SEMESTER V

Sr No	Course Category	Course Code	Course Title	Hours per Week			Credits	Maximum Marks		
				L	T	P		Continual Assessment	End Sem Examination	Total
1	PCC	23ME501T	Heat Transfer	3	-	-	3	30	70	100
2	PCC	23ME501P	Heat Transfer Lab	-	-	2	1	25	25	50
3	PCC	23ME502T	Design of Machine Elements	3	-	-	3	30	70	100
4	PCC	23ME502P	Design of Machine Elements Lab	-	-	2	1	25	25	50
5	PEC	23ME503T	Professional Elective course-I	3	-	-	3	30	70	100
6	PEC	23ME504T	Professional Elective course-II	3	-	-	3	30	70	100
7	PCC	23ME505P	Mechatronics Lab	-	-	2	1	25	25	50
8	OE	23ME561O	Open Elective - II	3	-	-	3	30	70	100
9	VSC	23ME506T	Technical Skill Development - II	2	-	-	2	50	-	50
10	SEC	23ME507P	Career Development - V	-	-	2	1	50	-	50
Total				17	-	8	21	325	425	750
11	MDM	**23ME531M**	Multidisciplinary minor-III	3	-	-	3	30	70	100
Total				20	-	8	24	355	495	850

Career Development - V: Training on reasoning ability

Technical Skill Development - II: Training on Matlab.

Open Elective - II	
23ME561O	Automobile Engineering

Professional Elective course-II	
23ME504T(i)	Heating Ventilation and Air Conditioning systems
23ME504T(ii)	Logistics and Supply Chain Management
23ME504T(iii)	Mechanical Vibrations

Professional Elective course-I	
23ME503T(i)	Refrigeration and Air Conditioning System
23ME503T(ii)	Production and Operation Management
23ME503T(iii)	Computer Aided Design

Multidisciplinary minor-III	
23ME531M	Industrial Safety

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME501T	Heat Transfer	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To give broad overview of and differentiate the different modes of heat transfer and governing laws. 2. To enable students to distinguish between steady and unsteady state heat transfer and their applications. 3. To inculcate analytical skills to estimate heat transfer rate for steady & unsteady state heat transfer processes. 4. To inculcate analytical skills to estimate heat transfer rate from different geometry under free and forced convection and radiation mode. 5. To equip students to design and evaluate the heat exchanger performance.	1. Explain the modes and governing laws of heat transfer and formulate analytical models to solve one dimensional steady state heat conduction problems for wall, cylindrical and spherical geometries. 2. Estimate heat transfer rate for one dimensional steady state heat conduction from fins and unsteady state heat transfer process. 3. Select appropriate non dimensional numbers & empirical correlations to estimate forced and free convection heat transfer, for internal and external flows. 4. Explain governing laws of radiation ad estimate heat transfer rate by radiation from ideal and real bodies. 5. Evaluate heat exchanger performance by LMTD and NTU methodsand design suitable heat exchanger geometry to deliver a desired heat transfer rate.

Unit I	[9Hrs]
Introduction to basic modes of heat transfer. Laws of heat transfer & conservation of energy. Introduction of general heat conduction equation in Cartesian, cylindrical and spherical coordinates (No derivation). One dimensional steady state heat conduction equation for the plane wall, and cylinder, overall heat transfer coefficient. Thermal resistance of composite structure (wall, and cylinder), contact resistance, Critical thickness of insulation for cylinder.	
Unit II	**[9Hrs]**
Extended surface, types of fins. Fins of uniform cross section area, Governing differential equation for fin. Temperature distribution and heat transfer rate under various geometrical & thermal boundary conditions (Analysis not needed), fin efficiency & effectiveness. Unsteady state heat transfer, lumped heat capacity analysis (Analysis not needed), Biot Number, Fourier's Number & itssignificance.	
Unit III	**[9Hrs]**
Forced convection, physical significance of non-dimensional parameter. Concept of thermal boundary layer thickness, local and average heat transfer coefficient. Empirical co-relations for external flow over flat plate and internal flows through pipe, laminar & turbulent flow. Free or natural convection. Grashoff's number, Rayleigh number, flow over horizontal and vertical plate.	
Unit IV	**[9Hrs]**
Radiation, spectrum of radiation, black body radiation, radiation intensity, laws of radiation-Kirchhoff, Planck's, Wien's displacement law, Stefan Boltzmann. Emissivity, Absorptivity, Transmissivity, Reflectivity, Radiosity, Emissive power, Irradiation. Radiation exchange between parallel plate, shape factor for simple geometry & its laws, Radiation shields between parallel plates.	
Unit V	**[9Hrs]**
Heat exchanger: Classification, overall heat transfer coefficient, fouling factor, LMTD & effectiveness, NTU method of heat exchanger analysis for parallel & counter flow single pass arrangement, design aspect of heat exchangers, Introduction to compact heat exchanger.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Fundamentals of Heat & Mass Transfer	Incropera, F.P., Dewitt, D. P	7th	John Wiley & Sons
2.	Engineering Heat and Mass Transfer	M.M. Rathore	2023	Laxmi Publications Pvt. Ltd,

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Heat Transfer - A Practical Approach	Yunus A. Cengel	5th	Tata McGraw Hill Pub Co. Ltd.
2.	Heat Transfer	J.P. Holman	10th	McGraw Hill Book Co., New York.

