



Shri Shamrao Patil (Yadravkar) Educational & Charitable Trust's
Sharad Institute of Technology College of Engineering
(An Autonomous Institute)
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Department of Mechanical Engineering

Final-Year Engineering

Teaching and Evaluation Scheme

and

Syllabus

as per New Education Policy 2020



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Abbreviations

L: Lecture

T: Tutorial

P: Practical

CA1- Continuous Assessment 1

CA2- Continuous Assessment 2

MSE: Mid Semester Exam

ESE: End Semester Exam

BSC: Basic Science Course

ESC: Engineering Science Course

PCC: Programme Core Course

PEC: Programme Elective Course

MDM: Multidisciplinary Minor

OE: Open Elective

VSEC: Vocational and Skill Enhancement Course

AEC: Ability Enhancement Course

IKS: Indian Knowledge System

VEC: Value Education Course

RM: Research Methodology

CEP: Common Engineering Project

FP: Field Project

CC: Co-curricular Courses

ELC: Experimental Learning Course

HSSM: Humanity Social Science and Management




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Department: Mechanical Engineering

Rev: Course Structure/ 01/ 2023-24

Class: Final Year B. Tech

Semester: VII

Course Code	Type of Course	Name of the course	Teaching Scheme				Evaluation scheme					Credit
			L	T	P	Total	CA1	CA2	MSE	ESE	Total	
23ME4701	PCC	Metrology and Quality Control	3	0	0	3	10	10	30	50	100	3
23ME4702	PCC	I.C. Engine and Hybrid Vehicles	3	0	0	3	10	10	30	50	100	3
23ME4703	PEC	Program Elective Course -IV	3	0	0	3	10	10	30	50	100	3
23ME4704	RM	Research Methodology	3	0	0	3	10	10	30	50	100	3
23ME4705	ELC	Capstone Project-II	0	0	4	4	15	15	-	20	50	2
23ME4706	PCC	Simulation Laboratory	0	0	2	2	25	25	-	-	50	1
23ME4707	PCC	Metrology and Quality Control Laboratory	0	0	2	2	15	15	-	20	50	1
23ME4708	PCC	I.C. Engine and Hybrid Vehicles Laboratory	0	0	2	2	15	15	-	20	50	1
23ME4709	RM	Industrial Case Study (Research Seminar)	0	0	2	2	25	25	-	-	50	1
23ME4710	VEC	Industrial Safety	1	0	0	1	25	25	-	-	50	1
23MEMDXX	MDM	Multidisciplinary Minor-V	3	0	0	3	10	10	30	50	100	3
Total			16	0	12	28	170	170	150	210	800	22

Program Elective Course -IV

Energy Conversion Systems (23ME4703A)	Design of Mechanical Systems (23ME4703B)	Advance Foundry Technology (23ME4703C)
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Multidisciplinary Minor-V

Basket A (Production and Operation Management)	Basket B (Aerospace)	Basket C (Mechatronics)
Project Planning and Execution (23MEMDA5)	Statistical Thermodynamics (23MEMDB5)	Robotics (23MEMDC5)


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Department: Mechanical Engineering **Rev:** Course Structure/ 00/ 2023-24

Class: Final Year B. Tech

Semester: VIII

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation scheme					Credit
			L	T	P	CA1	CA2	MSE	ESE	Total	
23ME4801	PEC	Self-Learning Course 1*	-	-	-	10	10	30	50	100	3
23ME4802	PEC	Self-Learning Course 2*	-	-	-	10	10	30	50	100	3
23ME4803	ELC	Internship	-	-	-	50	50	-	100	200	12
Total			-	-	-	70	70	60	200	400	18

List of Self-Learning Courses

Self-Learning Course 1* - Entrepreneurship and Management Domain

1. Financial Management for Managers
2. Global Marketing Management
3. Understanding Incubation and Entrepreneurship
4. Entrepreneurship Essentials

Self-Learning Course 2* - Multi Disciplinary Domain

1. Introduction to Machine Learning
2. Artificial Intelligence: Knowledge Representation and Reasoning
3. Block-chain and its Applications
4. Advanced Robotics

Important Note: * indicates that the same course or title may not be available in NPTEL SWAYAMcatalogue, then course from same domain or category whichever available on NPTEL SWAYAMcatalogue will be offered




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Honour's Degree in Robotics

List of Honour's Degree Courses (2025-26)

Sr. No.	Subject Name	NPTEL URL	Sem
1	Design of Mechatronics System	https://onlinecourses.nptel.ac.in/noc25_me179/preview	VII
2	Mechanics and Control of Robotic Manipulators	https://onlinecourses.nptel.ac.in/noc25_me105/preview	VII

List of Minor Degree Courses (2025-26)

Sr. No.	Subject Name	NPTEL URL	Sem
1	Fundamentals of Manufacturing Processes	https://onlinecourses.nptel.ac.in/noc25_me119/preview	VII
2	Automation in Manufacturing	https://onlinecourses.nptel.ac.in/noc25_me154/preview	VII

Policy for Honors with Research

Semester	Requirement	Credits
VI, VII and VIII	Research paper- I publication on Capstone Project in SCOPUS/ESCI/SCI indexed Journal	9
	Research paper- II publication on Capstone Project in SCOPUS/ESCI/SCI indexed Journal	9
Total		18




