K.E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2022-26 Batch

Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4894**	Course Name: **Mechanical System Design**

L	T	P	Credits
3	--	--	3

Course Description:

This course covers the design and analysis of essential mechanical components used in machines and vehicles. It includes rolling and sliding contact bearings, their load-carrying capacities, and selection criteria. Brake and clutch systems are examined with a focus on torque transmission, thermal considerations, and performance analysis. The design of machine tool speed drives, including gearboxes and speed regulation, is explored. Conveyor system design covers material handling principles, belt types, load capacities, and power requirements. The course also addresses hybrid electric vehicle (HEV) transmission systems, power split devices, and component sizing. Pressure vessel design is studied with an emphasis on stress analysis, failure modes, material selection, and reinforcement techniques as per industry standards.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Select proper type of bearing for given application.
2. Design brake and clutch based on functional requirements.
3. Design the machine tool gear box for different speeds and torques at driven shaft.
4. Design the flat belt conveyor systems for suitable applications.
5. Select transmission system for Hybrid Electric Vehicle.
6. Calculate the stresses induced in pressure vessel subjected to various types of loading.

Prerequisite:

Strength of Material, Mechanical Component Design and Machine Design.

Course Content

Unit No	Description	Hrs.
1.	**Bearings** **A. Rolling Contact Bearings** Types of rolling contact bearings, Designation, static and dynamic load carrying capacities, Stribeck's equation, Equivalent bearing load, load life relationship, selection of bearing life, Selection of rolling contact bearings from manufacturers catalogue, **B. Sliding Contact Bearings** Sliding Contact Bearings: Basic modes of Lubrication, Hydro-dynamic bearing: Reynolds's equation, Sommerfield Number. Design consideration in hydrodynamic bearings, Raimondi and Boyd method relating, bearing variables. Heat balance in journal bearings, Temperature rise	08
2.	**Design of Brake and Clutch systems**	04

	Design consideration in brakes, Internal expanding shoe brake, External contracting shoe brake. Introduction of anti-lock braking system, Thermal consideration and rating of brakes. Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multi disc clutch, Cone clutch and Centrifugal clutch.	
3.	**Design of Speed Drives for Machine Tool** Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, selection of electric drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gear box layout.	**06**
4.	**Design of Conveyor Systems** System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.	**06**
5.	**Transmission system in Hybrid Electric Vehicle (HEV)** Types of Hybrid Electric Vehicles: Basic Classification, Basic Modes of Operation, Other Derivatives, Degree of Hybridization. Power Split Devices (PSD): Simple and EM compound PSD, HEV Component Characteristics: The IC Engine, Electric Machines, Battery, HEV Performance Analysis: Series HEV, Parallel HEV, HEV Component Sizing: General Considerations, Sizing for Performance, Optimum Sizing, Power Management.	**06**
6.	**Design of Pressure vessels:** Thin and thick cylinders, Lame's equation, Clavarino's and Bernie's equations, auto-frettage and compound cylinders, Modes of failures in pressure vessels, unfired pressure vessels, classification of pressure vessels as per I. S. 2825 - categories and types of welded joints, weld joint efficiency, stresses induced in pressure vessels, materials for pressure vessel, thickness of cylindrical shells and design of end closures, nozzles and openings in pressure vessels, reinforcement of openings in shell and end closures - area compensation method. Use of ASME section 8, division -I in pressure vessel design.	**06**

References:

Text Books:

- V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication.
- S. P. Patil, Mechanical System Design, Jaico Publication House, New Delhi.
- S. K. Basu and D. K. Pal, Design of Machine Tools, Oxford and IBH Publication.
- N. K. Mehta, Machine Tool Design, Tata McGraw Hill Publication.
- Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.
- Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press.
- Chris Mi, M. Abul Masrur, and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley.

Reference Books:

- Shigley and C. R. Miscke, Mechanical Engineering Design, Tata McGraw Hill

Publication.

