ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR

(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

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

MECHANICAL ENGINEERING

SEMESTER VII

Sr No	Course Category	Course Code	Course Title	Hours per Week			Credits	Maximum Marks				Minimum Passing Marks	No of Hours for ESE
				L	T	P		Mid Semester Examination	Continual Assessment	End Sem Examination	Total		
1.	PCC	23ME701T	Automation and Robotics	3	-	-	3	15	15	70	100	45	3
2.	PCC	23ME701P	Automation and Robotics Lab	-	-	2	1	-	25	25	50	25	-
3.	PCC	23ME702T	Energy Conversion	3	-	-	3	15	15	70	100	45	3
4.	PCC	23ME702P	Energy Conversion Lab	-	-	2	1	-	25	25	50	45	-
5.	PEC	23ME703T	Program Elective Course – V	3	-	-	3	15	15	70	100	45	3
6.	PEC	23ME703P	Program Elective Course – V Lab	-	-	2	1	-	25	25	50	25	-
7.	PEC	23ME704T	Program Elective Course – VI	3	-	-	3	15	15	70	100	45	3
8.	MDM	23ME731M	Multidisciplinary Minor - V	3	-	-	3	15	15	70	100	45	3
9.	ELC	23ME705P	Project - II	-	-	8	4	-	50	50	100	50	
10.	ELC	23ME706P	Summer / Winter Internship*	-	-	-	2	-	50	-	50	25	
			Total	**15**	**-**	**14**	**24**	**75**	**250**	475	800		

* **Summer / Winter Internship (Evaluation of Four weeks Internship Completion till 6th Semester)**

Program Elective course-V	
23ME703T(i)	HVAC System Design
23ME703T(ii)	Industrial Robotics
23ME703T(iii)	Finite Element Method

Program Elective course -V Lab	
23ME703P(i)	HVAC System Design Lab
23ME703P(ii)	Industrial Robotics Lab
23ME703P(iii)	Finite Element Method Lab

Program Elective course -VI	
23ME704T(i)	Energy Conservation in HVAC System and Components
23ME704T(ii)	Smart Manufacturing and Production System
23ME704T(iii)	Machine Fault Diagnosis
23ME704T(iv)	Project Management for Engineers

Multidisciplinary Minor - V	
23ME731M	Automotive Auxiliary Systems Engineering

		July 2026	NEP 1.0	Applicable for 2026-27
Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME701T	Automation and Robotics	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To Introduce students to the fundamentals of automation and robotics, and to equip students with a clear understanding of NC, CNC, DNC and robot production systems, including part programming techniques 2. To familiarize students with CAD/CAM, Flexible Manufacturing Systems (FMS), Computer-Aided Process Planning (CAPP) 3. To provide insights into applications of Automated Guided Vehicle Systems (AGVS), Automated Storage and Retrieval Systems (AS/RS), automated inspection methods, and the principles of Group Technology (GT)	**Students will be able to:** 1. Describe automation, Its Type's, Strategies, Assembly Line Balancing and also analyse assembly line 2. Identify fundamentals and constructional features of robots, NC, CNC and DNC machines and prepare a CNC program for given part. 3. Explain the concept of CAD/CAM, CIM, FMS, SFC. 4. Explain Automated Material Handling Systems, Automated Storage and Retrieval System (AGVS, AS/RS) Its Analysis. 5. Describe Automated Inspection (CAPP, CAQC, CMM) and Group Technology.

Unit I	**[9Hrs]**
Automation- Definition, types, reasons for automating, arguments for and against automation. Organization and information processing in manufacturing. Automated Flow Lines-Methods of work part transport, Transfer mechanisms, Buffer storage. Analysis of flow lines. General terminology and analysis, analysis of transfer lines without storage, line balancing.	
Unit II	**[9Hrs]**
Numerical Control Production Systems- Basic concepts, coordinate system and machine motion- Types of NC systems- Point to point, straight cut and continuous path. Machine control unit and other components. NC part programming, CNC programming. Industrial Robotics - Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, end effectors. Robot applications.	
Unit III	**[9Hrs]**
CAD/CAM, FMS, CAPP -. Computer-aided manufacturing - Manufacturing planning, manufacturing control; Computer-integrated manufacturing; Flexible manufacturing systems -Components, Types of systems, FMS layout configuration, computer functions, data files, system reports, FMS benefits. Computer-aided process planning: Retrieval CAPP systems, generative CAPP systems, and the benefits of CAPP. Shop floor control. Computer Process Control.	
Unit IV	**[9Hrs]**
Automated material handling & storage -Conveyor systems: Automated Guided Vehicle Systems -Types: - Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications. Automated Storage & Retrieval System -Types:- Unit load AS/RS, mini load AS/I{S, man on board AS/RS, automated item retrieval system, deep lane AS/RS -Basic components & special features of AS/RS, Carousel storage systems, Work in process storage, quantitative analysis.	
Unit V	**[9Hrs]**
Automated inspection & Group technology:- Automated inspection principles & methods - coordinate measuring machines - construction, operation & benefits; Machine vision-image acquisition & digitisation, image processing & analysis, interpretation, Introduction to Group Technology. Group Technology: Part families, parts classification & coding, Opitz classification systems, production flow analysis; Machine cell design -composite part concept, types of cell design, benefits of group technology	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Automation, Production System & CIMS	M P, Groover	Third edition (2007)	PHI Prentice Hall
2.	CAD/CAM	Zimmers & Groover	Fifth edition (2008)	PIII Pearson Education India