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Metrology and Quality Control

23ME4701	PCC	Metrology and Quality Control	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Mathematics; Engineering Drawing; Manufacturing Process

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

CO1	Summarize the fundamental concepts of metrology and demonstrate an understanding of linear and angular measurement standards (L2)
CO2	Apply the principles of limits, fits, and tolerances and utilize various types of comparators for dimensional inspection (L3)
CO3	Analyze appropriate techniques for measuring surface finish parameters performance demonstrate proficiency in the metrology of screw threads and gears using relevant terminology (L4)
CO4	Utilize the principles of advanced metrology techniques for precise dimensional analysis. (L3)
CO5	Explain the fundamental concepts of quality and develop basic statistical quality control principles (L2)
CO6	Make use of the principles of various control charts and plan the effectiveness of different acceptance sampling using operating characteristic curves. (L3)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2	2												
CO3	2												
CO4	2												
CO5	2						2		1	1	2	1	
CO6	2	2		2	1		2					1	




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Course Contents:

Unit 1: Introduction: - Meaning of Metrology, Precision, Accuracy, Errors in Measurement, Calibration. Linear Measurement: Standards, Classification, Line Standard, End Standard, Wavelength Standard, Slip Gauges. Angular Measurement: Bevel Protractor, Sine bar, Uses of sine bars, Sine Center, Angle gauges, Auto Collimator Angle Dekkor.	[6]
Unit 2: Limits, Fits and Tolerances: - Meaning of Limit, Fits and Tolerance, Cost – Tolerance relationship, concept of Interchangeability, Indian Standard System. Design of limits Gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges. Inspection of Geometric parameters: Straightness, Parallelism, Concentricity, Scariness, and Circularity. Comparators: Uses, Types, Advantages and Disadvantages of various types of Comparators.	[6]
Unit 3: Surface Finish Measurement: - Surface Roughness, Elements of Surface Roughness, Evaluation of Surface Roughness, Surface Roughness Measurement: Straight Edge, Surface Gauge, Optical Flat, Profilometer, Grades of Roughness. Screw Thread Metrology: Internal/external screw thread, terminology, measurement of various elements of threads, thread micrometer method, two wire and three wire methods. Gear Metrology: gear terminology, measurement of various elements, constant chord method, base tangent method, gear tester, gear tooth measurement.	[6]
Unit 4: Advances in metrology: - Interferometry – Types of Interferometers – Michelson interferometer – NPL flatness interferometer, Laser-based Instrumentation ,Coordinate Measuring Machines, Automated Inspection, Machine Vision	[6]
Unit 5: Introduction to Quality: - Concept of Quality: Definition of Quality, Quality assurance, Specification of quality, Factors controlling the quality of design and conformance, Cost of quality, Seven QC tools Statistical Quality Control: Introduction, Chance Causes and Assignable Causes. SQC Benefits and Limitations. Fundamental concepts in probability - Normal curve Measures of Dispersion.	[6]
Unit 6: Theory of Control Charts: - Control Charts for Variables X bar and R charts, Standard deviation charts -run up run down Process capability studies. Control Charts for attributes - Fraction defectives and number of defects. Numerical on control charts. Acceptance Sampling Basic concept of sampling inspection, Single and double and sequential sampling plans, Operating characteristic curves.	[6]
Text Books: 1. Engineering Metrology, Jain. R. K Khanna Publishers 2. Statistical Quality Control & Quality Management , Gupta R.C. , Khanna Publisher, 10 th edition	




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| 3. I.C.Gupta, "A Text book of Engineering Metrology", Dhanpat Rai and Sons.
4. Engineering Metrology – M. Mahajan, Dhanpat Rai and Sons. |
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Reference Books:

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| 1. Rajput R.K; Engineering metrology and instrumentation; Kataria & sons publishers.
2. K.J.Hume, "Engineering Metrology", Kalyani publication ISBN8170290015
3. Engineering Metrology and Measurements, N.V. Raghavendra and L. Krishnamurthy Oxford |
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Internal Combustion Engines and Hybrid Vehicles

23ME4702	PCC	Internal Combustion Engines and Hybrid Vehicles	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Thermal Engineering, Fluid Mechanics

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

CO1	Classify I C Engine and identify its components. (L2)
CO2	Summarise various factors affecting SI and CI combustion. (L2)
CO3	Explain various engine systems and elaborate governing systems. (L2)
CO4	Evaluate various performance parameters and discuss SI and CI engine emissions. (L5)
CO5	Apply concepts of different alternate fuels used for SI and CI engines. (L4)
CO6	Outline different configurations of Hybrid Vehicles. (L2)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											1	
CO2	3											1	
CO3	3											1	
CO4	3	2										1	
CO5	3	2										1	
CO6	3											1	

Course Contents:

Unit 1: Fundamentals of IC Engines Applications, nomenclature, engine components, Engine classification, two and four stroke cycle	[6]
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engines; fundamental difference between SI and CI engines; valve timing diagrams. Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles and deviation of actual cycles from ideal cycles.	
Unit 2: Combustion Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of CI Engine fuels. Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation, Combustion in C.I. Engines, stages of combustion, combustion knock; types of SI and CI Engine combustion chambers.	[6]
Unit 3: Various Engine Systems Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.	[6]
Unit 4: Engine Testing and Performance of SI and CI Engines Parameters, Type of tests and characteristic curves. Super charging in IC Engine: Effect of attitude on power output, types of supercharging. Engine Emissions and control: Pollutants from SI and CI engines and their control, emission regulations such as Bharat and Euro.	[6]
Unit 5: Alternate fuels Need for alternative fuels, applications, various alternate fuels etc. Gaseous Fuels, Alcohols, Biodiesels, vegetable oil extraction, Trans-esterification process, properties of alternative fuels and fuel blends. Fuel Cell Technology: Operating principles, Types, construction, working, application, advantages and limitations	[6]
Unit 6: Layout of Electric vehicle and Hybrid vehicles Advantages and drawbacks of electric and hybrid vehicles, System components, Electronic control system – Different configurations of Hybrid vehicles, Power split device. High energy and power density batteries.	[6]
Text Books: 1. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Publications, New Delhi, 3rd edition. 2. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988 3. "Alternative Fuels", Dr. S. S. Thipse, Jaico publications.	
Reference Books: 1. "Engine Emissions, pollutant formation", G. S. Springer and D.J. Patterson, Plenum Press. 2. ARAI vehicle emission test manual. 3. Gerhard Knothe, Jon Van Gerpen, Jargon Krah, "The Biodiesel Handbook", AOCS Press. 4. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engine	




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Energy Conservation Systems

23ME4703A	PEC	Energy Conservation Systems	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Non-Conventional Energy Sources, Thermal Engineering, Energy Audit

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

CO1	Explain the forms, sources, and need for energy conservation in today's global and national context. (L2)
CO2	Apply energy audit techniques and use energy audit instruments to monitor and assess energy consumption. (L3)
CO3	Apply methods for conserving thermal energy in boilers, furnaces, HVAC systems, and solar thermal applications, including heat recovery and waste heat utilization. (L3)
CO4	Explain energy consumption patterns in buildings and industries, and describe energy-efficient building design principles. (L2)
CO5	Summarize energy-efficient building design practices, including orientation, insulation, and ventilation (L2)
CO6	Explain the role of smart grids and energy storage technologies in modern energy systems. (L2)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											1	
CO2	3	2										1	
CO3	3	2										1	
CO4	3	1										1	
CO5	3											1	
CO6	3											1	




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Course Contents:

Unit 1: Introduction to Energy Conservation Basics of energy, energy forms, and energy resources, Importance and benefits of energy conservation, Global and national energy scenario, Role of individuals and industries in energy conservation, Energy policy.	[6]
Unit 2: Energy Auditing and Monitoring Definition, energy audit, need, types of energy audit and approach, Audit methodology and instruments, Energy audit instruments, Key performance indicators, Case studies of energy audits in various sectors	[6]
Unit 3: Thermal Energy Conservation Basics of thermal energy systems (boilers, furnaces, heat exchangers, Heat recovery and waste heat utilization, Energy-efficient HVAC system, Solar thermal systems and applications.	[6]
Unit 4: Electrical Energy Conservation Basics of electrical systems, Efficient use of electrical energy in motors, pumps, fans, and compressors, Demand-side management (DSM), Power factor improving techniques.	[6]
Unit 5: Energy Conservation in Buildings and Industry Building energy consumption patterns, Green building concepts, Energy-efficient building design (orientation, insulation, ventilation), Role of automation and energy management systems	[6]
Unit 6: Policies, Standards, and Future Trends Energy conservation policies and regulations, Role of Bureau of Energy Efficiency (BEE), Energy Efficiency Improvement Programs, Smart grids and energy storage technologies, Future trends in energy conservation (IoT, AI in energy managements)	[6]
Text Books: 1. "Industrial Energy Conservation "Charles M. Gottschalk, , John Wiley and Sons, 1996. 2. "Energy Management Handbook", Author: Wayne C. Turner & Steve Doty, The Fairmont Press. 3. "Principles of Energy Conversion" Archie W. Culp Jr., McGraw-Hill. 4. Energy Conservation and Waste Heat Recovery, Prof. P K Das, IIT Kharagpur. 5. "Energy Management and Audit", Energy Management and Audit, Everest Publishing House, Pune.	
Reference Books: 1. "Industrial Energy Management and Utilisation", L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington. 2. "Industrial Energy Conservation Manuals" Elias P. Gyftopoulos, (1st edition) MIT Press. 3. "Energy Efficiency in Electrical Systems", Francesco Parasiliti and Paolo Bertoldi, Springer.	