- M. V. Joshi, Process Equipment Design, Macmillan Publication.
- James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley.
- John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, Wiley.
- Ron Hodkinson and John Fenton, Lightweight Electric/Hybrid Vehicle Design, Butterworth-Heinemann.
- Ali Emadi, Advanced Electric Drive Vehicles, CRC Press.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4034**	Course Name: **Metrology & Control Engineering**

L	T	P	Credits
3	--	--	3

Course Description:

Automatic control has now become an unavoidable part of day-to-day life and contributes lot to the recent development in the field of engineering. Feedback control has come in to existence after world war 2nd. there are many sophisticated examples of modern control systems based on automatic control i.e. blind landing of aero plane, design of robotics, CNC's, DNC's, Engine control of jet plane. Present scenario demands combined applications from different disciplines of engineering like mechanical, electrical, Electronic Instrumentation to satisfy ever-increasing demand of industries.
With this in mind, to aware the students of feedback control systems this subject has been introduced to third year Mechanical engineering students. The main focus of the subject is on feedback control systems. The course also covers representation of the control system mathematically and by using block diagrams.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply knowledge of various tools and techniques to determine geometry and dimensions of components in engineering applications.
2. Apply CMM and machine vision system for dimensional measurement and surface finish evaluation.
3. Explain feedback control system.
4. Represent control system mathematically and by using block diagrams and determine their response to various input conditions.

Prerequisite:

Basic Mechanical Engineering, Engineering Mathematics.

Course Content

Unit No	Description	Hrs.
1.	**Measurement, Tolerance and Limit Gauges** Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements. Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft-based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	06
2.	**A. Surface Measurement system** Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer, Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness	06

	standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. **B. Screw Thread measurement** Two wire and three wire methods, Floating carriage micrometer.	
3.	**CMM and Machine Vision System** **A. Coordinate Measuring Machine** CMM Types, Applications – Non-contact CMM using Electro optical sensors for dimensional metrology – non-contact sensors for surface finish measurements – Measurements / programming with CNC CMM – Performance evaluations – Measurement integration. **B. Machine Vision** Image Acquisition and Processing – Binary and gray level images, image segmentation and labelling, representation and interpretation of colours. Elements of measuring systems, Measurement system variables Bias, Linearity & Stability, Gauge R&R, Variable & Attribute MSA.	**06**
4.	**Automatic control & Mathematical model of control systems** Importance of control engineering. Open loop and close loop control system types of control systems. Generalized feedback control system, Mechanical components and transnational mechanical system. Examples on transnational mechanical systems Rotational system, Grounded chair representation. Series and parallel laws for mechanical & Electrical components, force-voltage analog. Force current analog.	**06**
5.	**Linear and Nonlinear functions** Linearization of nonlinear function. Applications of Linearization of nonlinear functions. Linearization of operating curves. Representation and plotting of operating curves.	**06**
6.	**Block Diagram Algebra and Transient Response** Rules of block diagram algebra, Reduction of block diagram and determination of transfer function. General form of transfer function Concept of poles and zeros, Distinct zeros Repeated and complex zeros Response of first order and second order system to step and impulse input. Response to ramp and sinusoidal input. Damping ratio and natural frequency Transient response specifications.	**06**

References:

Text Books:

- I. C. Gupta, Engineering Metrology, Dhanpat Rai Publications.
- R. K. Jain, Engineering Metrology, Khanna Publishers.
- F. H. Raven, Automatic Control Engineering, Tata McGraw Hill.
- R. Anand Natrajan and P. Ramesh Babu, Control System Engineering, SciTech Publications.