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Numerical Control And Computer-Aided Manufacturing	Rao, N K Tiwari, T K Kundra	13th edition (2007)	Tata McGraw-Hill Education
2.	Computer Control of Manufacturing Systems	Koren	2005	Mcgraw Hill

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME701P	Automation and Robotics Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To provide experiential learning on manual part programming for CNC machines. 2. To provide hands-on practical exposure on CNC lathe /milling machines, Robots, and Simulation software for programming 3. To prepare to demonstrate a case study of real-world automated system	**Students will be able to:** 1. Identify automation, corroborating this knowledge with case studies on automation systems. study and analyse the material handling systems, robots and Group Technology. 2. Perform Manual part programming 3. Perform a simulation on CNC milling / CNC lathe. 4. Execute a job using CNC milling / CNC lathe machine

Minimum 8 practicals to be performed

Expt. No.	Title of the experiment
1	Case Study on an Automated System of any Industry.
2	Performance on the Robot.
3	Practice on Manual Part Programming.
4	Performance of Simulation on CNC lathe
5	Performance of Simulation on CNC milling
6	Performance on CNC lathe
7	Performance on CNC Milling
8	Performance on Part Classification Coding in Group Technology

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Automation, Production System & CIMS	M P Groover	Third edition (2007)	PHI Prentice Hall
2.	CAD/CAM	Zimmers & Groover	Fifth edition (2008)	PIII Pearson Education India

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Numerical Control And Computer-Aided Manufacturing	Rao, N K Tiwari, T K Kundra	13th edition (2007)	Tata McGraw-Hill Education
2.	Computer Control of Manufacturing Systems	Koren	2005	Mcgraw Hill

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME702T	Energy Conversion	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To understand the construction, working and performance of steam generators, boilers and their accessories. 2. To study the principles of steam nozzles, steam turbines and condensers used in power plants. 3. To develop knowledge of air compressors and internal combustion engines with their performance analysis. 4. To familiarize students with gas turbine cycles and methods to improve their efficiency. 5. To introduce refrigeration and air-conditioning systems and psychrometric processes used in practical applications.	**Student will be able to:** 1. Explain the working principles, classification and performance evaluation of steam generators, boilers, mountings and accessories. 2. Analyze steam nozzle flow, steam turbine performance using velocity diagrams and understand the working of steam condensers. 3. Evaluate the performance of single-stage reciprocating air compressors and describe construction and operation of SI and CI internal combustion engines. 4. Apply Brayton cycle concepts to gas turbines and assess the effects of intercooling, reheating and regeneration on efficiency. 5. Describe vapor compression refrigeration systems and analyze air-conditioning processes using psychrometric charts.

UNIT I – Steam Generators and Boilers	**[9 Hrs]**
Principle of Steam Generation, Classification of Steam Generators, Fire Tube and Water Tube Boilers, Boiler Mountings and Accessories. Performance of steam generators: Evaporation capacity, Equivalent evaporation, Boiler efficiency.	
Unit II Steam Nozzles, Turbines and Condensers	**[9 Hrs]**
Steam nozzles – adiabatic expansion, maximum discharge, critical pressure ratio, throat and exit area calculations. Steam turbines – working principle, classification, impulse turbines,. Velocity diagrams, , work done, thrust and power, turbine efficiency. Steam condensers – types.	
Unit III Air Compressors & IC Engine	**[9 Hrs]**
Air compressors – classification and applications. Reciprocating compressors – construction, isothermal, polytropic and adiabatic compression, work done with and without clearance, P–V diagrams, volumetric and isothermal efficiency, effect of clearance.(Single Stage) Engines: Introduction, classification, components of Internal Combustion Engines, Two strokes, four strokes S.I. and C.I. Engines, advantages, disadvantages and applications.	
Unit IV Gas Turbines	**[9 Hrs]**
Brayton cycle, open and closed cycle gas turbines, applications of gas turbines, isentropic efficiency, effect of intercooling, reheating and regeneration, performance analysis of Brayton cycle.	
Unit V Refrigeration and Air Conditioning	**[9 Hrs]**
Refrigeration – unit of refrigeration, simple vapour compression refrigeration system, effect of subcooling and superheating on COP with P–h and T–s diagrams. Air conditioning – psychrometric properties and processes, psychrometric chart.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	A Course in Thermal Engineering	S. Domkundwar	Latest	Dhanpat Rai & Sons
2.	Thermal Engineering	P.L. Ballaney	Latest	Khanna Publishers
3.	Gas Turbines and Propulsive Systems	P.R. Khajuria & S.P. Dubey	Latest	Dhanpat Rai

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Refrigeration and Air Conditioning	C.P. Arora	Latest	McGraw Hill
2	Internal Combustion Engines	V. Ganesan	Latest	McGraw Hill

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME702P	Energy Conversion Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. Provide fundamental and applied understanding of boilers, compressors, IC engines, and refrigeration systems. 2. Develop the ability to perform performance analysis of thermal energy conversion devices through laboratory experimentation. 3. Enable students to evaluate efficiencies, heat balance, and emission characteristics of various engines and compressors. 4. Enhance practical skills in operating test rigs and interpreting experimental data for real-world engineering applications. 5. Expose students to industrial energy systems through field visits to strengthen practical insights.	**Students will be able to:** 1. Demonstrate understanding of boiler types, mountings, and accessories through model-based visualization. 2. Conduct performance tests on air compressors and compute volumetric, isothermal efficiency, power requirements, and pressure ratios. 3. Analyze performance parameters and prepare heat balance sheets for petrol and diesel engines using both conventional and computerized test rigs. 4. Evaluate exhaust emissions of IC engines using gas analyzers and interpret results with respect to environmental standards. 5. Determine the COP and assess the working of vapor compression refrigeration systems through experimental investigation.