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Design of Mechanical Systems

23ME4703B	PEC	Design of Mechanical System	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	CA I: 10 Marks CA II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Design of Machine Elements-I, Design of Machine Elements-II

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

CO1	Apply principles of Aesthetic and Ergonomics in mechanical system design.
CO2	Design IC Engine Components.
CO3	Design pressure vessels.
CO4	Design brakes and clutches.
CO5	Optimize the mechanical equipment's like spring, shaft and bar.
CO6	Make use of DFMA principal during design of system.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										2	
CO3	3	2										2	
CO4	3	2										2	
CO5	3											2	
CO6	3											2	




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Course Contents:

Unit 1: Aesthetics and Ergonomics considerations in design: Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgan's colour code. Ergonomic considerations Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipment using Ergonomics and aesthetic design principles.	[6]
Unit 2: Design of IC Engine Components Introduction to selection of material for I. C. engine components, Design of cylinder and Cylinder head, Construction of cylinder liners, Design of piston, Design of piston-pins, piston rings, Design of connecting rod, Design of crank-shaft and crank-pin.	[6]
Unit 3: Design of Pressure Vessel Concept of Thick and thin cylinders, Lame's equation, Clavarino's and Birnie's equation, Autofrettage and compound cylinders, Modes of failures in pressure vessels., Unfired pressure vessels – Classification of pressure vessels as per I.S. 2825 –1965. design of end closures as per code, Area compensation method.	[6]
Unit 4: Design of Braking and Clutch System. A) Brakes: Design consideration in brakes, Band, Internal expanding shoe, External contracting shoe. Thermal consideration and rating of brakes. B) Clutches: Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multidisc clutch, Cone clutch and Centrifugal clutch.	[6]
Unit 5: Optimum Design Objectives of optimum design, Johnson's Method of Optimum Design (MOD), Adequate and optimum design. Primary, subsidiary and limit equations, Optimum design with normal specifications, Optimum design with normal specifications of simple machine elements like bar, shaft and spring, Introduction to optimum design with redundant specifications, Introduction to Lagrange Multiplier optimization method (Theory only).	[6]
Unit 6: Design for Manufacturing and Assembly: Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly, Designs for Maintainability, Designs for Environment, Product costing, Legal factors and social issues, Engineering ethics and issues of society related to design of products.	[6]
Text Books 1. Bhandari V. B., "Design of Machine Elements" 3rd Edition, 2010, Tata McGraw Hill Education (India) Pvt. Ltd., New Delhi 2. Patil S. P., "Mechanical System Design", 2nd Edition, 2005, Jaico Publishing House, Mumbai 3. George E. Dieter and Linda C. Schmidt, Engineering Design, 4th Ed., McGraw Hill Higher Education, 2000	
Reference Books: 1. Johnson R.C., "Optimum Design of Mechanical Elements" John Wiley and Sons Inc., London. 2. Ray T. K., "Mechanical Handling of Materials", 2005, Asian Book Pvt. Ltd., Delhi	



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3. Rudenko N. "Material Handling Equipment", PEACE Publishers, Moscow.
4. G. Pahl, W. Beitz, J. Feldhusen and K.-H. Grote "Engineering Design-A Systematic Approach", Third Edition, Springer-Verlog 2007
5. "Design Data", P.S.G. College of Technology, Coimbatore.
6. Ullman D.G., "The Mechanical Design Process", McGraw Hill International Editions
7. John F Harvey, "Theory and Design of Pressure vessels", CBS publishers and distributors, Delhi
8. Willium C. Orthwine, "Machine Components Design I and II", Jaico Publishing House, Mumbai.
9. Joshi M. V., Mahajani V. V., "Process Equipment Design", MacMillan India, Ltd., Delhi 10. IS-2825-1969 Code for unfired pressure vessels.
10. S.S.Rao, "Engineering Optimization Theories and Practice", New Age Publication, 3rd Edition.
11. Johnson R.C., "Mechanical Design Synthesis with Optimisation Applications", Von Nostrand-Reynold Publication.




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Advanced Foundry Technology

23ME4703C	PEC	Advanced Foundry Technology	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Material science and Metallurgy, Manufacturing Process

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

CO1	Explain the principles and mechanisms of metal solidification (L2)
CO2	Apply gating and risering design principles, calculations, and optimization methods to produce defect-free castings. (L3)
CO3	Analyze the factors influencing casting design to recommend suitable modifications in casting geometry for improved quality (L4).
CO4	Analyze casting defects and evaluate casting quality using testing and failure analysis techniques (L4).
CO5	Apply special and precision casting processes for manufacturing complex engineering components. (L3).
CO6	Select suitable ferrous and non-ferrous casting materials and melting practices for industrial applications. (L5)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2									3	
CO2	3		3		2	2	2					3	2
CO3	3	3	3	2			2					3	
CO4		3		3			2						
CO5	3		2									3	
CO6	3		2		2	2	1					3	2



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Course Contents:

Unit 1. Solidification of Casting : Solidification of metals, Homogeneous and heterogeneous nucleation, Growth mechanism, Solidification of Pure metals and alloys, Mechanism of columnar and dendritic growth, Coring or Segregation, Solidification time and Chvorinov's rule, concept of progressive and directional solidifications, castability concept, Numerical exercises	[6]
Unit 2. Gating and Riser Design : Principles of gating system design ,Types of gates, Pressurized and non-pressurized gating design , Gating ratios and choke area calculations , Turbulence control and aspiration effect ,Pouring time calculations and optimization, Riser design using modulus method and Caine's method , Feeding distance and shape factor, Numerical problems on gating and riser design.	[6]
Unit 3. Casting Design: - Factors to be considered in casting design, design considerations in pattern making, pattern allowances, Moulding techniques, Technology of core making, organic binders, Cooling stresses and hot spots in casting and modification in casting geometry to overcome them	[6]
Unit 4. Casting Quality, Testing and Failure Analysis : □ Casting defects classification and analysis ,Root cause analysis of casting failures , Non-destructive testing methods (RT, UT, MPI, DPI) ,Mechanical and metallurgical testing of castings, Statistical quality control in foundries.	[6]
Unit 5. Special and Precision Casting Processes : Investment casting ,Vacuum moulding and vacuum casting ,Centrifugal casting and true centrifugal casting ,Squeeze casting and squeeze infiltration ,Semi-solid metal casting and thixocasting Rheocasting process, Continuous casting and strip casting	[6]
Unit 6. Casting of Ferrous and Non ferrous Metals: - Gray Cast- Chemical Composition and structure of gray cast iron. Types of graphite flakes, inoculation, Types of inoculation, ductile iron, melting of ductile iron, methods of Mg treatment, malleable iron, Annealing cycle for malleable iron, casting of steels. Copper and zinc base alloy castings, Aluminum alloys, Magnesium and its alloys, Melting Practices: factors to be considered.	[6]
Text Books: 1. Material science RK Rajput SK Kataria and sons 2. Material science and engineering Raghavan Prentice Hall of India, Delhi – 3. Material science and engineering Srivastava New age international (P) Ltd. 4. Materials and metallurgy OP Khanna Dhanpatrai", Dr. S. P. Sukhatme, Orient Longman, (2005)	
Reference Books: 1. Metal Casting Principles and Practice- T.V. RamanaRao- New Age International Publishers 2. Principles of Foundry Technology-P.L. Jain- Tata McGraw Hill	




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3. Principles of Metal casting - R. Heine and Rosenthal, TMH
4. Principal of foundry technology- P. L. Jain- Tata McGraw Hill
5. ASM Metal Handbook- Vol.-4, Casting
6. Foseco Ferrous Foundryman's Handbook- John R. Brown- Butterworth Heinemann Pub.
7. Foundry Technology- Peter Beeley- Butterworth Heinemann Pub.




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Research Methodology

23ME4704	RM	Research Methodology	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Explain the need of research
CO2	Classify different types of research and problems
CO3	Interpret the importance of research design
CO4	Construct a research report in different phases
CO5	Illustrate the importance of research ethics
CO6	Make a use of different ICT Tools for research

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											1	
CO2	3											1	
CO3	3											1	
CO4	3	1										2	
CO5	3						2					2	
CO6	3				1							2	




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Course Contents:

Unit 1 -Introduction to Research: Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research	[6]
Unit 2-Research Problem: What is a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem	[6]
Unit 3-Research Design Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs	[6]
Unit 4-Research Report: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports	[6]
Unit 5- Interpretation and Ethics in Research: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	[6]
Unit 6- ICT Tools for Research: Introduction, The Computer and Computer Technology, The Computer System, Important Characteristics, The Binary Number System, Computer Applications, Computers and Researcher.	[6]
Reference Books: 1. Alex Rosenberg, "Philosophy of Science: A contemporary introduction" Second Edition, Routledge, 2005. 2. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011. 3. Michael P. Marder, "Research Methods for Science", Cambridge University Press, 2015	
Text Books: 1. Praveen Chaddah, "Ethics in Competitive Research: Do not get scooped; do not get plagiarized" 2018. 2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers. 3. C. George Thomas: "Research Methodology and Scientific Writing", Springer Nature, 2015. 4. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Academic Press, Elsevier Inc.	




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Capstone Project-II

23ME4705	ELC	Capstone Project-II	0-0-4	2 Credits
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Teaching Scheme	Examination Scheme
Project Slot: 8 hrs/week	CA-I: 25 Marks CA-II: 25 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Knowledge of Core Mechanical Engineering Subjects

Course Outcomes: After learning the course, students will be able to:

CO1	Analyze and optimize solutions to real life problems with individual and team work through modern tool usage.
CO2	Imbibe and improve professional ethics and communication skill and engage with environment sustainability to build lifelong learning attitude.
CO3	Demonstrate the knowledge, skills, and attitudes of a professional engineer.

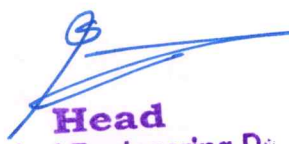
Course Contents:

- It is expected that the students should complete 100% of the total project work in Semester VII.
- The students should submit the report in a prescribed format, before the end of semester VII.
- The report shall be comprehensive and presented typed on A4 size sheets and bound paper.
- Number of copies to be submitted is number of students plus two.
- The student must submit one graphical abstract and must publish one unpaid journal or conference paper on their project work before end of semester VII.

Course Evaluation:

The evaluation of the project work will be done considering the performance of students in reviews 1, 2, & the final SEE examination.




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Review 1: For continuous assessment I students are expected to present their progress of project work till date. This review will ensure the 75 percent project work completeness. The following points can be considered for the preparation of the review 1 presentation:

- Manufacturing/ procurement of components
- Fabrication / Manufacturing of set up
- Experimentation/ Testing
- Data analysis
- Design Validation
- Implementation

Review 2: For continuous assessment II, review 2 will ensure the completeness of the project work and has to submit a comprehensive report of the same. The following points can be considered for the Review 2 presentation:

- Complete demonstration of project.
- Report writing.
- Plagiarism/Similarity report.
- Final draft of journal paper or conference paper.