Reference Books:

- P. Narayana, Engineering Metrology, SciTech Publications.
- A. L. Grant, Statistical Quality Control, McGraw Hill International, New York.
- A. Anand Kumar, Control Systems, Prentice Hall.
- K. Ogata, Modern Control Systems, Prentice Hall.
- R. A. Barapate, Feedback Control Systems, SciTech Publications.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4054**	Course Name: **Industrial Engineering**

L	T	P	Credits
2	--	--	2

Course Description:

The modules in industrial engineering are designed to produce engineers specializing in problem solving and decision-making functions. This course gives an overview of industrial engineering methodologies with reference to classical industrial engineering and ergonomics. The subject areas covered include: work methods and measurement, engineering economics, plant layout, material handling, production planning and control and project management. Due emphasis will be given to the application of the methodologies in an industrial environment.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply various methods of method study and time study to improve productivity.
2. Select the plant location and design appropriate type of layout along with material handling system.
3. Apply the concept of production planning and control to manufacturing operations.
4. Design the inventory system using appropriate inventory model.
5. Implement project management knowledge, tools and techniques to achieve project success.

Prerequisite:

Mathematics, Physics, Basic Engineering Principles Data Analysis and Management Concepts.

Course Content

Unit No	Description	Hrs.
1.	**Work System Design** History, role and position of Industrial Engineering, concept productivity and its measurements, productivity improvements techniques of I.E., Method study, micro-motion study, principles of motion economy,	04
2.	**Time Study and Work Measurement** Introduction and various methods of time study, stopwatch time study measurement, MOST, work sampling.	04
3.	**Manufacturing Systems Design** Facility location factors, types of plant layout and design of product and process layout, assembly line balancing, materials handling systems.	04
4.	**Production Planning and Control (PPC)** Functions and activities of PPC, Routing, loading, scheduling, and sequencing, Master Production Schedule (MPS), Material Requirements Planning (MRP) Break-even analysis, Make-or-buy decisions.	04
5.	**Inventory Management**	04

	Demand forecasting techniques, inventory analysis and control systems, inventory models-basic model, production model, price discount model.	
6.	**Project Management** Network scheduling terminology, risk analysis, network precedence diagrams – Network techniques for project management – PERT, CPM.	**04**

References:

Text Books:

- Buffa, Modern Production/Operations Management, Wiley Eastern, New York, 1999.
- Muhlemann Alan, Oakland John, and Lockyer Keith, Production and Operations Management, Macmillan India Publications Ltd., 2001.
- Mahadevan B., Operation Management: Theory and Practice, Pearson Education.

Reference Books:

- R. Paneerselvam, Production & Operations Management, 2nd Edition, PHI Publications, 2006.
- Adam and Ebert, Production and Operation Management, 5th Edition, Pearson Education Asia, 2003.
- H. B. Maynard, Industrial Engineering Handbook, McGraw Hill Book Company, New York.

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Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4154**	Course Name: **Condition Monitoring (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course will provide students with the state-of-the-art techniques in machinery condition monitoring along with the recent developments in the field of signal processing, thermography, contaminant analysis, ultra-Sonics along with the traditional noise and vibration monitoring. This is the ideal course for those who want a better understanding of condition monitoring. students will take away from this course with a very good understanding of the fundamentals and how to make use of Condition Monitoring data.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply breakdown, preventive, and predictive maintenance strategies for machinery management.
2. Monitor and analyze condition of rotating machinery using vibration-based techniques.
3. Apply oil analysis techniques to diagnose the wear debris.
4. Apply temperature monitoring techniques to diagnose the faults in mechanical applications.
5. Apply modern technologies for effective plant maintenance.

Prerequisite:

Basics of Vibration, Basics of Science.

Course Content

Unit No	Description	Hrs.
1.	**Basics of Condition Monitoring** Introduction to Machinery Condition Monitoring, Future Needs, Principles of Maintenance- break down, preventive and predictive monitoring. Fault diagnostics prognostics, Bath Tub Curve, Failure Modes Effects and Criticality Analysis (FMECA), Introduction to machine learning in condition-based maintenance.	06
2.	**Vibration Monitoring** Basics of vibration, free and forced response, vibration and shock isolation, basics of rotor dynamics, time domain analysis, frequency domain analysis, modulation and beats.	06
3.	**Vibration Monitoring Equipment** Vibration Measurement Scheme, transducers, vibration pickups for displacement, velocity and acceleration measurement, frequency domain signal analysis-Fourier series, discrete Fourier transform, Fundamentals of Fast Fourier Transform, Computer-Aided Data Acquisition, Signal Conditioning- Signal Filtering, Signal Demodulation, measurement error, calibration principle.	06

