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

SEMESTER V

Sr No	Course Category	Course Code	Course Title	Hours per Week			Credits	Maximum Marks				Min Passing Marks	No of Hours for ESE
				L	T	P		Mid-Sem Examination	Continual Assessment	End Sem Examination	Total		
1.	PCC	24ME501T	Heat Transfer	3	1	-	4	20	20	60	100	45	3
2.	PCC	24ME501P	Heat Transfer Lab	-	-	2	1	-	25	25	50	25	-
3.	PCC	24ME502T	Design of Machine Elements	3	1	-	4	20	20	60	100	45	3
4.	PCC	24ME502P	Design of Machine Elements Lab	-	-	2	1	-	25	25	50	25	-
5.	PEC	24ME503T	Program Elective - I	3	-	-	3	20	20	60	100	45	3
6.	PEC	24ME503P	Program Elective - I Lab	-	-	2	1	-	25	25	50	25	-
7.	VSC	24ME504P	Technical Skill Development-II	-	-	4	2	-	50	-	50	25	-
8.	SEC	24ME541P	Career Development-V	-	-	2	1	-	50	-	50	25	-
9.	MDM	24ME531M	MDM-III (Refer MDM Basket)	3	-	-	3	20	20	60	100	45	3
Total				**12**	**2**	**12**	**20**	**90**	**265**	**345**	**700**		

Program Elective - I	
24ME503T(i)	Industrial Robotics
24ME503T(ii)	Machine Fault Diagnosis
24ME503T(iii)	Renewable Energy Systems
24ME503T(iv)	Advanced I/C Engine

Program Elective - I Lab	
24ME503P(i)	Industrial Robotics Lab
24ME503P(ii)	Machine Fault Diagnosis Lab
24ME503P(iii)	Renewable Energy Systems Lab
24ME503P(iv)	Advanced I/C Engine Lab

Multi-Disciplinary Minor-III	
24ME531M	Industrial Safety

		July 2026	NEP 2.1	Applicable for 2026-27
Chairman - BoS	Dean – Academics	Date of Release	Version	

ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING &TECHNOLOGY, NAGPUR

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

MECHANICAL ENGINEERING

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
24ME501T	**Heat Transfer**	3	1	-	4	20	**20**	60	100

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

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

Text Books

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

Reference Books

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

		July 2026	NEP 2.1	Applicable for 2026-27
Chairman - BoS	Dean – Academics	Date of Release	Version	

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME501P	**Heat Transfer Lab**	-	-	2	1	25	25	50

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

Minimum 8 experiments to be performed

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

Text Books

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

Reference Books

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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
24ME502T	Design of Machine Elements	3	1	-	4	20	20	60	100

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

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

Text Books

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

Reference Books

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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME502P	Design of Machine Elements Lab	-	-	2	1	25	25	50

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

Minimum 8 experiments to be performed

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

Text Books

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

Reference Books

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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						CA	MSE	ESE	Total
23ME503T(i)	PE – I Industrial Robotics	3	-	-	3	20	20	60	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. 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	**[9Hrs]**
Introduction to robotics : Brief History, Basic Concepts of Robotics such as Definition , Elements of Robotic Systems i.e. Robot anatomy, DOF, Kinematics of Robot, Classification of Robotic systems such as work volume, types of drive, Associated parameters i.e., accuracy, repeatability.	
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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
23ME503P(i)	PE – I 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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
24ME503T(ii)	PE – I 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. Analyse 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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME503P(ii)	PE – I Machine Fault Diagnosis Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
At the end of this course, the student will able to 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. Explore the research prospect in the area of CBM.	1. To develop data acquisition system for machine fault diagnosis. 2. To analyse vibration signal for determination of presence of fault in machine 3. To analyse vibration signal for determination of location of fault in machine component. 4. To analyse vibration signal for determination of fault severity and remaining useful life of component.