Final semester end examination (SEE): For final SEE students are evaluated by panel of one industrial expert, one departmental internal examiner, and project guide.




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Simulation Laboratory

23ME4706	PCC	Simulation Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	CA-I: 25 Marks CA-II: 25 Marks

Pre-Requisites: Machine Drawing and CAD

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

CO1	Analyze mechanical components for generative design
CO2	Solve structural and thermal analysis problem using CAE software
CO3	Utilize casting simulation software to solve real world problem

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2		2	3							2	2
CO2	2	2		2	3							2	2
CO3	2	2		2	3							2	2

List of Experiments:

1. Generative design optimization for any four mechanical components using suitable software.
2. Minimum 2 structural analysis problems to be solved using a CAE software.
3. Minimum 2 thermal analysis problems to be solved using a CAE software.
4. Perform modal analysis to determine natural frequencies using CAE software.
5. Minimum 2 casting simulation problems to be solved using a casting simulation software




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Metrology and Quality Control Laboratory

23ME4707	PCC	Metrology and Quality Control Laboratory	0-0-2	1 Credit
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Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	CA-I: 15 Marks CA-II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites:

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

CO1	Demonstrate proficiency in selecting and using various linear, angular, and gear measurement instruments for accurate dimensional inspection of mechanical components.
CO2	Apply surface and thread inspection techniques using tools like optical flats, interferometers, and profile projectors to evaluate surface flatness.
CO3	Analyze and interpret quality control data using control charts, operating characteristic (OC) curves, and statistical process control (SPC) tools,

Mapping of CO's with PO's:

CO's\ PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 01	PSO 02
CO1	2	2	3		2				2		1		
CO2	3	2	2		2				2				
CO3	3	3	2	2	2				2		1		

Experiments: (ANY 8)

1. Study and use of Linear Measuring Instruments
2. Study and use of Angle Measuring Instruments
3. Identification of surfaces using optical flat/ interferometers
4. Screw Thread Measurement




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5. Study and Measurement of Thread parameters using Profile Projector.
6. Measurement of spur gear parameters using gear tooth Vernier.
7. Study and Use of Control Charts
8. Study of Operating Characteristics Curves
9. Industry visit to study CMM, Automated inspection
10. Industry case study for Inspection of Production Job by statistical Process Control.




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Internal Combustion Engines and Hybrid Vehicles Laboratory

23ME4708	PCC	Internal Combustion Engines and Hybrid Vehicles Laboratory	0-0-2	1 Credit
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Teaching Scheme:	Examination Scheme:
Practical: 2 hrs./week	CA-I: 15 Marks CA-II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Thermal Engineering, Fluid Mechanics, Thermal Engineering Lab

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

CO1	Identify various components of I C Engine by dismantling and assembly.(L3)
CO2	Evaluate for various engine performance parameters.(L5)
CO3	Illustrate different engine components through industrial visit. (L2)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										1	
CO2	3	2										1	
CO3	3	2										1	

Experiments

1. Demonstrate the constructional detail of internal combustion engines by dismantling and assembling.
2. Test on a four-stroke diesel engine.
3. Test on a computerised diesel engine by using LabVIEW-based software.
4. Test on a variable compression ratio engine.
5. Test on a four-stroke petrol engine.
6. Morse test on a multi-cylinder petrol engine.
7. Visit to an engine manufacturing company / repairing unit.
8. Case study on Market Survey on hybrid vehicles.




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Industrial Case Studies (Research Seminar)

23ME4709	RM	Industrial Case Studies(Research Seminar)	0-0-2	1 Credit
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Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	CA-I: 25 Marks CA-II: 25 Marks

Pre-Requisites:

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

CO1	Identify technical and practical issues in the industry related to the research area.
CO2	Construct a well-organised case study report employing elements of technical writing and critical thinking.
CO3	Take part in presenting a detailed report on research case study

CO-PO Mapping

CO's\ PO's	1	2	3	4	5	6	7	8	9	10	11	PSO 01	PSO 02
CO1	3								2	2		2	
CO2	3	2			1				2	2		2	
CO3	3	2	2		1				2	2		2	

Course Contents:

This course bridges academic knowledge and industry practice by engaging students in conducting research-driven case studies on real-world industrial challenges. Students will select a problem statement from industry or research databases, analyze it using appropriate methodologies, and propose data-backed solutions. It emphasizes critical thinking, stakeholder analysis, research skills, and documentation.

The student has to select a Seminar topic/Case Studies work based on topic of interest by visiting the different Industries. Periodically the implementation will be evaluated by the course coordinator. The end of each semester student will be evaluated by departmental committee/faculty assigned by HOD.