4.	**Vibration Monitoring applications** vibration faults like bearing defects, misalignment in shaft, unbalance on rotor, looseness, gear faults, etc. in rotor bearing system. Use of ISO standards for vibration-based condition monitoring.	06
5.	**Contaminant analysis** Contaminants in used lubricating oils, monitoring techniques (wear debris) – SOAP technique, Ferrography, X-ray spectrometry, Analysis of Type of Particles, Advanced testing using RPVOT and RULER test. **Temperature Monitoring**: Various techniques – thermograph, pyrometers, Role of emissivity, Applications – Mechanical & Electrical.	06
6.	**Recent Techniques** Non-destructive techniques, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, Structural health monitoring weldments for surface and subsurface cracks, Condition Monitoring of Electrical Systems-Introduction to Electrical Condition Monitoring Program, Use of AI, digital twin.	06

References:

Text Books:

- J. S. Rao, Vibration Condition Monitoring, Narosa Publishing House.
- A. R. Mohanty, Machinery Condition Monitoring: Principles & Practices, Taylor & Francis Group.

Reference Books:

- R. Isermann, Fault Diagnosis Applications, Springer-Verlag, Berlin.
- Allan Davis, Handbook of Condition Monitoring, Chapman and Hall.
- K. K. Choudary, Instrumentation, Measurement and Analysis, Tata McGraw Hill.
- R. A. Collacott, Mechanical Fault Diagnosis, Chapman and Hall, London.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 423**	Course Name: **Computer Aided Design and Analysis (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course is designed to provide final-year mechanical engineering students with a comprehensive understanding of computer-aided design (CAD) and its integral role in the design and analysis processes. CAD is an essential tool in modern engineering, enabling efficient design, analysis, and optimization of mechanical systems. To use CAD effectively, students must be well versed in the associated hardware, software, and related processes.

The course focuses on the principles of CAD systems, their implementation, and their integration with computer-aided manufacturing (CAM) and computer-aided engineering (CAE) systems. Students will explore foundational concepts such as 2D and 3D transformations, projection transformations, and the mathematical representation of geometric entities. The curriculum emphasizes the practical application of CAD tools for solving real-world engineering challenges.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Analyze implementation of principles of CAD systems and their connections to CAM and CAE systems.
2. Implement proficiently 2D and 3D transformations as well as projection transformations.
3. Analyze various approaches to geometric modeling.
4. Formulate mathematical representations for 2D and 3D entities with accuracy.
5. Develop and analyze finite element models for engineering and interpreting simulation results to provide practical solutions.

Prerequisite:

Basics of Computer Software and Hardware.

Course Content

Unit No	Description	Hrs.
1.	**CAD Hardware and Software** Types of systems and system considerations, input and output devices, Software modules, Principle of networking, classification networks.	06
2.	**Overview of PLM Software**	06

	Integration of CAD with PLM, PLM Software: Team Centre / Wind Chill. Evolution of CAD Data Exchange Format – Shape-Based format, Product data-based format.	
3.	**Computer Graphics** Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models – Translation, rotational, general mapping, Inverse transformations, Projections. Augmented reality and virtual reality.	**06**
4.	**Geometric Models** Projections of geometric models, Geometric Modeling, Parametric Modeling, Curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations, Surface representation, surface manipulations, Tutorials.	**06**
5.	**Solid Modeling** Fundamentals of solid modeling, Boundary representation (B-rep), Constructive Solid Geometry (CSG), Sweep representation, Analytic Solid Modeling (ASM), Solid manipulations, solid modeling-based applications: mass properties calculations, mechanical tolerancing, coloring, rendering, assembly modeling, etc.	**06**
6.	**Finite Element Modeling and Analysis** Finite Element Analysis, Development of integral equations, Finite elements, Assembly of element equations, Applying boundary conditions, Finite element solutions, Finite element modelling, Mesh generation, Tutorials.	**06**

References:

Text Books:

- Ibrahbim Zeid, Mastering CAD / CAM McGraw Hill Publication
- Jim Browne, Computer Aided Engineering and Design.
- P. Radhakrishnan, V. Raju and S. Subramanyam, CAD / CAM / CIM.
- P.N. Rao, CAD / CAM principles and applications, Tata Mcraw-Hill.