LIST OF EXPERIMENTS

Minimum 8 practicals to be performed

Exp. No.	Title of the Experiments
1	Demonstration of different types of boiler model , Boiler Mountings and Accessories
2	Performance test on Two Stage Reciprocating Air Compressor **– determination of volumetric and isothermal efficiency.**
3	Performance test on Rotary Air Compressor **– evaluation of pressure ratio, power consumption and efficiency.**
4	Performance test of Four Cylinder Petrol Engine and conduction of Morse Test **on four-stroke petrol engine.**
5	**Performance test on computerized single cylinder Petrol Engine** and preparation of heat balance sheet.
6	Performance test on computerized single cylinder Diesel Engine **and preparation of heat balance sheet.**
7	Performance evaluation of Four-Cylinder Four-Stroke Petrol Engine **and preparation of heat balance sheet.**
8	Performance test on Four-Stroke Twin Cylinder Diesel Engine **and preparation of heat balance sheet.**
9	Analysis of Exhaust Emission of Four-Stroke Single Cylinder Petrol Engine **(Motor Cycle) using gas analyzer.**
10	**Experiment on Vapour Compression Refrigeration Test Rig** to determine Co-efficient of Performance (COP) of the system.
11	Industrial Visit to thermal power plant

Text Books

S.N	Title	Authors	Edition	Publisher
1.	A Course in Thermal Engineering	S. Domkundwar	Latest	Dhanpat Rai & Sons
2.	Thermal Engineering	P.L. Ballaney	Latest	Khanna Publishers
3.	Gas Turbines and Propulsive Systems	P.R. Khajuria & S.P. Dubey	Latest	Dhanpat Rai

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Refrigeration and Air Conditioning	C.P. Arora	Latest	McGraw Hill
2	Internal Combustion Engines	V. Ganesan	Latest	McGraw Hill

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME703T(i)	PE – V HVAC System Design	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To provide overview of the HVAC design process. 2. To enhances the analytical and design skills of the students on heating, refrigeration, ventilation and air distribution systems.	**Students will be able to:** 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 air distribution systems for HVAC applications. 5. Analyze and design water distribution systems for HVAC applications.

Unit I	**[9 Hrs]**
Advanced Psychrometry:- Indoor design conditions, indoor design condition envelopes, indices of thermal comfort, the comfort equation, other considerations, outdoor air design conditions, frequency of occurrence of outdoor air conditions, outdoor air condition envelopes, RSHF, GSHF, ESHF, psychrometric calculations for cooling, selection of air-conditioning apparatus for cooling and dehumidification, evaporative cooling.	
Unit II	**[9 Hrs]**
Advanced Heat Load Calculations: - Preliminary considerations, internal heat gains, system heat gains, break-up of ventilation load and effective sensible heat factor, data collection for load calculation, various components of heat load estimate, methods of cooling and heating load calculation, application of advanced psychrometric for load calculations.	
Unit III	**[9 Hrs]**
Energy Consumption in HVAC system: The bin method, Short Route to Determine Energy Consumption Difference, Energy Saving of a Heat Recovery Unit, load diagrams, scheduling, fan and pump energy consumption, building requirements and energy conservation in air conditioned buildings	
Unit IV	**[9 Hrs]**
Design of Ducted Air Systems:- General Principles of air flow, pressure distribution, pressure losses due to friction, pressure losses in fittings, bends, obstructions, Resistance to air flow, duct sizing procedures, layout considerations.	
Unit V	**[9 Hrs]**
Fans and Balancing of fluid flow systems:- Characteristics and types of fans, fan laws, adjustment of total flow rate, series and parallel operation, selecting the fan for the system, fan noise, theory of proportional balancing, ma's method, balancing water systems.	

Text Books:

S.N	Title	Authors	Edition	Publisher
1.	Air-Conditioning System Design	Roger Legg	2017	Elsevier, Oxford, UK
2.	Refrigeration and Airconditioning	C.P. Arora	2017	Tata McGraw Hill

Reference Books:

S.N	Title	Authors	Edition	Publisher
1.	HVAC: equations, data, and rules of thumb	Arthur A. Bell, Jr	2000	The McGraw-Hill Companies, Inc
2.	Principles of Heating, Ventilation And Air Conditioning With Worked Examples.	Nihal E Wijeysundera.	2016	World Scientific Publishing Company Pte. Ltd., Singapore.

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME703P(i)	PE – V HVAC System Design Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To provide hands-on design of HVAC system using AutoCAD, AUTODESK Revit software. 2. To guide students to estimate costing for HVAC projects using Revit software.	**Students will be able to:** 1. Perform hands-on design of HVAC system using AutoCAD. 2. Perform hands-on design of HVAC system using AUTODESK Revit software. 3. Estimates costing for HVAC projects using Revit software.