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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME501P	**Heat Transfer Lab**	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To enable students to verify modes of heat transfer and governing laws by conducting experiments. 2. To enable students to determine thermal conductivity of solid (metal /nonmetal) ,powdery substance and liquid. 3. To enable students to determine convective heat transfer coefficient, overall heat transfer coefficient emissivity, Stefan Boltzmann constant, heat transfer rate and critical heat flux rate .	1. Examine the effect of various parameters on heat transfer rate and verify the governing laws of 03 modes of heat transfer. Also to examine phase change process and seebek effect. 2. Experiment with steady and unsteady state to estimate thermal conductivity, thermal resistance and heat transfer rate for solid (metal & nonmetal), powdery substance and liquid. 3. Demonstrate and perform experiments to determine the convective heat transfer coefficient for cylindrical and pipe surfaces & fin effectiveness under forced and free convection. Also, to evaluate heat transfer coefficient and heat transfer rate in film wise and dropwise condensation & critical heat flux in boiling. 4. Demonstrate and perform experiments to determine Stefan Boltzman constant and emissivity of solid surfaces and compare with theoretical value. 5. Demonstrate and perform experiments to evaluate the effectiveness and heat transfer rate in parallel and counter flow heat exchanger (concentric & plate type) and for heat pipe

Minimum 8 experiments to be performed

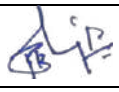
Expt. No.	Title of the experiment
1	Determination of thermal conductivity of metal bar / insulating powder.
2	Determination of the thermal conductivity of composite wall.
3	**Determination of the thermal conductivity of liquids by the two slab guarded hot plate method.**
4	Determination of heat transfer coefficient in natural convection for air flow over vertical tube.
5	Determination of heat transfer coefficient in forced convection for fluid flowing through a closed conduit.
6	Determination of heat transfer rate in unsteady state.
7	Determination of Stefan Boltzmann constant.
8	Determination and evaluation of the effectiveness of a heat exchanger (concentric tube &/or plate type) and heat pipe.
9	Determination of temperature distribution & heat transfer rate from fin under free and forced convection.
10	Determination of critical heat flux.
11	Determination of heat transfer coefficient in film wise & drop wise condensation. **(Experiment beyond syllabus)**
12	3 - 4 virtual lab experiments .(http://vlab.amrita.edu/?pg=bindex&bsub=login_page) 12.1 Determination of emissivity of non black plate. 12.2 Examination of phase change process. 12.3 Verification of Newton's law of cooling. 12.4 Examine the thermocouple Seebeck effect.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Fundamentals of Heat & Mass Transfer	Incropera, F.P., Dewitt, D. P	2018	John Wiley & Sons
2.	Engineering Heat and Mass Transfer	M.M. Rathor	2023	Laxmi Publications Pvt. Ltd

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Heat Transfer - A Practical Approach	Yunus A. Cengel,	5th	Tata McGraw Hill Pub Co. Ltd.
2	Heat Transfer,	J.P. Holman	10th	McGraw Hill Book Co., New York.

		July 2025	1.0	Applicable for 2025-26
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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME502T	Design of Machine Elements	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To enable students to attain the basic knowledge required to analyze, design and select machine elements. 2. To impart design skills in students for solving problems of real life industrial applications. 3. To create awareness among students about safety, ethical, and other societal constraints in execution of their design projects.	1. Describe general process of design of machine elements, design considerations, classifications and able to apply basic theory and principals of product design and development. 2. Design shaft and suggest suitable bearing for given loading condition. 3. Design and select flexible power transmission elements like belts and chain drives and analyze performance of plate clutches. 4. Use principles and procedures for design and selection of various types of gear drives. 5. Analyze forces and stresses on structural welded and riveted joints and suggest suitable specifications of flange coupling.

Unit I	**[9Hrs]**
Introduction to Mechanical Engineering Design: General design process, Classification of machine design, Design considerations, Material selection, Material classification and standard designation in various systems.Introduction to Product Design & Development: Importance of product design, types of design, product definition, product specification, Phases of product development	
Unit II	**[9Hrs]**
Design of shaft: Design of shaft subjected to torsional, bending load, ASME code for shaft design. Design of bearings: Introduction to hydrodynamic and hydrostatic bearings, Classification of antifriction bearings, selection of ball bearings.	
Unit III	**[9Hrs]**
Introduction to frictional Drives (Belt and Clutch), Design of V-Belt and roller chain drives. design of single and multi-plate clutch.	
Unit IV	**[9Hrs]**
Introduction to gear drives, gear terminologies, design of spur gear drive, design of worm-worm gear drives.	
Unit V	**[9Hrs]**
Introduction and types to welded, riveted joints (structural applications), Design of welded and rivetted joints subjected to axial and eccentric loading. Introduction and classifications of shafts couplings, design of rigid flange coupling.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Design of Machine Elements	V. B. Bhandari	2020	McGraw Hill education.
2.	Design Data book	B.D. Shiwalkar	2017	Central Techno publications

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Hand book of Machine Design	Shigley & Mischke	2018	McGraw Hill education.
2.	Design of Machine Elements,	B.D. Shiwalkar	2017	Central Techno publications

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME502P	Design of Machine Elements Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To make students well conversant with the design procedure of standard machine components. 2. To Impart design skills in students for solving problems of real life industrial applications. 3. To inculcate an attitude of team work, communication and planning through design problems.	1. Evaluate forces and stresses acting on various components of mechanical power transmission system. 2. Suggest suitable design specification of standard machine component and interpret OEM catalogue for Standard machine component. 3. Work in team to solve real life problem related to mechanical power transmission system used in machines and mechanisms.