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Tentative week wise task student has to be done as follows:

1. Week 1: Introduction to Case Study Methodology
2. Week 2: Research Methodologies in Industry Context
3. Week 3: Case Selection and Problem Identification
4. Week 4: Literature Review & Benchmarking
5. Week 5: Research Design and Data Collection
6. Week 6: Data Analysis Techniques
7. Week 7: Mid-Term Presentation
8. Week 8: Developing Solutions and Recommendations
9. Week 9: Case Documentation Standards
10. Week 10: Report Review and Peer Feedback
11. Week 11: Final Report Compilation
12. Week 12: Final Presentation and Viva




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Industrial Safety

23ME4710	VEC	Industrial Safety	3-0-0	1 Credit
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Teaching Scheme	Examination Scheme
Lecture: 2 hrs/week	CA-I: 25 Marks CA-II: 25 Marks

Pre-Requisites:

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

CO1	Identify common accident causes, investigation methods and the need for safety organization.
CO2	Outline the principles and procedures of safety assessment tools, including Incident Recall Technique (IRT), Job Safety Analysis (JSA), and safety audits.
CO3	Explain the applications of human factors engineering, including the roles of humans as sensors, information processors, and controllers.
CO4	Summarize occupational diseases and safety methods used in industry.
CO5	Explain the use of personal protective equipment (PPE).
CO6	Explain the key provisions and significance of environmental and safety regulations acts.

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						1					1	1	
CO2			1			1					1	1	
CO3	1		1			1					1	1	
CO4						1					1	1	
CO5						1					2	1	
CO6						1					1	1	

Course Contents:

Unit: 1 General Safety	
Need to organize for safety, accidents, Accidents- Some definitions and codes, accident investigation, How accident prevention is accomplished, Hazard identification and assessment	[4]



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techniques, ways and means to promote safety and safety culture	
Unit: 2 Safety Techniques Incident Recall Technique (IRT), Job Safety Analysis (JSA), Components of safety audit, types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report – review of inspection safety survey, safety inspection, safety sampling, Safety Audit.)	[4]
Unit: 3 Human Factors Engineering Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine. Ergonomics interventions in Repetitive works, training prevention of manual handling injuries in the work place, postural stability	[4]
Unit: 4 Occupational Safety and Health management Occupational Diseases, fire prevention, industrial housekeeping, waste management and disposal, principles of ventilation.	[4]
Unit: 5 Personal protection Personal protective equipment's, on the job eye protection, how to protect your skin on job, stay out of Harm's way, respiratory protective equipment's, Oxygen- how it supports life, First aid.	[4]
Unit: 6 Safety rules and regulation The environment protection rules 1986, The environment protection act 1986, Indian electricity rules 1981, Gas cylinder rules, The static and mobile pressure vessels, The petroleum act and rules.	[4]
Text Books: 1. "Industrial safety management", D. M. Dhar, Everest Publishing house. 2. "Safety Management in Industry" Krishnan N.V. Jaico Publishing House, Bombay, 1997. Reference Books: 1. "Industrial Accident Prevention" Heinrich H.W. McGraw-Hill Company, New York, 1980. 2. "Industrial Safety" Roland P. Blake, Prentice Hall, Inc., New Jersey, 1973 3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989. 4. The Factories Act 1948, Madras Book Agency, Chennai, 2000. 5. Explosive Act, 1884 and Explosive rules, 1883 (India), (2002), Eastern Book company, Lucknow, 10th Edition 6. Human factors in engineering & design, MARK S.SANDERS	




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Project Planning and Execution

23MEMDA5	MDM	Project Planning and Execution	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of project management, Operation research and management

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

CO1	Explain the fundamentals of project planning (L2)
CO2	Apply project identification and formulation methods (L3)
CO3	Identify project planning tools and techniques.(L3)
CO4	Explain the concepts of project execution (L5)
CO5	Demonstrate resource mobilization and procurement in project execution(L2)
CO6	Analyze work execution procedures.(L4)

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1									3	
CO2	3	3	2	1								3	1
CO3	2	3	3	2								2	2
CO4	2	1	2									2	
CO5	2	2	3	2								2	2
CO6	2	1	2									2	




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Course Contents:

Unit 1: Introduction to Project Planning: Definition and importance of project planning Project life cycle: concept, planning, execution, monitoring, closure Characteristics and types of projects Feasibility study: technical, financial, environmental, social	[6]
Unit 2: Project Identification & Formulation: Project selection criteria, Idea generation and screening, Market, technical, and financial feasibility, Project formulation steps, Pre-feasibility and detailed project report (DPR)	[6]
Unit 3: Planning Tools and Techniques: Work Breakdown Structure (WBS), Project scope planning and specification, Project charter, Logical Framework Analysis (LFA), SWOT analysis, Project matrix and planning templates	[6]
Unit 4: Introduction to Project Execution: Meaning and importance of the execution phase, Project life cycle and position of execution, Roles of project manager, teams, stakeholders, Execution planning and mobilization	[6]
Unit 5: Resource Mobilization & Procurement: Resource allocation: manpower, materials, equipment, Procurement processes and vendor coordination, Contract administration and compliance, Logistics planning and scheduling, Inventory control and material management	[6]
Unit 6: Project Work Execution: Execution plan and work package implementation, Standard operating procedures (SOPs), Field management and site supervision, Coordination between departments and contractors, Health, safety, and environmental (HSE) practices	[6]
Text Books: 1. Project Management by P. N. Reddy, Vasant Desai, H. R. Ramanath & H. R. Appannaiah 2. Project Planning and Control with PERT and CPM by B. C. Punmia & K. K. Khanelwal 3. Project Management & Control by Rao P. C. K..	
Reference Books: 1. Project Management: Planning and Control by Albert Lester 2. Project Management Core Textbook (2nd Indian Edition) by M. R. Gopalan 3 Project Management: A Managerial Approach by Jack R. Meredith & Samuel J. Mantel Jr	