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

Expt. No.	Title of the experiment
1	Measurement of critical speed of a rotating shaft supported on sleeve bearings.
2	Dynamic balancing of rotor by using Regular-triangle Method
3	Bearing fault detection using vibration signal analysis
4	Shaft misalignment fault detection subjected to parallel misalignment
5	Shaft misalignment fault detection subjected to angular misalignment
6	Bent shaft fault detection using vibration signal analysis
7	Looseness fault detection using vibration signal analysis
8	Rubbing of bearing fault detection using vibration signal analysis
9	Oil Whirl and Oil Whip fault detection of Sliding Bearing

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.

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2.	Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications	Robert Bond Randall	2011	John Wiley & Sons Ltd

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits		Evaluation		
						MSE	CA	ESE	Total
24ME503T(iii)	PE – I Renewable Energy System	3	-	-	3	20	20	60	100

Course Objectives	Course Outcomes
1. To develop a fundamental understanding of various renewable and non-conventional energy sources, including their characteristics, potential, and global relevance. 2. To familiarize students with technologies and engineering principles involved in the utilization of solar, wind, biomass, geothermal, ocean, and advanced renewable systems. 3. To create awareness of environmental, operational, and sustainability aspects associated with renewable energy technologies and their role in future energy systems.	**Student will be able to:** 1. Explain the, measurement techniques of solar radiation and basic principles, and characteristics of solar energy systems. 2. Compare and analyze different types of solar collectors and evaluate their suitability for various thermal and photovoltaic applications. 3. Describe and examine biomass and biogas energy systems, including their generation processes and applications. 4. Describe the working principles of wind, tidal, and ocean thermal energy technologies. 5. Explain and evaluate geothermal energy systems and Magneto Hydro Dynamic (MHD) power generation with respect to classification, operation, and environmental impacts.

Unit I	**[9 Hrs]**
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: Solar thermal principle :- Types of collectors, liquid flat plate collectors, solar air heaters, 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. collector efficiency, novel designs of collector.	
Unit II	**[9 Hrs]**
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 systems, Solar Ponds.	
Unit III	**[9 Hrs]**
Biomass: Introduction, methods of obtaining energy from biomass, Incineration, thermal gasification, classification of gasifiers & constructional details, applications of gasifiers.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.	
Unit IV	**[9 Hrs]**
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, Tidal energy, basic principles of tidal power & components of tidal power plants.	
Unit V	**[9 Hrs]**
Geothermal energy: Introduction, classification of geothermal systems, vapour dominated & liquid dominated system and petrol-thermal systems, applications of geothermal energy, operational & environmental problems. Magneto Hydro Dynamic power generation: Introduction, principles of MHD power generation, MHD open and closed systems, their comparative study.	

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 Sources	G .D . Rai	1 January 1988	Khanna publishers

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Non-Conventional Energy Resources	B.H.Khan	3RD edition	Tata Mc-Graw Hill
2.	Renewable Energy Sources and Emerging Tech	D. P. Kothari	1 January 2011	Prentice Hall India

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Chairman - BoS	Dean – Academics	Date of Release	Version	

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME503P(iii)	PE – I Renewable Energy Systems Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. To enable to explain the fundamental principles and performance parameters of solar thermal, solar photovoltaic, and wind energy systems through laboratory experimentation. 2. To enable to analyze the effect of operating parameters such as radiation intensity, flow rate, temperature, tilt angle, and shading on the performance of renewable energy devices. 3. To enable to evaluate key performance indicators such as overall heat loss coefficient (UL), heat removal factor (FR), efficiency (η), and coefficient of performance (COP) for renewable energy 4. To develop practical skills in conducting experiments, plotting characteristic curves, interpreting experimental data, and correlating theoretical concepts with real-time observations.	**Student will be able to:** 1. Determine the performance parameters (UL, FR, η) of solar thermal collectors operating under thermosyphonic and forced circulation modes. 2. Analyze the influence of solar radiation intensity and mass flow rate on the thermal efficiency of solar energy systems using experimental data. 3. Plot and interpret I–V and P–V characteristics of photovoltaic modules under varying radiation, temperature, series–parallel configurations, and shading conditions. 4. Evaluate the effect of tilt angle and partial shading on photovoltaic module output power and system performance. 5. Experimentally determine wind turbine performance characteristics such as start-up speed, cut-in speed, and coefficient of performance.