Minimum 8 experiments to be performed

Expt. No.	Title of the Practicals
1	Design of Shaft for given mechanical system.
2	Design and Selection of bearing for a shaft subjected to radial and axial load.
3	Design of V-belt drive.
4	Design of roller chain drive.
5	Design and selection of spur gear drive.
6	Design and selection of worm-worm gear drive.
7	Design of Clutch.
8	Design of structural riveted joints subjected to eccentric loading.
9	System Design:- To design real life mechanical power transmission comprising of minimum 4 components.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Design Data book	B.D. Shiwalkar	2020	Central Techno publications
2.	Hand book of Machine Design	Shigley & Mischke	2017	McGraw Hill education.

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Design Data Hand Book	Mahadevan	2018	CBS publishers
2.	Hand book of Machine Design	Shigley & Mischke	2017	McGraw Hill education.

B. Tech. Scheme of Examination & Syllabus 2023-24

MECHANICAL ENGINEERING

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME503T(i)	PE-I Refrigeration and Air Conditioning System	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To introduce the basic concept of refrigeration and air conditioning and further to carry out their engineering analysis. 2. To make student aware of the conventional and new refrigeration systems, cryogenics, air conditioning with psychometric, heat load calculations, design of air conditioning system & transmission and distribution of conditioned air. 3. To enhance student's knowledge about environmental impact of refrigerants and alternative refrigerants.	1. Describe and analyze air cycle refrigeration and aircraft refrigeration. 2. Describe and analyze vapor compression system and select appropriate refrigerant in the light of contemporary issues of ozone depletion and global warming. 3. Describe and analyze multipressure vapor compression systems and other non-conventional refrigeration systems. 4. Describe and analyze the basic air-conditioning processes and their application for achieving thermal comfort for better health and work productivity. 5. Describe and analyze transmission and distribution of air through ducts and related systems.

Unit I	**[9Hrs]**
Air cycle refrigeration: The Reversed Carnot Cycle, Gas as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle, Reversed Brayton or Joule or Bell-Coleman Cycle, Application to Aircraft Refrigeration	
Unit II	**[9Hrs]**
Vapour Compression System: Modifications in Reversed Carnot Cycle with Vapour as a Refrigerant, Vapour Compression Cycle, Vapour Compression System Calculations, Standard Rating Cycle and Effect of Operating Conditions, Actual Vapour Compression Cycle **Refrigerants:** Properties, classification, nomenclature, its global warming & ozone depletion potential, alternate refrigerants.	
Unit III	**[9Hrs]**
Multipressure Systems:- Introduction, Multistage or Compound Compression, Multi-Evaporator Systems **Other refrigeration systems:** Vapour–Absorption System, vortex tube, thermoelectric refrigeration	
Unit IV	**[9Hrs]**
Properties of Moist Air:- Psychrometric Properties, DBT, WBT, DPT, Thermodynamic WBT, Psychrometric Chart **Psychrometry of Air-Conditioning Processes:** Mixing Process, Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Simple Air-Conditioning System, Summer Air Conditioning-apparatus Dew Point, Winter Air Conditioning	
Unit V	**[9Hrs]**
Transmission and Distribution of Air - Room Air Distribution, Total, Static and Velocity Pressures, Friction Loss in Ducts, Dynamic Losses in Ducts, Air Flow through a Simple Duct System, Air-duct Design, Processing, Transmission and Distribution of Air in Clean Rooms, Air Locks, Air Curtains and Air Showers	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Refrigeration and Airconditioning	C.P. Arora	3rd Edition, 2017	Tata McGraw Hill,
2.	A text book of Refrigeration and Air Conditioning	Khurmi R.S., Gupta, J. K	2019	Eurasia Publishing housing (P) Ltd, New Delhi

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	A course in Refrigeration and Air conditioning	Arora, S. C., Domkundwar, S	2018	Dhanpat Rai (P) Ltd., New Delhi
2.	Refrigeration and Air Conditioning	D S Kumar	2017	S.K. Kataria & Sons

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(An autonomous institution affiliated to RashtrasantTukadoji Maharaj Nagpur University)