LIST OF PRACTICALS

Minimum 5 practical to be performed

Experiment No.	Title of the Experiments
1	Hands-on on AutoCAD interface
2	Drawing Civil layout, creating blocks, drawing line diagram of HVAC system, machine placing, duct routing
3	2-D drafting of complete HVAC system using AutoCAD Software
4	Hands-on on Revit software interface
5	Creating Revit Civil layout, starting HVAC project, insert mechanical system, energy analysis using Revit
6	Complete HVAC project on Revit
7	Estimation: Prepare estimation of HVAC equipment, material; prepare project quotations, bill of quantity using Revit.

Text Books

S.N	Title	Authors	Edition	Publisher
1	Autodesk AutoCAD user manual	AUTODESK	2024	AUTODESK
2	Autodesk Revit 2022 MEP fundamentals	ASCENT	2021	ASCENT - Center for Technical Knowledge

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Exploring Autodesk Revit 2022 for MEP	Prof. Sham Tickoo	8th	CADCIM Technologies, USA
2.	BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers	Rafael Sacks, Charles Eastman, Ghang Lee, Paul Teicholz	2018	John Wiley & Sons, Inc

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME703T(ii)	PE – V Industrial Robotics	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To familiarize the evolution of robotics, it's principles, classify robotic systems, analyze the parameters of resolution. 2. To select robots based on usage of grippers and sensors including types and design guidelines, 3. To discuss robot cell layout programming methods and languages, 4. To consider socio-economic impacts, safety standards, and AI integration.	**Student will be able to:** 1. Describe classification and parameters of robotic systems and application of automation. 2. Explain various grippers and sensors and select them for robotics. 3. Explain drives, actuators, transmission systems, and controllers to the design and control of robotic systems. 4. Apply concepts of robot cell layout design and robot programming methods. 5. Describe social-economic impacts, safety standards, emerging trends, and the role of artificial intelligence in robotics.

Unit I	**[9 Hrs]**
Introduction to robotics: Brief History, Basic Concepts of Robotics such as Definition , Elements of Robotic Systems i.e. Robot anatomy, DOF, etc., Classification of Robotic systems such as work volume, types of drive, Associated parameters i.e., accuracy, repeatability. Introduction to Principles & Strategies of Automation, Types & Levels of Automation, Need of automation, Industrial applications of robot.	
Unit II	**[9 Hrs]**
Grippers and Sensors for Robotics: Grippers for Robotics - Types of Grippers and applications. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.	
Unit III	**[9 Hrs]**
Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control.	
Unit IV	**[9 Hrs]**
Robot Cell layouts and Languages for Robotics: Robot Cell layouts, multiple robots and machine interface, other considerations in work cell design. Robot Programming: Methods of robot programming, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, ROS	
Unit V	**[9 Hrs]**
Economical trends & Future aspects in Robotics: Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Industrial Robotics	Groover.M.P.	1996.	McGraw – Hill International edition
2.	Introduction to Robotics	S. K. Saha	2014	TATA McGraw Hills Education
3.	Robotics and Control	R. K. Mittal, I. J. Nagrath	2003	TATA McGraw Hill Publishing Co Ltd

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Robotics Technology and Flexible Automation	Deb S R	1994	Tata McGraw Hill, New Delhi,
2.	Fundamentals of Robotics	Dilip Kumar Pratihar,	2019	Narosa Publishing House

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME703P(ii)	PE – V Industrial Robotics Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. Familiarize students with robotic systems and sensors. 2. Develop practical skills in robotics and automation by controlling the devices through programming. 3. Provide hands-on experience with industrial automation tasks.	**Students will be able to:** 1. Perform various robotic operations including pick and place, object detection, and palletizing. 2. Develop skills in utilizing sensors such as photoelectric and color sensors for automation tasks. 3. Design and implement conveyor belt systems for efficient material handling. 4. Integrate multiple components to develop automation systems for a given problem statement.

LIST OF EXPERIMENTS

Minimum 8 practical to be performed

Exp. No.	Title of the Experiments
1	a. Demonstration of Dobot Magician B. Performance of blockly programming on Dobot magician robot
2	Performance of pick and place operation using suction cup on Dobot magician robot
3	Performance based on to detect objects in front of the photoelectric switch (Proximity Sensor).
4	Performance based on mini conveyor belt for material handling.
5	Performance based on to categorize red, blue and green objects using color sensor.
6	Performance based on proximity sensor, conveyor belt and colour sensor for detection and sorting and palletizing of cubical boxes.
7	Performance based on teaching and playback
8	Performance based on writing/drawing/laser engraving using dobot magician robot
9	Implementation of Forward kinematics of PUMA 560 through Virtual Lab.
10	Implementation of Reverse kinematics of PUMA 560 through Virtual Lab

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Industrial Robotics	Groover.M.P.	1996.	McGraw – Hill International edition
2.	Introduction to Robotics	S. K. Saha	2014	TATA McGraw Hills Education
3.	Robotics and Control	R. K. Mittal, I. J. Nagrath	2003	TATA McGraw Hill Publishing Co Ltd

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Robotics Technology and Flexible Automation	Deb S R	1994	Tata McGraw Hill, New Delhi,
2.	Fundamentals of Robotics	Dilip Kumar Pratihar,	2019	Narosa Publishing House

