



B. Tech. Scheme of Examination & Syllabus 2022-23
MECHANICAL ENGINEERING

VII Semester B. Tech. Mechanical Engineering

Sr No	Course Code	Course Title	Hours per Week			Credits	Maximum Marks		Total
			L	T	P		Continual Assessment	End Sem Examination	
1	22ME701T	Automation in Production	3	-	-	3	30	70	100
2	22ME701P	Automation in Production Lab	-	-	2	1	25	25	50
3	22ME702T	Professional Elective - V	3	-	-	3	30	70	100
4	22ME702P	Professional Elective - V Lab	-	-	2	1	25	25	50
5	22ME703T	Professional Elective - VI	3	-	-	3	30	70	100
6	22ME761O	Open Elective - III	3	-	-	3	30	70	100
7	22ME704P	Project - II	-	-	8	4	75	75	150
8	22ME705P	Summer / Winter Internship *	-	-	-	2	50	-	-
9	22ME706P	Capstone Course – II **	-	-	2	1	50	-	50
Total			12	-	14	21	345	405	750

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

** Capstone Course – II (Comprehensive knowledge gained in Mechanical Engineering)

22ME761O	Open Elective - III
22ME761O	Renewable Energy Resources

22ME702T	Professional Elective - V
22ME702T(i)	HVAC System Design Using BIM Software
22ME702T(ii)	Industrial Robotics
22ME702T(iii)	Finite Element Method

22ME702P	Professional Elective - V Lab
22ME702P(i)	HVAC System Design Using BIM Software Lab
22ME702P(ii)	Industrial Robotics Lab
22ME702P(iii)	Finite Element Method Lab

22ME703T	Professional Elective - VI
22ME703T(i)	Heating Ventilation and Air Conditioning Systems
22ME703T(ii)	Smart Manufacturing and production system
22ME703T(iii)	Tool Design

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Scheme of Examination of Bachelor of Technology (Mechanical Engineering)

Semester Pattern

VIII Semester B. Tech. Mechanical Engineering

Option A

Sr No	Course Code	Course Title	Hours per Week			Credits	Maximum Marks		
			L	T	P		Continual Assessment	End Sem Examination	Total
1	22ME801P*	Project based on one semester internship in Industry/Research Institute/ National Laboratories/ Incubation Center	-	-	-	12	300	100	400
Total			0	0	0	12	300	100	400

*End semester examination will consist of evaluation of seminar & project report.

Option B

Sr No	Course Code	Course Title	Hours per Week			Credits	Maximum Marks		
			L	T	P		Continual Assessment	End Sem Examination	Total
1	22ME802P#	Institutional Internship	-	-	12	6	100	100	200
2	22ME803P	Project – III	-	-	12	6	100	100	200
Total			-	-	24	12	200	200	400

Option B is available to students only after recommendation of the concerned Head of the department. The project and internship should contribute towards career development plan of the students.

* Minimum 90 days internship in any industry and project is to be carried out during internship.

Two NPTEL courses (as per choice of student) or Institutional Internship by IEDC, SVP CET.

		June 2024	1.0	Applicable for 2025-26
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MECHANICAL ENGINEERING DEPARTMENT

TRACKS	5 th Sem	6 th Sem	6 th Sem	6 th Sem	7 th Sem	7 th Sem
	Prof Elect - I	Prof Elect - II	Prof Elect - III	Prof Elect - IV	Prof Elect - V	Prof Elect - VI
HVAC	Refrigeration and Air Conditioning System	Fundamentals of HVAC System	Passive Heating and Cooling of Building	Energy Conservation in HVAC System and Components	HVAC System Design with BIM Software	PE-VI Smart Manufacturing and production system
Production Engineering and Management	Production and Operation Management	Logistics and Supply Chain Management	Sustainable Production System	Advances in Project and Quality Management	Industrial Robotics	Smart Manufacturing and Production System
Design	Design Thinking	Mechanical Vibrations	Computer Aided Design	Design of Mechanical Power Transmission system	Finite Element Method	Tool Design
Process Plant Engineering	Finance for Professionals	Applied Industrial IoT	Piping Engineering	Fire and Life safety in Infrastructure	HVAC system design for buildings	Project Management for Engineers