B. Tech. Scheme of Examination & Syllabus 2023-24

MECHANICAL ENGINEERING

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME503T(ii)	PE-I Production and Operation Management	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To introduce the concepts and scope of POM, and to develop knowledge of product / process design, product life cycle management, and value analysis techniques. 2. To prepare to identify the factors influencing plant location and layout decisions 3. To provide insights into production planning and control techniques, and to familiarize students with materials management processes, including inventory control	1. Classify various operations management techniques and be able to select andapply suitable processes for an engineering product. 2. Infer various product & process design and analysis, and be able to select andapply suitable processes for new product development 3. Demonstrate various factors Influencing Plant Location 4. Illustrate the application of various planning techniques like capacity, Facility, material requirement and aggregate planning 5. Illustrate the application of Integrated Materials Management techniques

Unit I **[9Hrs]**

INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT

Introduction, scope of production and operations management , Classification of Production System: Job shop production, Batch production, Mass production, Continuous production, Production: Relationship with Other Functions, various types of utility,Production management: concept, scope ,objective, Operating system: concept, Operations Management: concept scope, Objectives , activities production and operations management functions:, Difference between Production and Operations Management

Unit II **[9Hrs]**

PRODUCT & PROCESS DESIGN AND ANALYSIS

New product Design; reason to design the new product ,Product life cycle (Characteristics of Phases in Product Life cycle (PLC),Aspects of Product Design and Analysis, Product design (development) process , factors that affect a product design, steps of product Design , Product analysis ,Process design, selection and Classification of Process , process planning and Design, Stepsin Process Planning, Process Design , Value Analysis/Value Engineering

Unit III **[9Hrs]**

PLANT LOCATION & PLANT LAYOUT

Plant Location: Factors Influencing Plant Location ,Plant layout ;need, objectives , Classification of Layout - Advantages and Limitations of Product Layout - Objectives – Work Flow patterns - Factors Influencing Plant Layout - REL(Relationship) Chart -

Unit IV **[9Hrs]**

PRODUCTION PLANNING MANAGEMENT

Capacity and Facility Planning: Importance of capacity planning- Capacity measurement - Capacity Requirement Planning (CRP) process for manufacturing and service industry- Material Requirement Planning (MRP) and Control: MRP concept and process , JIT and Lean manufacturing, Aggregate production planning

Unit V **[9Hrs]**

MATERIALS MANAGEMENT

Materials Management: Planning – Definition, Objectives primary & secondary , scope ,flow , purpose ,principle ,function of MM , Components of Integrated Materials Management: Stores Management: Incoming Materials Control - Inventory Control – Inventory Model ABC Analysis – XYZ Analysis

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Production and Operations Management	Panneerselvam	3rd	PHI.
2.	Production and Operations Management,	Ajay K Garg,	2017	TMH.
3.	Production Operations Management,	Prof. L.C. Jhamb:	18th	Everest Publishing House.

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Production and Operations Management,	Dipak Kumar Bhattacharyya,		Universities Press.
2.	Operations Management: Theory and Practice	B. Mahadevan,		Pearson.

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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME503T(iii)	PE-I Computer Aided Design	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To introduce fundamentals of CAD and developing algorithms to generate basic geometric entities. Also, perform fundamental geometric transformations. 2. To illustrate various 3D modeling techniques and introduce different types of geometric curves. 3. To provide comprehensive understanding about Finite Element Methods and develop analytical skills to solve 1D finite element problems for various loading conditions.	1. Design logical algorithms to perform specific tasks and construct computer programs based on these algorithms. 2. Examine the principles behind fundamental transformations normal, as well as special transformations into two-dimensional and three-dimensional graphics. 3. Compare and evaluate various three-dimensional model generation techniques and analyze their applications in practical scenarios. 4. Create finite element models for engineering problems, apply appropriate loading and boundary conditions, and solve them to interpret performance in simulated conditions.

Unit I **[9Hrs]**

Introduction: Introduction of CAD, Difference between conventional design & CAD, Rasterization techniques. Simple algorithms for the generation of basic geometric entities like line, circle by using parametric & non- parametric equations. Introduction to windowing and clipping (excluding algorithm), window and viewport, line clipping & polygon clipping.

Unit II **[9Hrs]**

Two dimensional Transformation: scaling, translation, rotation, reflection, shear. Concept of homogeneous representation and concatenated transformations. Inverse transformations.(Enumeration of entity on graph paper)
3D transformation: Translation, scaling, rotation about arbitrary line, reflection etc.

Unit III **[9Hrs]**

3D Modeling Techniques: Techniques for Geometric modelling: Wire frame modeling, surface modeling, solid modeling methods, primitive creation function, Constructive solid geometry (CSG) & Boundary representation (B-rep) technique etc. using set theory. Introduction to Analytical curves, synthetic curves, Bezier curve, cubic spline curve and B spline curve.

Unit IV **[9Hrs]**

1D Finite Element Method: Fundamental Concept of Finite Element Method: Plain Stress and Strain, Finite element modelling, Potential energy approach, Galerkin Approach, Coordinate and shape function, Assembly of Global stiffness matrix and load vector, properties of stiffness matrix, Finite element equations, Quadratic shape function, point load to a bar, torsional load to shaft.