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME703T(iii)	PE – V Finite Element Method	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To impart a rigorous comprehension of Finite Element Methods and enhance analytical proficiency in the mathematical modeling, discretization, and solution methodologies of Finite Element problems. 2. To facilitate practical application of the finite element methodology for solving diverse engineering problems, including truss structures, beam analysis, constant strain triangle (CST) formulations, and steady-state heat transfer simulations.	**Students will be able to:** 1. Explain the application of fundamentals of solid mechanics for evaluation of structural problems subjected to Point load, body force, and torsional loads. 2. Analyze the practical applications of finite element methods in truss structures and develop a systematic approach for their mathematical formulation 3. Develop mathematical models for a beam, apply finite element formulations to analyze load distribution and to evaluate system behavior. 4. Analyze the application and significance of 2D finite element methods to formulate simple in-plane loading problems. 5. Differentiate between the formulation and application of steady-state heat transfer problems using 1D finite elements.

Unit I	**[9Hrs]**
Introduction: Theoretical background, Brief History of FEM, General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM. Finite element modeling: Concept of Node, Element, (types of Finite elements), Coordinate systems – global, local (natural) coordinate systems, Types of loads, Concept of Degrees of freedom, field and dependent variables. Principle of Minimum Potential Energy (Rayleigh-Ritz Method), mathematical formulation and application in 1D finite element formulation. Shape functions – linear, properties of shape functions. Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, Boundary conditions. FE Problems on 1D bar element and composite element. Finite element formulation of Point load, self-weight and torsion.	
Unit II	**[9Hrs]**
Truss: Introduction Plane truss, formulation of stiffness matrix for truss, problem on truss. Axisymmetric formulation for truss assembly.	
Unit III	**[9Hrs]**
Beam: Finite Element formulation of Beams – Introduction, element formulation, load vector for point load, UDL & UVL, boundary conditions, problems on beam.	
Unit IV	**[9Hrs]**
CST: 2D CST ELEMENT: Coordinate Mapping Global and local coordinates. Formulation of stiffness matrix, load vector. Plane stress problem formulation and numerical.	
Unit V	**[9Hrs]**
Thermal Load Formulation: 1D Thermal Load problem using the coefficient of Thermal expansion, 1D Steady State Heat Conduction using Fourier's law, Finite Element formulation of 1D Steady-State Heat Transfer.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Introduction to Finite Elements in Engineering	Chandrupatla.T.R., Belegunda A. D.,	4th	Pearson Education India
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.	Practical Finite Element Analysis	Nitin S. Gokhale	2nd	Finite To Infinite
2.	Finite Element Method with Applications in Engineering	Y. M. Desai, T. I. Eldho and A. H. Shah	First Edition	Pearson Education India

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME702P(iii)	PE – V Finite Element Method Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To develop the ability to model finite element problems using commercial software, emphasizing the use of preprocessors, solver, and post-processor functionalities. 2. To impart knowledge on evaluating and interpreting Finite Element Analysis results for the design and analysis of one-dimensional finite element formulations. 3. To teach the fundamentals of finite element modeling for solving two-dimensional in-plane loading problems effectively.	**Students will be able to:** 1. Model finite element problems using commercial software and understand the fundamental use of finite element preprocessors, solver and post-processor. 2. Demonstrate the ability to evaluate and interpret Finite Element Analysis results for the design and evaluation of 1D finite element formulations. 3. Perform the Finite Element Modeling of 2D Finite Element problem for solving in-plane loading problems.

List of Experiments

Minimum 8 experiments to be performed

Exp. No	Title of the Experiments
1	Evaluate axial deformation and stress distribution in a bar using 1-D finite elements under axial loading.
2	Analyze the static structural response of a bar subjected to self-weight using finite element techniques.
3	Examine the stress and deformation characteristics of a bar under applied torque using finite element methods.
4	Assess the load distribution and deformation in a 1-D truss structure using finite element analysis.
5	Apply finite element analysis to static structural evaluation of a 2-D Plate (CST) element.
6	Analyze the structural response of a beam under transverse loading using finite element principles.
7	Determine the temperature distribution within a composite wall using 1-D steady-state heat transfer analysis.
8	Analyze the space truss for structural deformation
9	Evaluate Deformation behavior of beam subjected to transverse point load
10	Evaluate Deformation behavior of beam subjected to uniformly variable load.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Introduction to Finite Elements in Engineering	Chandrupatla.T.R.,Belegunda A. D.,	4th	Pearson Education India
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.	Practical Finite Element Analysis	Nitin S.Gokhale	2nd	Finite To Infinite
2.	Finite Element Method with Applications in Engineering	Y. M. Desai, T. I. Eldho and A. H. Shah	1st	Pearson Education India

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME704T(i)	PE – VI Energy Conservation in HVAC System and Components	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To learn energy audit and management practices on HVAC systems. 2. Learn analysis of heat conversion systems for HVAC applications 3. To update new system/ equipment for the utilization of both thermal and electrical energy optimally.	**Student will be able to:** 1. Identify and classify areas of energy conservation in HVAC industry. 2. Analyze and modify existing working of the energy utilizing and generating machines. 3. Explain working principle of and choose energy auditing instruments for specific application. 4. Implement proper energy saving techniques in Compressor, fans, heat exchangers , pumps etc.