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Statistical Thermodynamics

23MEMDB5	MDM	Statistical Thermodynamics	3-0-0	3 Credits
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Thermal Engineering, Engineering physics

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

CO1	Summarize the concepts of internal energy, enthalpy, and entropy and their interdependence in thermodynamic systems. (L2)
CO2	Compare different equations of state used to model real gases and describe the laws of corresponding states(L2).
CO3	Classify the fundamental principles of statistical thermodynamics, including partition functions and equipartition of energy. (L2)
CO4	Apply Gibbs phase rule to solve problems involving phase equilibrium in multi-component systems (L3).
CO5	Summarize energy-efficient building design practices, including orientation, insulation, and ventilation (L2).
CO6	Explain the basic assumptions of kinetic theory and summarize the principle of equipartition of energy(L2).

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											1	
CO2	3											1	
CO3	3											1	
CO4	3	1										1	
CO5	3											1	
CO6	3											1	




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Course Contents:

Unit 1: Thermodynamics Relations Maxwell relations, T-ds equations, Energy Equations, General Relations involving internal energy, Enthalpy & entropy, Thermodynamics Relations involving specific heat, Clapeyron equation, Joule Thomson Coefficient	[6]
Unit 2: Real Gases Deviation from ideal gas behavior, Equation of state for real gases, Reduced properties, Generalizes equation of state, Laws of corresponding states, Generalized compressibility charts, Enthalpy deviation and entropy deviation charts and their applications, P-V-T surfaces of real substances	[6]
Unit 3: Statistical Thermodynamics Fundamental Principles, Equilibrium distribution, Significance of Lagrangian Multipliers λ & β , Partition function, Equipartition of energy, Distribution of speeds in an Ideal monotomic gas, Statistical Interpolation of Work and Heat, Entropy & Information.	[6]
Unit 4: Phase and Chemical Equilibrium Equilibrium requirements, Equilibrium between two phases of a pure substances, Equilibrium of a multi-component, Multiphase system, Gibbs phase Rule, Meta stable Equilibrium, Chemical equilibrium	[7]
Unit 5: Mixtures and Solutions Dalton Model, Amagat Model, Simplified model of a mixture involving gases and a vapour, First law applied to Gas-Vapour mixtures, Adiabatic saturation process, Partial Molar properties	[6]
Unit 6: Kinetic Theory of Gases Kinetic theory of gases introduction, Basic assumption, Molecular flux, Equation of state for an ideal gas, Collisions with a moving wall, Principle of equipartition of energy, Classical theory of specific heat capacity. Transport phenomena-intermolecular forces	[6]
Text Books: 1. V. Wylen & E. Sonntag. "Fundamentals of Classical Thermodynamics" Wiley Eastern Limited, New Delhi, 2. J. P. Holman, "Thermodynamics", McGraw Hill, London. 3. Adrian Bejan, George T., Michael Moran, "Thermal Design and Optimization" John Willey and Sons, Inc., pp 113-127, 1996. 4. Nag P.K., Basic & Applied Thermodynamics, TMH, New Delhi.	
Reference Books: 1. Turns, Thermodynamics- Concepts and Applications, Cambridge University Press 2. Wark, Advanced Thermodynamics, McGraw Hill 3. Jones & Dugan, Advanced Thermodynamics, Prentice Hall Int. 13. Bejan, Advanced Thermodynamics, John Wiley, Inc.	



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Robotics

23MEMDC5	MDM	Robotics	3-0-0	3 Credit
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Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 End Semester Exam: 50

Pre-Requisites: -

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

CO1	Explain the significance, social impact and future prospects of robotics in various engineering applications.
CO2	Identify and describe the components and anatomy of robotic system.
CO3	Apply forward and inverse kinematic techniques to determine the position, orientation, and velocity of robotic manipulators
CO4	Select the suitable drives and end-effectors for a given robotics application.
CO5	Identify various path planning techniques and analyze different motions of robotics system
CO6	Apply robotics concept to automate the monotonous and hazardous tasks and categorize various types of robots based on the design and applications in real world scenarios.

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											1	
CO2	3	2										1	
CO3	3											1	
CO4	3											1	
CO5	3											1	
CO6	3	2										1	




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Course Contents:

Introduction To Robotics: Introduction to Robotics, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots.	[6]
Robot Anatomy And Motion Analysis: Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope	[6]
Robot Kinematics: Position and orientation in 3D space, Homogeneous transformation matrices, Forward kinematics: Denavit–Hartenberg (D-H) parameters, Inverse kinematics: General methods and algebraic approaches, Kinematic redundancy and singularity, Velocity kinematics and Jacobian matrix.	[6]
Robot Drives And End Effectors: Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors.	[6]
Path Planning: Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial- Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.	[6]
Robotics Applications: Material Handling, pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing.	[6]
Text Books: 1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009. 2. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, Special Edition, (2012). 3. Ganesh S Hegde, "A textbook on Industrial Robotics", University science press, 3rd edition, 2017.	
Reference Books: 1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006. 2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987. https://www.robots.com/applications .	




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