Minimum 8 experiments to be performed

Expt. No.	Title of the experiment
1	Evaluation of UL, FR and η in thermosphonic mode of flow with fixed input parameters
2	Evaluation of UL, FR, η in Thermosyphonic mode of flow at different radiation level
3	Evaluation of UL, FR, and η in forced mode of flow with fixed input parameters
4	Evaluation of UL, FR, η and drawing of different curves in forced mode of flow with different flow rate
5	To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.
6	To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
7	To show the effect of variation in tilt angle of PV module.
8	To demonstrate the effect of shading on module output power.
9	Find out the start up speed and cut -in speed of wind turbine experimentally.
10	Evaluate the coefficient of performance of wind turbine.
12	3 - 4 virtual lab experiments Few experiments on virtual lab https://vlab.amrita.edu/index.php?sub=77&brch=298 https://vlab.amrita.edu/?sub=77&brch=297

Text Books

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1	Renewable Energy Resources: Basic Principle and Applications	G.N.Tiwari, M.K. Ghosal	1 August 2004	Narosa publication
2.	Non-Conventional Energy Sources	G .D . Rai	1 January 1988	Khanna publishers

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Non-Conventional Energy Resources	B.H.Khan	3RD edition	Tata Mc-Graw Hill
2.	Renewable Energy Sources and Emerging Tech	D. P. Kothari	1 January 2011	Prentice Hall India

		July 2026	NEP 2.1	Applicable for 2026-27
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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
24ME503T(iv)	PE – I Advanced IC Engines	3	-	-	3	20	20	60	100

Course Objectives	Course Outcomes
1. The course aims to impart a comprehensive understanding of the operating cycles and working principles of modern internal combustion engines, including their lubrication and cooling systems. It focuses on the study of conventional and alternative fuels, fuel characteristics, and fuel supply systems used in spark ignition (SI) and compression ignition (CI) engines. 2. The course also emphasizes the fundamentals of combustion in SI and CI engines, factors influencing the combustion process, formation of pollutants, and methods for emission control. 3. It seeks to develop the ability to apply analytical and experimental techniques for performance evaluation, testing, and problem-solving related to internal combustion engines, with an outlook toward advanced and future IC engine technologies.	**Student will be able to:** 1. Explain the classification, construction, and working of internal combustion engines, including operating cycles, engine components, and the fundamentals of engine friction, lubrication, and cooling systems. 2. Analyze the properties and performance characteristics of conventional and alternative fuels, and describe the working principles of fuel supply and air induction systems used in SI and CI engines. 3. Illustrate the combustion process in SI and CI engines and evaluate the factors influencing ignition delay, abnormal combustion, and overall combustion performance. 4. Assess engine emissions and applicable Bharat Stage and Euro norms, and explain emission measurement techniques and control strategies along with ignition and governing systems in IC engines. 5. Determine engine performance parameters through testing and experimentation, perform performance analysis using standard methods, and appraise advanced IC engine concepts for improving efficiency and emissions.

Unit I **[9 Hrs]**

Introduction to I. C. Engine: Engines types and their operation, Engine Classifications, Engine Operating cycles (ideal and actual), Engine Components, Engine friction, Lubrication and cooling lubrication systems, Frictional losses, blow by losses, pumping loss and Factors affecting mechanical friction.

Unit II **[9 Hrs]**

I C Engine fuels: S.I. Engine fuels characteristics, C.I. Engine fuels characteristics, Rating of engine fuels, Alternative fuels like Alcohols, Vegetable oils, CNG, LPG, Biodiesel etc. Fuel supply systems of S. I. Engine, Carburetors, S.P.F.I., MPFI, GDI. Fuel supply system of C.I. Engine, Fuel injection pump, fuel injector, High presser D.I. Systems, fuel distribution systems. Worked examples on fuel supply systems.

Unit III **[9 Hrs]**

Combustion in SI and CI Engine: S. I. Engine Combustion, ignition delay, auto ignition, factors affecting delay, abnormal combustion in SI engine. Combustion in C.I. Engines, delay period, factors affecting delay. Abnormal combustion in C I engine.