Reference Books:

- Rogers, Adams, Mathematical Elements for Computer Graphics.
- Rooney and Steadman, Principles of Computer Aided Design.
- Jerry Banks, John Carson, Barry Nelson, David Nicol, Discrete-Event System Simulation.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4194**	Course Name: **Autotronics & Vehicle Intelligence (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course provides a comprehensive understanding of automotive sensors, engine management systems, electric and hybrid vehicle control, battery performance, and intelligent vehicle systems. Students will learn about the fundamentals of mechatronics in automotive applications, advanced sensors, and actuators used in modern vehicles. The course will also cover battery technologies and management systems, safety sensor applications, and the role of intelligent systems in autonomous and connected vehicles.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Analyse the principles and functioning of sensors in automotive applications.
2. Discuss the architecture and operation of an ECU in automotive systems.
3. Compare different configurations of Electric and Hybrid Vehicles.
4. Apply battery management principles to optimize vehicle performance.
5. Describe the role of sensors in vehicle safety systems.
6. Explain the role of Intelligent Vehicle Systems for advanced automotive applications.

Prerequisite:

Vehicle Dynamics, Internal Combustion Engines, and Basic Automotive Systems.

Course Content

Unit No	Description	Hrs.
1.	**Basics of electric vehicles and automotive sensors** Electric Vehicles History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs), Fundamentals of Automotive Mechatronics & Control System, Engine sensors and actuator: Manifold Absolute Pressure sensor, knock sensor, Coolant and Exhaust gas temperature sensor, Exhaust Oxygen level sensor, Throttle position sensor & crankshaft position sensor, Air mass flow sensor.	06
2.	**Engine management system** Microprocessor and Microcomputer controlled devices in automobiles, Architecture of an ECU, Electronic engine control: Input, output devices, electronic fuel control system, engine control operating modes, electronic ignition systems, Engine cooling and warm up control, acceleration, detonation and idle speed control-integrated engine system.	06
3.	**Control of Electric and Hybrid Vehicles** Electric vehicle-batteries electric motor and controller, different configuration, regenerative braking-control of hybrid vehicles, CNG, electric hybrid vehicle-	06

	hybrid vehicle case studies.	
4.	**Battery performance and selection** Introduction, types of battery, Battery Performance Measurements, Factors Affecting Battery Performance, battery Standardization - Battery Design – Battery Management System - Battery Fault Detection, Maintenance and Test - Battery Installation - Selection of Battery for Automotive application, Advance batteries: General Characteristics, Description of the Electrochemical Systems, Cell Design and Performance Characteristics of - Metal/Air Batteries - Zinc/Bromine Batteries - Sodium-Beta Batteries – Lithium / Iron Sulfide Batteries.	**06**
5.	**Automotive Safety Sensor Applications** Automatic rain sensing/wiper activation system, drowsy-driver sensing system, active safety sensor system, passive sensor safety system-side impact sensing, front impact sensing system.	**06**
6.	**Intelligent Vehicle System** Vision based autonomous road vehicles, object detection, collision warning and avoidance system, tire pressure warning system, security systems, emergency electronics braking, Intelligent vehicle systems, Unmanned ground vehicles, vehicle platooning.	**06**

References:

Text Books:

- William B. Ribben, Understanding Automotive Electronics: An Engineering Perspective, Elsevier Science.
- John Miller, Propulsion Systems for Hybrid Vehicles, Institute of Electrical Engineers.
- Robert A. Huggins, Advanced Batteries: Material Science Aspects, Springer Publications.