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ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR
(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B. Tech. Scheme of Examination & Syllabus 2022-23

MECHANICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME701T	Automation In Production	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
<ol style="list-style-type: none"> To Introduce students to the fundamentals of automation in production , and to equip students with a clear understanding of NC, CNC, and DNC production systems, including part programming techniques To familiarize students with CAD/CAM, Flexible Manufacturing Systems (FMS), Computer-Aided Process Planning (CAPP) 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) 	<ol style="list-style-type: none"> Describe automation, Its Type's, Strategies , Assembly Line Balancing and also analyse assembly line Recognize fundamentals and constructional features of N.C,CNC and D.N.C machines and prepare a CNC program for given part. Explain the concept of CAD/CAM,CIM,FMS,SFC. Explain Automated Material Handling Systems, Automated Storage And Retrieval System (AGVS,AS/RS) Its Analysis. 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 workpart 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, NC words, methods of part programming APT programming, Direct numerical control. Computer numerical control.

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, 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/RS , 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 & digitization, 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

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME701P	Automation In Production Lab	-	-	2	1	25	25	50
Course Objectives				Course Outcomes				
1. To provide experiential learning on APT and manual part programming for CNC machines. 2. To provide hands on practical exposure on CNC lathe /milling machines, and Simulation software for programming 3. To prepare to demonstrate case study of real world automated system				1. Recognize automation, corroborating these knowledge with case studies on automation systems. study and analyze the material handling systems, robots and GT, 2. Perform Manual/APT part programming 3. Perform simulation on CNC milling/ lathe. 4. Built job using CNC milling/ lathe machine				

Minimum 8 practical to be performed

Expt. No.	Title of the experiment
1	Practice Programming on APT
2	Practice Programming on Manual Part.
3	Performance, Simulation on lathe (at least two Complex Geometric)
4	Performance, Simulation on CNC milling (at least two Complex Geometries)
5	Performance, on CNC lathe (at least two Complex Geometric)
6	Performance, on CNC Milling (at least two Complex Geometric)
7	Case Study on Automated System of any Industry.
8	Performance/ Practical on Robot.
9	Part Coding and Group Technology
10	Study of FMS

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)	Pill 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

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702T(i)	PE-V HVAC System Design Using BIM Software	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To provide overview of the HVAC sector, components, Codes & standards in HVAC systems to the students. 2. To develop the analytical and design skills of the students on heating, refrigeration, ventilation and air distribution system design.	1. Explain the most important concepts, components, Codes & standards related to HVAC systems. 2. Explain and classify chillers, AHU's and design AHU room. 3. Estimate heat load for given building using BIM software. 4. Design ducting for HVAC system using BIM software. 5. Select pumps, fans and piping system for HVAC systems.

Unit I	[9Hrs]
Introduction to HVAC systems: An Overview of HVAC Systems, Scope of HVAC Engineering, Standards and codes used in HVAC, Modes of heat transfer, Basic Laws for HVAC designing, study on psychrometric charts (manual and software), Psychrometric properties	
Unit II	[9Hrs]
Chillers and AHU's: Introduction, classification, selection of chiller, Installation of chillers, chiller plant layout, Accessories, chiller valves & fittings. Introduction to AHU, classification of AHU, AHU process, accessories, AHU room design	
Unit III	[9Hrs]
Heat Load Calculation: -Methods for Heat load calculation, manual heat load calculation, building survey, material survey, U-factor, tonnage calculation, dehumidified flow rate, hourly Analysis Program (HAP), E20 sheet Calculation.	
Unit IV	[9Hrs]
HVAC Ducting: - Introduction to Duct Family, classification, duct material, installation of duct, duct joining methods, leak-proof test, acoustic insulation, Manual Duct Design, McQuay Duct Sizer, constant friction method, velocity reduction method, thumb rule, sheet metal calculation	
Unit V	[9Hrs]
Air Terminals: Diffusers, grills, dampers, types. Piping: Introduction, Refrigerant Piping, insulation, piping accessories, chiller water piping, condenser piping, drain piping, pipe testing, sizing. Pumps and Fans: Pump selection, pump head calculation, selection of fan, static pressure calculation.	