Unit V **[9Hrs]**

FEM to truss member: Plane truss problem. Finite element method for truss. Introduction, element formulation, load vector, boundary condition, support reaction.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Mathematical Approaches in Computer Graphics	D.P Kothari, G.K Awari, D D Shrimankar, A.R Bhende	First	New Age International
2.	A First Course in the Finite Element Methods	Daryl Logan	5th	Cengage Learning India Private Limited

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Cad/Cam Computer-Aided Design And Manufacturing	Mikell P Groover	1st	Prentice Hall Of India
2.	Mathematics for Computer Graphics and Game Programming	D. P Kothari, G. K. Awari, D. D. Shrimankar, A. R. Bhende	1st	Mercury Learning, US

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME504T(i)	PE-II Heating Ventilation and Air Conditioning systems	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To provide overview of the HVAC sector and the related codes & standards to the students. 2. To enable students to understand and apply the basic heat and mass transfer processes for the analysis of the HVAC systems. 3. To enhances the design skills of the students for heating, refrigeration, ventilation and air distribution system.	1. Explain the most important concepts, components, Codes & standards related to HVAC systems. 2. Explain and apply steady heat and moisture transfer processes for estimating heat transfer in buildings 3. Analyze performance of air washers and cooling towers 4. Analyze and design ducting systems for HVAC applications. 5. Analyze and design water distribution systems for HVAC applications.

Unit I	**[9Hrs]**
Introduction to HVAC systems and components: An Overview of HVAC Systems, Some Optional Designs of HVAC Systems, HVAC system using air as the energy transport medium, HVAC system using water as the energy transport medium, HVAC system using water and air as energy transport media, Packaged and unitary systems, Reversible heat pumps for heating and cooling, Overview of HVAC Design Procedure, Codes & standards for HVAC systems.	
Unit II	**[9Hrs]**
Steady Heat and Moisture Transfer Processes in Buildings:- Introduction, Steady Heat Transfer through Multi-Layered Structures, Parallel path method, Isothermal plane method, Zone method, Steady Heat Transfer through Fenestrations, Windows and doors, Below Grade Heat Transfer in Buildings, Heat transfer through basement walls, Heat transfer through basement floors, Heat transfer through surfaces at grade level, Infiltration in Buildings, Heating load due to infiltration, Infiltration air flow rates, Estimation of infiltration flow rates, Moisture Transport in Building Structures, Fick's law.	
Unit III	**[9Hrs]**
Direct-Contact Transfer Processes and Systems: Introduction, Review of Mass Transfer Principles, Steady mass diffusion through a plane wall, Steady convection mass transfer, Simplified Model for Simultaneous Heat and Mass Transfer, Air Washers or Humidifiers, Analysis of air washers, Efficiency and number of transfer units (NTU), Cooling Towers, Analysis of cooling towers, Enthalpy potential based model for cooling towers, Approach and range of cooling towers.	
Unit IV	**[9Hrs]**
Air Distribution Systems:- Introduction, Total Pressure Distribution, Pressure Loss in Duct Networks, Pressure loss in straight ducts, Pressure loss in fittings, Total pressure loss in duct sections, Air Distribution Fans, Axial flow and centrifugal fans, Fan characteristics, Fan laws, Fan–Duct Network Interaction, Design Methods for Duct Systems, Equal friction method, Static regain method, Optimization of Duct Systems, Air Distribution in Zones, Air flow from diffusers, Air diffusion performance index, Design aspects of air distribution systems.	
Unit V	**[9Hrs]**
Water Distribution Systems:- Introduction, Energy Equation for Hydronic Systems, Head Losses in Hydronic Systems, Friction head loss in pipes, Dynamic head loss in fittings, Pump Characteristics, System–Pump Interaction and Flow Control, Design of Water Distribution Systems, Direct-return and reverse-return systems, Design of pipe networks.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Principles of Heating, Ventilation And Air Conditioning With Worked Examples.	Nihal E Wijeysundera.	2023	World Scientific.
2.	Handbook Heating, Ventilating, And Air-Conditioning Applications.	ASHRAE	2019	ASHRAE, Atlanta, GA.

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Principles of Heating, Ventilation, and Air Conditioning in Buildings	John W. Mitchell, James E. Braun	2012	John Wiley & Sons, Inc.
2.	Handbook of Heating, Ventilation, & Air Conditioning	Jan F. Kreider	2000	CRC Press Inc

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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME504T(ii)	PE-II Logistics and Supply Chain Management	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1.To enable students to acquire knowledge of strategic importance of logistics in the SCM framework 2. To explain basics of Supply chain management and its importance in making strategic decision in th organization 3.To enable students to acquire knowledge of forecasting methods,Inventroy management techniques for planning 4. To equip student to interpret the concept of network designing for Supply chain management	1 Explain the fundamentals, objectives, elements, roles, and activities of Logistics and Logistics Management, and demonstrate an understanding of Integrated Logistics Management concepts.. 2 Illustrate the concept of logistics strategies and evaluate their role in business development. 3 Explain the fundamentals of Supply Chain Management (SCM) and analyze its role in achieving business goals. 4 Analyze and apply the concepts of forecasting, inventory management, and aggregate planning in supply chain operations 5 Develop and evaluate supply chain distribution and transportation networks. Also explain the role of E-business in Supply Chain Management (SCM).