Unit I	**[9 Hrs]**
Principle of Energy audit in HVAC system, Identifying avenues for Energy conservation, Conservation through periodic maintenance of HVAC systems, Predictive and Preventive maintenance, concept of thermal insulation	
Unit II	**[9 Hrs]**
Energy efficiency in Compressor: Introduction, Compressor Types, Compressor Performance, Compressed Air System Components, Efficient Operation of Compressed Air Systems, Compressor Capacity Assessment, Energy Efficiency in Compressed Air System. Heating, ventilation, air conditioning and Refrigeration System. Energy efficiency in fans and blowers, Introduction, Fan Types, Fan Performance Evaluation and Efficient System Operation, Fan Design and Selection Criteria, Flow Control Strategies, Fan Performance Assessment, Energy Saving Opportunities	
Unit III	**[9 Hrs]**
Energy conservation in Refrigeration Systems, Air conditioning apparatus-Unitary equipment, Refrigeration Equipment-Reciprocating Refrigeration Machine, Centrifugal Refrigeration Machine, Absorption Refrigeration Machine, Heat Rejection Equipment, and Energy Efficient motors	
Unit IV	**[9 Hrs]**
Energy Conservation Opportunities in Heat Exchangers, performance analysis of condenser and evaporators, energy efficiency in heat exchangers and energy saving opportunities in heat exchangers Energy efficiency and Conservation Opportunities in pumps and pumping system, Pump Types, System Characteristics, Pump Curves, Factors Affecting Pump Performance, Efficient Pumping System Operation, Flow Control Strategies	
Unit V	**[9 Hrs]**
Energy conservation feasibility analysis-conventional ventilating systems, constant volume induction system, Multizone unit system, Variable volume induction system, constant temperature system. Heat Pipe Applications in Air conditioning systems	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Energy Engineering and Management	Amlan Chakrabarti	2011	Prentice Hall publication
2.	Energy Management Principles	CB Smith	2015	Pergamon Press

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Book 1,2,3,4, Energy Manager and Energy Auditor Examination	-	-	Bureau of energy efficiency
2	ASHRAE Hand Book–Equipment,	-	2005	ASHRAE, Atlanta, GA.

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME704T(ii)	PE – VI Smart Manufacturing and Production System	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To ignite students interest in learning concepts of industry 4.0 and smart manufacturing 2. To cultivate comprehensive understanding about smart manufacturing pillars and practices	**Students will be able to:** 1. Explain the terminology and practices in Smart Manufacturing 2. Interpret the challenges in Industry 4.0 & also contribute towards advancement. 3. Demonstrate active participation for implementation of Industry 4.0 (Fourth Industrial Revolution) 4. Develop smart production system and co-created product development concepts in planning and controlling company's operations. 5. Create real time data analytics and software systems to support planning, scheduling and control of smart production processes and systems.

Unit I	**[9Hrs]**
Industry 4.0 Concept, The Fourth Revolution, LEAN manufacturing, Smart and connected business perspectives, Smart factories.	
Unit II	**[9 Hrs]**
Nine Pillars of Smart Manufacturing ,Big Data & analytics ,Autonomous Robots ,Simulation ,Universal System Integration ,IIOT – Industrial Internet of Things ,3 D Printing – Additive Manufacturing ,cloud Computing ,Augmented Reality.	
Unit III	**[9Hrs]**
Convergence of Nine Pillars ,Business Propositions delivered with Smart Manufacturing ,Adding Smartness to Manufacturing – Adoption & Scaling ,Economic Aspects ,Ecosystem Required for Smart Manufacturing ,Skill set Required for Smart Manufacturing ,Effects on 4 M- Man, Machine, Materials & Methods in Smart Manufacturing.	
Unit IV	**[9Hrs]**
Operation management strategy in industry 4.0 context,Impact of industry 4.0 on modern operation management in strategic level, Smart product and co-created design concept and tools, The design of smart production planning system and supply chain model	
Unit V	**[9Hrs]**
Intelligent ERP and integration of IoT, massive data analytics. Cognitive and process automation, Integrated planning system including aggregated planning, master production schedule (MPS), material requirement planning (MRP), and capacity planning (CRP) by utilizing real-time data, Advanced shop floor control	

Text Books

S. N	Title	Authors	Edition	Publisher
1.	Smart Manufacturing	Shoukat Ali	2016	LAP LAMBERT Academic Publishing
2.	Industry 4.0 Data Analytics	Rajesh Agnihotri and Samuel New	2016	CreateSpace Independent Publishing Platform
3.	Operations and Supply Chain Strategy in the Industry 4.0 Era	Guilherme Frederico	2018	Independently Published,

Reference Books

S. N	Title	Authors	Edition	Publisher
1.	Shaping the Future of the Fourth Industrial Revolution	Klaus Schwab and Nicholas Davis	2018	Crown Publishing Group
2.	Handbook of Industry 4.0 and SMART Systems	Diego Galar Pascual, Pasquale Daponte and Uday Kumar	2018	CRC Press

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME704T(iii)	PE – VI Machine Fault Diagnosis	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. Understand the basics of Condition Monitoring Techniques (CBM) which would give insight into machine fault finding in mechanical components. 2. Select appropriate instrumentation for CBM. 3. Analyzed signals sensed by the instrumentation by using appropriate signal processing techniques. 4. Explore the research prospect in the area of CBM.	**Student will able to:** 1. Select appropriate maintenance strategy for machine condition monitoring. 2. Identify and distinguish between the types of machinery failure 3. Develop data acquisition system for machine fault diagnosis. 4. Select appropriate signal processing technique to detect machine fault. 5. Analyze signal for determination of presence of fault, location of fault, level of fault severity and remaining useful life of component.