Text Books:

S.N	Title	Authors	Edition	Publisher
1.	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
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	2013	John Wiley & Sons, Inc.
2.	Principles of Heating, Ventilation And Air Conditioning With Worked Examples.	Nihal E Wijeyesundera.	2017	World Scientific.

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702P(i)	PE-V HVAC System Design Using BIM Software Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
<ol style="list-style-type: none">To provide hands-on design of HVAC system using AutoCAD, AUTODESK Revit software.To guide students to estimate costing for HVAC projects using Revit software.	<ol style="list-style-type: none">Perform hands-on design of HVAC system using AutoCAD.Perform hands-on design of HVAC system using AUTODESK Revit software.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	8 th	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

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702T(ii)	PE-V Industrial Robotics	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
<ol style="list-style-type: none"> To familiarize the evolution of robotics, its principles, classify robotic systems, analyze the parameters of resolution. To enable to select robots based on usage of grippers and sensors including types and design guidelines, To impart knowledge of robot cell layout programming methods and languages, To give awareness about socio-economic impacts, safety standards, and AI integration of robots. 	<ol style="list-style-type: none"> Describe classification and parameters of robotic systems and application of automation. Explain various grippers and sensors and select them for robotics. Explain drives, actuators, transmission systems, and controllers to the design and control of robotic systems. Apply concepts of robot cell layout design and robot programming methods. Describe social-economic impacts, safety standards, emerging trends, and the role of artificial intelligence in robotics

Unit I	[9Hrs]
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	[9Hrs]
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 Pratihari,	2019	Narosa Publishing House

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702P(ii)	PE-V Industrial Robotics Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
<ol style="list-style-type: none">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..	<ol style="list-style-type: none">1. Acquire proficiency in 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	Performance based on pick and place using Dobot magician robot
2	Performance based on to detect objects in front of the photoelectric switch (Proximity Sensor).
3	Performance based on to categorize red, blue and green objects using color sensor.
4	Performance based on palletizing cubical box.
5	Performance based on mini conveyor belt for material handling.
6	Performance based on writing/drawing/laser engraving using dobot magician robot
7	Performance based on to integrate color sensor, conveyor belt and robotic arm.
8	Performance based on milling operation using cartesian coordinate 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

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702T(iii)	PE-V Finite Element Method	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
<p>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.</p> <p>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.</p>	<p>1. Explain the application of fundamentals of solid mechanics for evaluation of structural problems subjected to Point load, body force, and torsional loads.</p> <p>2. Analyze the practical applications of finite element methods in truss structures and develop a systematic approach for their mathematical formulation</p> <p>3. Develop mathematical models for a beam, apply finite element formulations to analyze load distribution and to evaluate system behavior.</p> <p>4. Analyze the application and significance of 2D finite element methods to formulate simple in-plane loading problems.</p> <p>5. Differentiate between the formulation and application of steady-state heat transfer problems using 1D finite elements.</p>

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.,	4 th	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	2 nd	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

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME702P(iii)	PE-V Finite Element Method Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
<ol style="list-style-type: none">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.	<ol style="list-style-type: none">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.,	4 th	Pearson Education India
2.	A First Course in the Finite Element Methods	Daryl Logan	5 th	Cengage Learning India Private Limited

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Practical Finite Element Analysis	Nitin S.Gokhale	2 nd	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

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME703T(i)	PE-VI Heating Ventilation and Air Conditioning Systems	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
1. To familiarize students with advanced psychrometrics and heat load calculations. 2. To enhance students skills for estimating energy consumption in different HVAC systems. 3. To build the design skills of students related to the ducted air systems and balancing of fluid flow systems.	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	[9Hrs]
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	[9Hrs]
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	[9Hrs]
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	[9Hrs]
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	[9Hrs]
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 Air-conditioning	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 Wijesundera.	2019	World Scientific Publishing Company Pte. Ltd., Singapore.

