language, Communication, and Personality	2	0	4	4
5	25SCI202BS106	Computational Chemistry and Biology	2	0	2	3
6	25HUM300HS102	Ancient Knowledge and Constitution of India	3	0	0	3
		Hobbies, Co-Curricular and Extra-Curricular Elective	0	0	2	1
Total			**14**	**2**	**12**	**21**

SR UNIVERSITY

B. TECH. MECHANICAL ENGINEERING
(Applicable from the batch admitted during the 2025-26 Academic Year and onwards)

Contents

(R25) COURSE STRUCTURE 2
B. TECH. MECHANICAL ENGINEERING 2
DETAILED SYLLABUS 9
PROGRAM ELECTIVE 48
PROGRAM ELECTIVE – I 48
PROGRAM ELECTIVE – II 52
PROGRAM ELECTIVE – III 56
PROGRAM ELECTIVE – IV 60
SMART MANUFACTURING SPECIALIZATION CORE 64
SPECIALIZATION ELECTIVE - I (Smart Manufacturing) 68
SPECIALIZATION ELECTIVE - II (Smart Manufacturing) 72
SPECIALIZATION ELECTIVE - I (Robotics and Automation) 80
SPECIALIZATION ELECTIVE - II (Robotics and Automation) 84
COURSES FOR HONORS IN MECHANICAL ENGINEERING 87
COURSES FOR MINORS IN SMART MANUFACTURING 96
OPEN ELECTIVE 105

SR UNIVERSITY

Ananthasagar | Hasanparthy | Warangal – 506 371. (T.S.)

DEPARTMENT OF
MECHANICAL ENGINEERING

R25- B.Tech Program

Course Structure & Syllabus
2025 Admitted batch