Unit I	**[9Hrs]**
Logistics: Definition, History and Evolution, Objectives, Elements, activities importance, the work of logistics, Logistics interface with marketing, Retails logistics. Logistics Management: Definition, Evolution of the concept, model, process, activities. Achievement of competitive advantage through logistics framework, Role of logistics management, Integrated Logistics Management.	
Unit II	**[9Hrs]**
Logistics Strategies: Strategic role of logistics, Definition, Role of logistics managers in strategic decisions; Strategy options: Lean, Agile & other strategies; Designing & implementing logistical strategy; emerging concepts in logistics. Outsourcing Logistics: Reasons, Third party logistics provider, Fourth party Logistics providers (4PL), Stages, Role of logistics providers.	
Unit III	**[9Hrs]**
Introduction to SCM , Definition, Concepts Objectives, Nature and Scope , Process of SCM, Decision Phases , Supply Chain Performance in achieving strategic fit , Major drivers , factors affecting strategic fit , Importance of SCM in business management, Bullwhip Effect ,Centralized and Decentralized SCM	
Unit IV	**[9Hrs]**
Planning Demand and Supply in a Supply Chain: Forecasting- Need for forecasting, Quantitative methods. Inventory Management- Various costs in inventory management and need, Deterministic models and discounts, Probabilistic Inventory management. Aggregate Planning The Role of Aggregate Planning, Aggregate Planning Strategies.	
Unit V	**[9Hrs]**
Designing supply chain distribution and transportation network, Concepts, Factors affecting the distribution network design, network design options, Network design , Transportation , factors influencing transportation decisions, modes of transportation, design options, tradeoffs , E-Business in SCM	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Supply Chain Management, strategy, planning, and operation	Chopra, S., and Meindl, P.	Second edition 2014.	PHI
2.	Operations Management	Evans and Collier.	1983	Tata McGraw-Hill Publishing Co. Ltd

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Logistics and Supply Chain Management	Martin Christopher	Sixth 2023	Pearson Education Asia, New , Delhi.
2.	Production and operations Management	R. Panneerselvan,,	2000	Prentice Hall of India, Delhi

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME504T(iii)	PE-II Mechanical Vibrations	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To introduce to the concept of vibration in Mechanical systems including identification of vibration elements, forces and its response. 2. To develop analytical skill to find solution of two degree and multi degree of freedom vibratic system. 3. To familiarize about the vibration signal patterns in various machine fault diagnosis.	1. Model a vibrating system into single degree of freedom system using spring mass damping element and applying design principles. 2. Design an absorber system by using a concept of two degree of freedom vibration system for vibration mitigation. 3. Solve multi degree of freedom vibration problem using numerical methods to determine its natural frequencies and mode shapes. 4. Derive the natural frequency equation and mode shapes of a continuous system subjected longitudinal, transverse and torsional vibration. 5. Analyse vibration signal in time domain and frequency domain to determine presence of machine fault and its location using data acquisition system.

Unit I	**[9Hrs]**
Introduction to single degree of freedom systems: Introduction to vibration, technical terms in vibrations, types of vibration, parts of vibration, mathematical representation of SHM, equilibrium method, **Undamped Free systems:** Derivation of differential equation using Newton's method, Energy method, Reyleigh's method, Equilibrium method, torsional vibrations. Damped Free systems: Derivation of differential equation, Logarithmic decrement. **Forced vibration:** Equation of motion with harmonic force, response of rotating unbalance. Vibration isolation and transmissibility.	
Unit II	**[9Hrs]**
Two degree of freedom system: damped, undamped free and forced vibration systems. Torsional vibrations, Vibration absorber, dynamic vibration absorber, tuned dynamic vibration absorber.	
Unit III	**[9Hrs]**
Multi-degree of freedom system: Numerical techniques for M.d.o.f. systems. Matrix method. Influence coefficient method. Holzer's method for spring-mass and torsional vibration system. Dunkerley's Method for Critical Speed and natural frequency with shaft self weight. Rayleigh Ritz, Stodola method for determination of all the natural frequencies and mode shapes. Rayleigh's method of MDOF system, Eigen value and eigen vector	
Unit IV	**[9Hrs]**
Vibration of continuous system: Lateral Vibration of beams, Torsional vibration of shaft, longitudinal vibration of bar or rod, transverse vibration of string or cable.	
Unit V	**[9Hrs]**
Vibration Measurement: vibration measurement pickups, proximity probe spectrum analyzer, FFT & DFT(DiscreteFT), vibration measurement, digital vibration measurement, philosophy of vibration condition monitoring in industry 4.0 scenario. Case studies of vibration based fault detection in industry.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Mechanical Vibrations	V. P. Singh	Sixth edition (2020)	Dhanpat Rai, Delhi
2.	Mechanical Vibrations	Singiresu S. Rao	Sixth edition (2018)	Pearson India Education
3.	Vibration Condition Monitoring of Machines	J.S. Rao	First edition (2000)	Narosa publications.