Unit I	**[9 Hrs]**
Maintenance Strategies: Basic maintenance strategies, maintenance concepts, factors which influence the maintenance strategy, periodic monitoring, continuous monitoring, condition monitoring techniques for fault detection, concept of machine condition based monitoring (CBM), CBM techniques, and effectiveness of CBM across all types of faults.	
Unit II	**[9 Hrs]**
Introduction to machine failures: Machinery failure and types of faults, equipment life cycle, bath tub curve, causes of failure, ways of preventing equipment failure, , frequency of failure, various failure mechanisms.	
Unit III	**[9 Hrs]**
Design of measurement system in CBM: Sensors & transducers, displacement sensor, velocity pickup, accelerometer, piezo-sensor, acoustic sensors, different sensors in measurement for machine fault detection, selection of sensors (frequency), accuracy, static and dynamic characteristics of sensor, Data Acquisition, single channel & multi-channel DAQ system, Signal Conditioning and its functions, sampling rate, selection of sampling rate, sampling errors, Nyquist theorem of sampling, Signal Processing,	
Unit IV	**[9 Hrs]**
Signal Analysis: Basics of signal, classification of signals, Signal generation from various failures (characterization), Signal Processing Techniques, Selection of Signal Processing Techniques to detect machine failure, signal analysis in time domain, time domain statistical parameters, signal analysis in frequency domain, Fast Fourier Transform (FFT), wavelet transform, time-frequency analysis, signal analysis softwares.	
Unit V	**[9 Hrs]**
Fault Detection: Machine faults and their severity, Bend pulley failure analysis, rotor imbalance detection, bearing terminology, shaft misalignment detection Bearing Fault, bearing characteristic frequency calculations, gear terminology, Gear Fault, gear mesh frequency calculations Balancing Defects, Shaft Misalignment, bent shaft, looseness, soft foot. Remaining useful life of a component.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Introduction to Machinery Analysis and Monitoring	John S. Mitchell	1993	Penn Well Books
2.	Maintenance Engineering and Management	R. C. Mishra, K. Pathak	2002	Prentice Hall of India Pvt. Ltd.

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Machinery Condition Monitoring Principles and Practices	Dr. Amiya R. Mohanty	2014	CRC Press
2.	Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications	Robert Bond Randall	2011	John Wiley & Sons Ltd

ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR

(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.Tech. Scheme of Examination & Syllabus 2024-25

MECHANICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME704T(iv)	PE – VI Project Management for Engineers	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To provide students with a comprehensive understanding of project management concepts 2. To equip students with the skills to organize human resources, and contracting 3. To enable students to apply tools and techniques for project planning, and understand evaluating performance indicators	**Student will be able to:** 1. Summarize a comprehensive understanding of project management concepts, and the roles and responsibilities of a project manager. 2. Develop the ability to organize human resources effectively by understanding delegation, team building, and project organization, while demonstrating the skills and responsibilities required for project management. 3. Interpret effective systems and procedures for project management, 4. Apply project management and allocation model for time and cost optimization 5. Interpret and utilize performance indicators to evaluate project success.

Unit I	**[9 Hrs]**
Concepts of Project Management: Concepts of projects, characteristics of project, Phases of project life cycle, Tools and techniques for project management, Role and Responsibility of Project Manager, Project Manager as a profession. **Project Planning and estimating: Concepts of** Feasibility report, Preparation of cost estimation, Evaluation of the project profitability.	
Unit II	**[9 Hrs]**
Organizing Human Resources and Contracting: Delegation, Skills / abilities required for project manager, Authorities and responsibilities of project manager, Project organization, Contracts, Tendering and Selection of contractors, Team Building	
Unit III	**[9 Hrs]**
Organizing Systems and Procedures for project management: Working of systems, Design of Systems Work Breakdown Structure (WBS), Project Execution plan , Project Direction Communication Coordination Control, Scheduling	
Unit IV	**[9 Hrs]**
Tools and techniques of project management: Bar (GANTT) chart, Networks – PERT and CPM, Applications, Basic steps in PERT/CPM, Rules for drawing network diagram, Labeling, Time estimates, Critical Path Method, Project Evaluation and Review Technique (PERT)	
Unit V	**[9 Hrs]**
Performance measures in Project Management: Performance indicators, Performance Improvement, Project management and environment.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Project Management	S Choudhry	2010	Tata McGraw-Hill
2.	Projects: Planning, Analysis, Financing, Implementation, and Review	Prasanna Chandra	2005	Tata McGraw-Hill
3.	Operations Research and Engineering Management.	S. D. Sharma,	2010	Kedar Nath Ram Nath & Co

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Project management a system approach to planning scheduling and controlling	Harold Kerzner	2002	CBS Publisher and distributors
2.	A management guide to PERT and CPM	Weist and Levy	2002	Eastern Economy of PH

		July 2026	NEP 1.0	Applicable for 2026-27
Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME705P	Project – II	-	-	8	4	50	50	100