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

B. Tech. Scheme of Examination & Syllabus 2022-23

MECHANICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME703T(ii)	PE-VI Smart Manufacturing and Production System	3	-	-	3	30	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	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	[9Hrs]
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

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B. Tech. Scheme of Examination & Syllabus 2022-23**MECHANICAL ENGINEERING****SEVENTH SEMESTER**

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME703T(iii)	PE-VI Tool Design	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
Objectives of this course are : 1. To develop analytical skills to solve numerical on design and analysis of single and multi-point cutting tools. 2. To introduce to various press working and forging operations and prepare to design press working tools. 3. To make well conversant with fundamentals and design of jigs and fixture.	1. Design tool shank for single point cutting tool, boring tool and perform calculations for multipoint cutting tool. 2. Design press working cutting operation dies and calculate cutting forces in press working operation. 3. Explain press working bending, drawing operations operation, evaluate various parameters and design drawing dies. 4. Explain and classify forging operation dies. Also, describe design procedure for closed and open die forging. 5. Design jigs and fixture for given component using general principles of design, location, clamping.

Unit I	[9Hrs]
Design of single Point Cutting Tool: Design of tool shank for turning operation, Design of boring bar Form tools- Introduction, types of form tools. Multipoint cutting tools: Drills- Introduction, Types, Geometry, calculations of moment, thrust, power, MRR etc. Milling cutters - Introduction, Types, Geometry, calculations of MRR, power, cutting time, torque, number of teeth etc.	
Unit II	[9Hrs]
Press working (Cutting operation): Introduction, types of press tool cutting operations, tonnage of press, cutting force calculations, methods of reducing cutting forces, Types of cutting operation dies (construction and working), Design of blaking and piercing dies.	
Unit III	[9Hrs]
Press Working (Bending & Drawing operation): Introduction and types to bending operations, calculation of blank development, spring back effect, and calculation of bending force. Press working (Drawing operation): Introduction, calculation of number of draws, drawing force, blank holdong force, design of drawing die.	
Unit IV	[9Hrs]
Forging operation: Introduction, types of forging operations, various allowances in forging die, classification of forging dies, forging die design factors, Preliminary forging operation - fullering, edging, bending, drawing, flatterring, blacking finishing, cutoff. Die design procedure for machine forging in closed & open die forging, materials of forging dies.	
Unit V	[9Hrs]
Jigs and Fixture: Introduction, general principles for design of jigs and fixtures, principle of location, principle for clamping, clamping devices, types of jig bushes, design of drill jig. Design of Milling Fixtures and lathe fixtures.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Production Engineering	P.C. Sharma	11 th	S.Chand Publication
2.	Tool Design	Donaldson	8 th	Tata McGraw Hill, New Delhi
3.	Jigs and Fixtures	P.H.Joshi	2001	Tata McGraw Hill, New Delhi

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Fundamentals of the Tool Design	ASTME	2010	Prentice-Hall of India Private Ltd., New Delhi
2.	Manual of Jigs and Fixtures Design	Henrickson	2012	Industrial Press Inc., New York.

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME7610	OE-III Renewable Energy Resources	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
<ol style="list-style-type: none">To familiarize students on various non-conventional energy sources, its generation and utilization.To make students aware about importance of renewable energy systems.	<ol style="list-style-type: none">Define basic characteristics, properties of renewable sources of energy and technologies for their utilization.Describe main elements of concentration type of collectors, also explain various applications of solar energy.Identify various sources of biomass based energies, Various methods of obtaining it. Its properties and utilization.Explain methods of energy generation from wind, ocean, tides, also its advantages. disadvantages.Explain types of geothermal energy, its applications, operational & environmental problems. Explain Magneto Hydro Dynamic power generation.

Unit I **[9Hrs]**

Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, solar radiation measuring instruments. Solar radiation geometry and solar angles. Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, collector efficiency, analysis of flat plate collector, novel designs of collector.