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Mechanical Vibration	Debabrata Nag	First edition (2001)	Wiley
2.	Mechanical Vibrations	J.S. Rao	Second edition (1999)	New Age publishers
3.	Mechanical Vibration	Dukkipati & Srinivas	Second edition (2012)	PHI Learning

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME505P	Mechatronics Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To provide hands-on experience on the development of data acquisition system by properly selecting sensor, signal conditioning unit, signal processing unit. 2. To provide demonstrate design and development of the concepts hydraulic and pneumatic actuation elaborating a role of direction control valves in development of logic. 3. To provide hands-on experience of various types of sensors, their working principles and applications. 4. To provide experiential learning on working of PLC including elements, ladder logic and hardware & software interface.	1. Choose appropriate sensors to measure a physical quantity by considering various constraints of measurement. 2. Develop pneumatic / hydraulic circuit for given application using actuators and control valves. 3. Demonstrate the Implementation of ladder diagram, programming using PLC to develop a new mechatronics application. 4. Develop a measurement system using data acquisition system by properly selecting sensor, signal conditioning unit, signal processing unit.

- **Minimum eight experiments to be performed from the list**

Expt. No.	Title of the experiment
1	Performance based on the working of Digital-to-analog conversion.
2	Performance based on the working of Analog-to-digital conversion.
3	To design & develop a measurement system using single-channel Data Acquisition System & LabVIEW software.
4	To design & develop a measurement system using multi-channel Data Acquisition System on multi functional machine fault simulator.
5	Performance based on pneumatic/hydraulic cylinder using single acting cylinder.
6	Performance based on pneumatic/hydraulic cylinder using double acting cylinder.
7	Performance based on distance measurement sensor.
8	Performance based on weight measurement sensor
9	Performance based on displacement measurement sensor
10	Peformance based on proximity sensor (Inductive & Capacitve)
11	Development of ladder diagram, programming using PLC for Lift / elevator control.
12	Development of ladder diagram, programming using PLC for elecro-hydraulic system.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Mechatronics	W. Bolton	Fourth edition	Pearson Education Ltd
2.	Mechatronics Integrated Mechanical Electronics Systems	K P Ramchandran, G k Vijayaraghavan, m S Balasundaram	First edition (2008)	Wiley

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Mechatronics	HMT Ltd	Third Edition (Kindle Edition)	Tata McGraw-Hill
2	Introduction to Mechatronics	Appu kuttan K.K	First edition (2007)	Oxford University Press

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME561O	OE-II Automobile Engineering	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To enable students to identify and describe the fundamental components and systems of an automobile. 2. To develop the ability to explain and compare the working principles and functions of various automobile control systems. 3. To equip students with knowledge of modern advancements in automotive technology, including electric vehicles, hybrid vehicles, fuel cell vehicles, alternative energy sources, vehicle body design, safety features, and recent innovations in the field.	1. Classify and identify the main components of automobile chassis and frames, and explain the construction and working of fuel supply, cooling, and lubrication systems used in automobiles. 2. Illustrate and compare the functions of various types of clutches and gearboxes; select appropriate systems for specific applications, and explain the working of transmission system components. 3. Describe and analyze the working principles and functions of different braking, steering, and suspension systems along with their components. 4. Explain and evaluate the functions of key electrical systems used in automobiles also compare different types of automobile wheels and tyres. 5. Explain the need, design considerations, and functional requirements of electric and hybrid vehicles; discuss and analyze modern trends in automobile technology including automotive safety features and recent innovations

Unit I **[9Hrs]**

Introduction to Automobile: Chassis and Frame: Layout of chassis & its main components. Types of frames, conventional Frames and unitized chassis, articulated, rigid vehicles, prime movers, Power Plant: Constructional features of different types of engines used in automobiles. Fuel supply systems, cooling systems, lubrication systems.

Unit II **[9Hrs]**

Transmission system: Clutch: Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single and multiplate clutch, fluid clutch. **Gear Box:** Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism, lubrication and control. Torque converter, semiautomatic and automatic transmission. Propeller shaft, drives, differential and axles.

Unit III **[9Hrs]**

Brakes, Steering systems and Suspension system: Brakes: Need & types, mechanical, hydraulic & pneumatic brakes, electrical brakes, engine exhaust brakes, drum and disc brakes, comparison and details of components. Brake adjustment **Steering systems:** principle of steering, center point steering, steering linkages, steering geometry and wheel alignment, power steering. **Suspension systems:** Function of spring and shock absorber, conventional and Independent suspension system, Telescopic shock absorber, linked suspension systems, rubber, plastic, hydro and pneumatic suspension system

Unit IV **[9Hrs]**

Electrical systems, Wheels and Tyres: Automobile Battery, lighting circuit, horn, side indicator, wiper and panel board instruments. Battery, magneto and electronic ignition systems. Automobile air-conditioning. Wheels and Tyres. Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, comparison of radial and bias-ply tyres, tyre construction, factor affecting tyre life, precautions regarding the tyres and wheel balancing.