Course Objectives	Course Outcomes
1. To enable students to develop Problem-solving and analytical thinking. 2. To enable the student to propose 2 -3 alternate solutions (hypothesis) considering parameters involved for their problem statement. 3. To design and develop experimentation to test their hypothesis. 4. To enable students to develop the skill of effective oral communication and Technical documentation writing. 5. To enable students to develop collaboration and team work spirit in project conduction. 6. To Use of engineering design software and simulation tools.	**Students will be able to:** 1. Acquire the ability to generate, develop and evaluate ideas by synthesizing complex information from a variety of sources so as to apply these skills to the project task. 2. Demonstrate the ability to make links across different areas of knowledge and utilize critical thinking in problem solving. 3. Acquire collaborative skills and interpersonal relationship through working in a team to achieve common goals. 4. Acquire self-learning skills for evaluation and understanding of engineering applications and practices.

Module 1 : **Implementation and Detailed Analysis**

- Continuation of the work from the 6th semester.
- Conducting detailed experiments or simulations.
- Data analysis, performance evaluation, and refinement of designs.
- Use of tools and software for in-depth analysis (e.g., MATLAB, ANSYS, HYPERMESH).

Module 2 : **Prototype Development / Final Experimentation**

- Final development of the project prototype or experimental setup.
- Implementation of control strategies or design optimization.
- Testing and validation of results against expected outcomes.
- Troubleshooting and debugging as necessary.

Module 3: Result **Discussions, and Conclusion**

- Thorough analysis and documentation of results.
- Comparison with existing methodologies or industry standards.
- Discussions on the significance of findings.
- Conclusion based on analysis and potential future work or applications.

Module 4: **Report Writing and Documentation**

- Preparation of the final project report:
- Abstract.
- Introduction, problem statement, objectives.
- Literature review, methodology, results, and discussion.
- Conclusion, references, and appendices (if any).
- Proper formatting and presentation of the document.

Module 5: **Project Presentation and Viva**

- Final project presentation to a panel of faculty members.
- Demonstration of the project work.
- Answering viva questions regarding methodology, results, and implementation.
- Submission of final reports and any prototypes (if applicable).

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Research Methodology: Methods and Techniques	Kothari C..R.	2nd Revised Edition, 2004	New Age International Pvt Ltd
2	Design and Analysis of Experiments	Douglas C. Montgomery	9th Edition , 2017	John Wiley & Sons

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	5th Edition , 2022	SAGE Publications
2.	Statistics for Experimenters: Design, Innovation, and Discovery	Paul D. Berger	2nd Edition 2016	CRC Press

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Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
23ME731M	MDM – V Automotive Auxiliary Systems Engineering	3	-	-	3	15	15	70	100

Course Objectives	Course Outcomes
1. To explain the working principles and components of lighting, ignition, and instrumentation systems. 2. To analyze automotive comfort and chassis-related systems including air-conditioning, wheels, and tyres. 3. To study and apply concepts of electric and hybrid vehicle drives, including motor types and power electronics. 4. To evaluate different energy storage systems used in EV/HEV and battery management systems. 5. To analyze automotive electronic control systems, sensors, actuators, and advanced safety and driver-assist technologies.	Students will be able to: 1. Explain conventional automotive auxiliary systems and their components. 2. Analyze automotive comfort and chassis-related auxiliary systems such as air-conditioning, wheels, and tyres. 3. Apply concepts of electric and hybrid vehicle drives including motors and power electronics. 4. Evaluate different energy storage systems used in EV/HEV and their management. 5. Analyze automotive electronic control systems, sensors, actuators, and advanced safety features.

Unit I	**[9 Hrs]**
Conventional Automotive Auxiliary Systems Lighting system, Horn, wiper, indicators, Panel board instruments, Battery, ignition systems (magneto & electronic)	
Unit II	**[9 Hrs]**
Automotive Comfort & Chassis Systems Automobile air-conditioning, Wheels and tyres:,Types, construction .Radial vs bias,Tyre life & maintenance ,Wheel balancing	
Unit III	**[9 Hrs]**
Electric & Hybrid Vehicle Drives EV motors, DC, Induction, BLDC, PMSM, SRM, Motor sizing & selection, Power electronics-DC, DC-AC converters Thermal management of EV systems	
Unit IV	**[9 Hrs]**
Energy Storage Systems for EV/HEV Batteries: Types, characteristics, Charging & management, Battery Management System (BMS). Fuel cells. Hybrid energy storage systems, Flywheel & hydraulic storage.	
Unit V	**[9 Hrs]**
Automotive Electronics & Control Systems Sensors & actuators: Engine chassis sensors, ECU architecture, Electronic fuel injection, Engine control systems. Advanced control systems: ABS, traction control. Cruise control, Electronic steering & suspension, Safety systems: Airbags, collision avoidance TPMS, driver information systems	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Automobile Engineering Vol I and II	Kripal Singh		Standard Publications
2.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles"	Mehrdad Ehsani, Yimin Gao, Ali Emadi		CRC Press
3.	Automotive Electrical and Electronic Systems	Tom Denton		Routledge / Butterworth-Heinemann

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Electric and Hybrid Vehicles: Design Fundamentals"	Iqbal Husain		CRC Press
2.	Hybrid Electric Vehicles: Principles and Applications	Chris Mi, M. Abul Masrur		David Wenzhong Gao