Unit II **[9Hrs]**

Concentric collectors: line focusing, point focusing and non focusing type, central receiver concept of power generations, compound parabolic collector, and comparison of flat & concentric collectors. Applications of solar energy to water heating, space heating, space cooling, drying, refrigeration, distillation, pumping. Solar furnaces, solar cookers, solar thermal electric conversion, solar photo-voltaic. Solar energy storage, solar pond.

Unit III **[9Hrs]**

Biogas: - Introduction, bio gas generation, fixed dome & floating drum biogas plants, their constructional details, raw material for biogas production, fuel properties of biogas and utilization of biogas. Biomass: Introduction, methods of obtaining energy from biomass, Incineration, thermal gasification, classification of gasifiers & constructional details, applications of gasifiers.

Unit IV **[9Hrs]**

Wind and Ocean energy :Power in wind, forces on blades. Basic principle of wind energy conversion, site selection consideration, wind data and energy estimation. Basic components of WECS, classification of WEC systems. Ocean energy: Introduction, ocean thermal electric conversion, open and closed cycle of OTEC, energy from tides, basic principles of tidal power & components of tidal power plants.

Unit V **[9Hrs]**

Geothermal energy: Introduction, classification of geothermal systems, vapour dominated & liquid dominated system, petrol-thermal systems, and magma resources, applications of geothermal operational & environmental problems. Magneto Hydro Dynamic power generation: Introduction, principles of MHD power generation, MHD open and closed systems, power output from MHD generators.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Renewable Energy Resources: Basic Principle and Applications	G.N.Tiwari, M.K. Ghosal	1 August 2004	Narosa publication
2.	Non-Conventional Energy Resources	B.H.Khan	3 RD edition	Tata Mc-Graw Hill

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Non-Conventional Energy Sources	G .D . Rai	1 January 1988	Khanna publishers
2.	Renewable Energy Sources and Emerging Tech.	D. P. Kothari	1 January 2011	Prentice Hall India

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SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME705P	Project-II	-	-	8	4	75	75	150

Course Objectives	Course Outcomes
<ol style="list-style-type: none">To enable students to develop Problem-solving and analytical thinking.To enable the student to propose 2 -3 alternate solutions (hypothesis) considering parameters involved for their problem statement.To design and develop experimentation to test their hypothesis.To enable students to develop the skill of effective oral communication and Technical documentation writing.To enable students to develop collaboration and team work spirit in project conduction.To Use of engineering design software and simulation tools.	<ol style="list-style-type: none">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.Demonstrate the ability to make links across different areas of knowledge and utilize critical thinking in problem solving.Acquire collaborative skills and interpersonal relationship through working in a team to achieve common goals.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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MECHANICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
22ME707P	Capstone Course-II	-	-	2	1	50	-	50

Course Objectives	Course Outcomes
1. To revise and strengthen fundamentals of mechanical engineering courses, so as to prepare students for various competitive exams and technical interviews.	1. Solve numerical on design of machine elements and joints. 2. Analyze and solve questions on free and forced vibrations. 3. Analyze and determine solutions of numerical on heat transfer in various modes. 4. Analyze and determine solutions of numerals on topics of energy conversion. 5. Analyze and determine solutions of numerical on topics operation research and industrial engineering.

Unit I	[4 Hrs]
Design of Machine Elements: Principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs	
Unit II	[2 Hrs]
Mechanical Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.	
Unit III	[4 Hrs]
Heat Transfer: Modes of heat transfer; one-dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis	
Unit IV	[4 Hrs]
Energy Conversion I /II: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbo-machinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines	
Unit V	[2 Hrs]
Operation Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM. Industrial Engg./ PPC: Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing.	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	GATE Tutor 2024 (Mechanical Engg)	Er. Dinesh Goswami	Fourteenth	Arihant Publications Ltd
2.	Mechanical Engineering for Competitions	R.K.Jain	Thirty fourth	Khanna Publishers

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Mechanical Engineering (Objective Type)	R.S. Khurmi, J.K.Gupta	20 September 2018	S.Chand and Company Pvt. Ltd
2.	Mechanical Engineering	D S Kumar	7 th	Katson Books

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