Unit V **[9Hrs]**

Electric vehicles, Hybrid vehicles and Fuel cell vehicles. Alternative energy sources, CNG, LPG, biodiesel, bio-ethanol and hydrogen fuels in automobiles. Body and Safety Considerations and Modern Developments in Automobiles: Requirements of automobile body, safety considerations, crash worthiness. Recent advances in automobiles such as ABS, electronic power steering, Active suspension, collision avoidance, intelligent lighting, navigational aids and electronic brake distribution system.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Automobile Engineering Vol I and II	Kripal Singh	14th	Standard Publications
2.	Automobile Engineering	R. K. Rajput	2nd	Laxmi Publications (P) Ltd.
3.	Automobile Engineering	G.B.S. Narang	5th	Khanna Publishers

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Motor Vehicle	Newton & Steeds	12th	Life & Sons Limited
2.	Automotive Mechanics	Joseph Heitner	2nd	McGraw Hill pub. Co

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME506T	Technical Skill Development-II	2	-	-	2	50	-	50

Course Objectives	Course Outcomes
1. To give hands on experience on design and analysis of basic engineering structures. 2. To facilitating computational analysis and performance evaluation through software-driven finite element simulations utilizing industrial tools, for structural response assessment and interpretation.	1. Evaluate the design of simple engineering structures for performance and effectiveness. 2. Formulate methods for analyzing basic engineering problems and construct appropriate solutions. 3. Analyze and interpret the results of analytical evaluations to derive meaningful insights.

Problem Statement: Design and evaluation of deflection behavior for a cantilever beam using numerical and analytical techniques.(All the following experiments have to be performed)

Expt. No.	Title of the experiment
1	Determine the deflection of a cantilever beam under a point load.
2	Analyze the stress response of a cantilever beam under applied loading conditions.
3	Construct basic geometric entities, including points, lines, and surfaces.
4	Create closed volumes by integrating defined surfaces.
5	Specify thickness and material properties using Hypermesh.
6	Discretize surfaces and assign thickness and material properties.
7	Define force as a vector and apply constraints to discretized surfaces.
8	Perform linear static analysis using OptiStruct software.
9	Evaluate and interpret the results of linear static analysis to assess performance.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Design Data for machine elements	B.D.Shiwalkar	1st	Denett
2.	Fundamentals of strength of materials	P. N. Chandramouli	2018	PHI Learning

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Applied mechanics and strength of materials	R.S.Khurmi	13th	S. Chand/Eurasia Publishing co. Pvt. Ltd.

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME507P	Career Development-V	-	-	2	1	50	-	50

Course Objectives	Course Outcomes
1. To ignite the importance of aptitude skill development for better career prospects. 2. To develop analytical and aptitude skills for preparation of competitive exams and placement drives.	1. Solve analytical questions on time and work, time and distance, pipes and cistern interest by application of mathematical concepts. 2. Analyze and select correct alternative for analytical reasoning ability questions on seating arrangement. 3. Analyze the question and apply logic for questions on direction sense and coding-decoding.

Topics to be Covered

Topic No.	Topic
1	Time and Work
2	Pipes and Cistern
3	Chain rule problems
4	Linear and circular arrangement problems
5	Time and distance (Part-1: Basic problems, relative speed)
6	Time and distance (Part-2: Problem on trains, races)
7	Time and distance (Part-3: Boats and streams)
8	Direction sense problems
9	Coding - decoding

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Quantitative Aptitude for Competitive Examinations.	R.S.Agrawal	2025	S.Chand & Company
2.	Quantitative Aptitude	Shripad Deo	2014	Allied Publishers

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	A modern approach to verbal and non verbal reasoning.	R.S.Agrawal	2025	S.Chand & Company
2.	Verbal & Non-verbal reasoning	Neeraj Kumar	2022	NRBC Publishers

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME531M	MDM-III Industrial Safety	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To provide awareness about importance of safety and industrial safety practices. 2. To give comprehensive knowledge about various safety aspects and standard guidelines for industrial safety and health.	1. Identify, assess, and evaluate various industrial hazards and risks associated with industrial processes. 2. Explain the significance of Personal Protective Equipment (PPE) and safety training programs for workers. 3. Interpret safety management systems and standards in industrial environments. 4. Appraise the ergonomic risks,risk assessments in industrial settings. 5. Describe the principles of machine guarding and demonstrate knowledge of safety considerations in material handling processes.

Unit I **[9Hrs]**

Need for safety. Safety and productivity. Principles of Accident Prevention: Definition: Incident, accident, injury, dangerous, occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes etc. Types of Hazards in an Industrial Setup Mechanical, Electrical, Civil ,Chemical, etc

Unit II **[9Hrs]**

Personal protection in the work environment, Types of **Personal Protective Equipment (PPE),** Education, Training and Employee Participation in Safety: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs.

Unit III **[9Hrs]**

Monitoring for Safety, Health & Environment: Occupational Safety, Health and Environment Management System, Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000, ILO and EPA Standards. OHSAS18001

Unit IV **[9Hrs]**

Relevance of ergonomics in industry. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disordere valuation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

Unit V **[9 Hrs]**

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. , Material Handling-Classification-safety consideration- manual and mechanical handling.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Industrial Safety , Health and Environment Management Systems	R.K. Jain and Sunil S. Rao,	2006	Khanna publishers, New Delhi
2.	Industrial Safety and Environment	A.K. Gupta	3rd	Laxmi Publications Pvt Ltd

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Industrial Safety, Health Environment and Security	Basudev Panda	2013	Laxmi Publications Pvt Ltd
2.	Safety Management System And Documentation Training Programme Handbook	S.V.Paul	2019	CBS Publication.