Reference Books:

- Tom Denton, Automobile Electrical and Electronics Systems, Taylor and Francis Group.
- Tom Denton, Automobile Mechanical and Electrical Systems, Taylor and Francis Group.
- Ronald K. Jurgen, Electric and Hybrid Electric Vehicles, SAE International.
- Gianfranco Pistoia, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Elsevier.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 421**	Course Name: **Engineering Failure Analysis (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

Fail-safe design is the primary intention of any design engineer. Engineering Failure Analysis syllabus typically covers the principles and techniques used to understand the causes of failures in engineering systems and structures. The course is designed to equip students with the skills needed to identify the root causes of failures, assess their impact, and learn how to prevent future. The topics covered in this course includes, approaches to failure analysis, fracture mechanics concepts, material characterization and corrosion, fractography and industrial case studies.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Select the appropriate approach to perform failure analysis
2. Calculate stress and strain and predict the failure using failure criteria
3. Apply the principles of fracture mechanics and analyse the fractured surface .
4. Choose the technique for material characterization and also comment on the corrosion aspects.
5. Use fractography technique to explore the details of crack initiation and propagation.
6. Write a detailed investigation failure report along with recommendations to prevent the failure in future.

Prerequisite:

Strength of Material and Design Engineering.

Course Content

Unit No	Description	Hrs.
1.	**Investigation of Failure Analysis** Engineering products and their performance, Properties of materials, Failure of engineering product, Imperfect Vs Defect, Definition and objectives of failure investigation, Approaches to failure analysis investigation. Case study on failure of engineering alloys due to improper processing practice.	06
2.	**Evaluation of property and stress analysis** Non-destructive tests, Destructive tests. Uniaxial state of stress, Generalized state of stress. Multiaxial stress-strain relationship, Thermal stress, Types of stresses required to produce plastic deformation Criteria for onset of plastic deformation, criteria for mechanical failure. Analysis of stresses in mechanical components, Case study on effect of variation in design on service performance.	06
3.	**Macroscopic aspects of fracture and fracture mechanics** Definition and objectives of fracture mechanics, Brittle and ductile fracture, Crack loading modes and macroscopic morphology of fracture surface, Crack	06

	propagation under plane stress, plane strain and mixed state of plane stress and plane strain. Sequence of event leading to fracture, variables affecting fracture behavior, principles of fracture mechanics, Linear elastic fracture mechanics, use of fracture mechanics in failure analysis. Use of ASTM standards (E1823).	
4.	**Material characterization and corrosion** Material Characterization: Introduction, Techniques for microstructural characterization, Techniques for chemical analysis, Microstructure of engineering alloys. Corrosion: Introduction, low temperature aqueous corrosion, high temperature corrosion, Case study on engineering product failure during service due to unanticipated service condition and improper material selection	**06**
5.	**Fractography** Introduction, Microscopic aspects of crack nucleation and mechanism of crack propagation, fracture modes, fractography. Industrial case studies	**06**
6.	**Failure analysis procedure** Introduction, Definition of the problem, technical background, experimental program and analysis, Modes of failure Vs. cause of failure, data interpretation and terminology, Recommendations, Failure Analysis Reports.	**06**

References:

Text Books:

- Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education.
- H. M. Tawancy, A. Hamid, and N. M. Abbas, Practical Engineering Failure Analysis, Marcel Dekker Publisher.

Reference Books:

- J. L. Otegaul, Failure Analysis, Springer Publisher.
- D. R. H. Jones, Failure Analysis Case Study, Pergamon Publisher.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4234**	Course Name: **Cryogenics (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course introduces students to the fundamental principles and applications of cryogenics, focusing on low-temperature engineering and its significance in various fields. Topics covered include the historical development of cryogenics, cryogenic temperature scales, and the behavior of materials and fluids at cryogenic temperatures. Students will explore gas liquefaction systems, cryocoolers, and cryogenic measurement techniques. The course also delves into gas separation systems, vacuum technology, cryogenic fluid storage, transfer systems, and insulation methods. Practical applications in superconducting devices, electronics, space technology, and medical fields are emphasized to provide a comprehensive understanding of cryogenics.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Explain the cryogenics applications, cryocoolers, etc.
2. Apply low temperature principles to choose the materials and cryogenic fluids for a given application
3. Select the cryogenic liquefaction systems.
4. Evaluate the gas separation systems.