Unit IV **[9 Hrs]**

Engine Emission and their control: Air pollution due to IC engines, Euro and Bharat stage norms, HC, CO and NOx emission, Pollution measurement techniques and different methods to control pollution like catalytic convertor, EGR, particulate traps. Ignition and Governing System, Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing.

Unit V **[9 Hrs]**

Measurement and Testing of I C engines: Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan's Line Method and Morse Test, calculation of brake thermal efficiency, brake power and brake specific fuel consumption. Advance I C. Engine Concept, variable compression ratio engines, heat balance sheet of I C Engines.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Internal Combustion Engine	V. Ganeshan	3rd	McGraw-Hill
2.	Internal Combustion Engine	M. C. Mathur , R. D.Sharma	1st	Dhanpat Rai& sons

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Internal Combustion Engine Fundamental	John B. Heywood	1st	McGraw Hill Education
2.	Internal Combustion Engine and Air Pollution	Edward F. Obert	3rd	Intex Educational Pub

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FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME503P(iv)	PE - I Advanced IC Engine Lab	-	-	2	1	25	25	50

Course Objectives	Course Outcomes
1. Compare the constructional details, working principles, and nomenclature of 2-stroke and 4-stroke SI (petrol) and CI (diesel) engines. 2. Conduct performance tests on engines (speed, load, fuel consumption) to determine parameters like thermal efficiency, specific fuel consumption, and mean effective pressure. 3. Prepare heat balance tests to analyze the distribution of energy in an engine. 4. Interpret valve timing and port timing diagrams to understand engine breathability and timing. 5. Analyze the emission characteristics of engines (CO, CO2, NOx, HC) and identify methods to reduce pollution.	**Students will be able to:** 1. Students will be able to identify and compare the components of 2-stroke and 4-stroke petrol and diesel engines. 2. Measure and calcuate engine performance parameters (Brake Power, Indicated Power, Efficiency) using dynamometers. 3. Acquire ability to map valve timing diagrams, port timing diagrams, and understand air-fuel ratio, combustion processes, and cooling systems. 4. Determine fuel properties (flash point, fire point, calorific value) and analyze emissions to suggest reduction techniques. 5. Perform Morse tests for multi-cylinder engines and prepare heat balance sheets to evaluate efficiency.

LIST OF EXPERIMENTS

Minimum 8 practicals to be performed

Exp. No.	Title of the Experiments
1	Performance test on two stage reciprocating air compressor.
2	Performance evaluation of four-cylinder four stroke petrol engine and preparation of heat balance sheet.
3	Performance test on four stoke twin cylinder diesel Engine.
4	Performance evaluation of four stroke single cylinder diesel engine and preparation of heat balance sheet.
5	Performance evaluation of four stroke single cylinder petrol engine and preparation of heat balance sheet.
6	Analysis of exhaust emission of four stroke single cylinder petrol engine.
7	Analysis of exhaust emission of four stroke single cylinder diesel engine.
8	Conduction of morse test on four cylinder, four- stroke petrol engine.
9	Analysis of exhaust emission of four stroke single cylinder petrol engine with varying compression ratio.
10	Performance analysis of open and closed ECU using single cylinder research engine.

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Internal Combustion Engine	J.B.Heywood	2017	McGraw Hill
2.	Internal Combustion Engine	V Ganeshan	4Th	McGraw Hill Education

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Internal Combustion Engine	R.K.Rajput	30/12/2005	CBS Publishers and Distributors
2.				

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME504P	Technical Skill Development – II	-	-	4	2	50	-	50

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

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

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

Text Books

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

Reference Books

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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
24ME541P	Career Development – V	-	-	2	1	50	-	50

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

Topics to be Covered

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

Text Books

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

Reference Books

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

FIFTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation			
						MSE	CA	ESE	Total
24ME531M	MDM – III Industrial Safety	3	-	-	3	15	15	70	100

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

Unit I **[9Hrs]**

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

Unit II **[9Hrs]**

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

Unit III **[9Hrs]**

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

Unit IV **[9Hrs]**

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

Unit V **[9 Hrs]**

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

Text Books

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

Reference Books

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