Prerequisite:

Design, Thermal Engineering and Heat Transfer.

Course Content

Unit No	Description	Hrs.
1.	**Refrigeration and Cryogenic** Refrigeration: VCC cycle and refrigerants, Cryogenics: History and development its importance, cryogenic temperature scale. Applications in superconducting devices, electronics, space technology, cryobiology, food storage, medical application.	06
2.	**Cryogenic fluids and behavior of materials at low temperature** Low temperature properties of materials, Mechanical properties, Thermal properties, electric and magnetic properties, Properties of cryogenic fluids: Properties of fluids other than hydrogen and helium, Properties of hydrogen, helium3, helium4	06
3.	**Gas Liquefaction Systems** Refrigeration & liquefaction, Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion, Thermodynamically ideal system, System performance parameters, Liquefaction systems; Linde-Hampson (L-H),	06

	Precooled L-H, Linde Dual-Pressure, Claude System, Kapitza system, Heylandt System, Collins System, (simple numerical)	
4.	**Cryocoolers** Ideal Refrigeration system, Cryocoolers for temperature above 2k (Philips refrigerator, Vuilleumier refrigerator, Solvay Refrigerator, Gifford-McMohan refrigerator) Cryocoolers for temperature below 2k (Magnetic cooling, magnetic refrigerator, Dilution Refrigerator)	**06**
5.	**Gas Separation Systems** The thermodynamically ideal separation system, Properties of mixtures, Temperature composition and enthalpy-composition diagrams, Principles of gas separation, Principles of rectifications, (simple numerical), Vacuum pump; Diffusion pumps, ion pumps	**06**
6.	**Cryogenic fluid storage and transfer systems** Introduction, Basic storage vessels, inner and outer vessel design considerations, suspension system design considerations, piping, safety devices, Draining of vessel. Two phase flow in cryogenic fluid transfer system, Transfer through uninsulated line, vacuum insulated lines, porous insulated lines etc. Vapour shielded and liquid shielded vessels, Types of Cryogenic Insulations.	**06**

References:

Text Books:

- Fundamentals of Cryogenic Engineering, M. D. Atrey, Alpha Science International, 2015.
- Cryogenics: A Textbook, P. C. Thomas, Tata McGraw-Hill, 2020.
- Introduction to Cryogenic Engineering, V. P. S. Awana, H. Kishan, Narosa Publishing House, 2020.

Reference Books:

- Cryogenic Systems, R. F. Barron, Oxford University Press, 1985.
- Cryogenic Engineering, T. M. Flynn, Marcel Dekker Inc., 2005.
- Part I Fundamentals, Cryocoolers, Walkers,Prentice Hill Publication Plenum Press, New York, 1983.
- Cryocoolers, Part II, Walkers, Prentice Hill Publication Plenum Press, New York,
- 1983.
- Cryogenic Engineering, R. W. Vançe, New York, John Wiley & Sons, Inc., 1962.
- Cryogenic Engineering, R. B. Scott, D. Van Nosfrand Co. New York, 1959.
- Cryogenic Engineering, J. H. Bell, Prentice Hall, Englewood Cliffs, N. J., 1963.

Online Resources:

- Prof. M.D. Atrey, Department of Mechanical Engineering, IIT Bombay. https://www.youtube.com/watch?v=4gGMBNEzeuc&list=PLbMVogVj5nJTvV6PaBMpvjBwfT4FzqcN8

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 425**	Course Name: **Design of Heat Exchanger (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course discusses the mechanical design requirements of different heat exchangers for various plant applications. It also highlights the primary features of air-cooled, double-pipe, and plate-and-frame exchangers and condensers and evaporators.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Select suitable heat exchanger for particular application.
2. Design of heat exchanger.
3. Design and analyse boiler furnace.
4. Analyse different heat transfer equipment.

Prerequisite:

Thermodynamics, Fluid Mechanics, and Heat Transfer.

Course Content

Unit No	Description	Hrs.
1.	**Heat Transfer, fluid Flow and Stress in Heat Exchangers** **A. Design Aspects** Types of heat exchanger, Parallel flow, counter flow and cross flow; shell and tube and plate type; single pass and multipass, Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers. **B. Flow and Stress Analysis** Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures	06
2.	**Thermal Design** Performance evaluation of Heat Exchangers, LMTD, e-NTU methods. Rating and sizing problems, Heat Transfer and Pressure drop calculations. Mechanical Design: Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges etc. Flow induced vibration.	06
3.	**Design of Shell and Tube Heat Exchanger** Thickness calculation, Tube sheet design using TEMA formula, concept of equivalent plate for analyzing perforated analysis, flow induced vibration risks including acoustic issues and remedies, tube to tube sheet joint design, buckling of tubes, thermal stresses Basic Design Methods of Heat Exchanger Fouling of Heat Exchanger, Effects of fouling on heat exchanger, Effects of fouling pressure drop,	06

	Types of fouling, Fundamental processes of fouling, Techniques to control fouling.	
4.	**Heat Transfer in Two-Phase Flow** Heat transfer in two phase flow-Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drop in two phase flow using Thom's method	**06**
5.	**Design of Process Equipment** Design of Fuel Oil Suction Heater, Design of Fuel Oil Heater, Design of Recuperative Air Pre Heater, Design of Economizer Design includes estimation of heat transfer area, pressure drop etc. Superheater and Reheater Design.	**06**
6.	**Design of Condensers and Evaporators** Shell and tube condensers, Air cooled condensers, Direct contact condensers, Condensers and evaporators for refrigeration and air conditioning. Darcy flow model, forced convection and natural convection boundary layer. Modeling and Simulation.	**06**

References:

Text Books:

- R. K. Rajput, Heat and Mass Transfer, S. Chand and Company Ltd., New Delhi.
- Dr. D. S. Kumar, Heat and Mass Transfer, S.K. Kataria and Sons, Delhi.
- P. K. Nag, Heat Transfer, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

- Ramesh K. Shah, Fundamentals of Heat Exchanger Design, John Wiley and Sons.
- J. P. Holman, Heat Transfer, Tata McGraw Hill Publisher.
- M. Necati Ozisik, A Basic Approach to Heat Transfer, Tata McGraw Hill International Edition.
- Yunus A. Cengel, Heat Transfer: A Practical Approach, Tata McGraw Hill.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 427**	Course Name: **Battery Thermal Management System (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

In this course, you will get a complete overview of electrochemistry, battery terminologies, battery management system, charging and discharging for EV application and thermal management. This course is especially useful to students and working professionals at a beginning stage of learning about the battery system of electric & hybrid electric vehicles. You will gain knowledge about lithium-ion battery systems, chemistry, and management systems & cooling.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Illustrate major functions and parts of a battery-management system.
2. Design various configurations of battery pack and recent trends in battery pack.
3. Compute stored energy in a battery pack.
4. Measure and control current, temperature, and isolation in battery-management system.

Prerequisite:

Thermodynamics, Heat transfer, Drive systems and Basic electrical technology.

Course Content

Unit No	Description	Hrs.
1.	**Energy and Electrochemistry** Sources of energy for propulsion & their comparison: Net Calorific Value, Conversion efficiency, History and background of battery technology, Electrochemistry fundamentals & terminologies, Lithium ion battery and different chemistries, Portable power applications and electrical load requirements, Factors affecting the choice of EV battery systems, Commercially available lithium ion cells, Electrical characteristics of battery: Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycles, Mechanical characteristics, Form factor, Safety.	06
2.	**Battery Pack Construction** Battery modules and complete battery pack system, Assembly methods, Electrical connections, Cell level protection system, battery pack level protection system, Understanding laptop battery pack system.	06
3.	**Battery Management System** Introduction, Battery pack requirements: Measurement, Protection and management, Cell balancing, Battery pack electronics, Battery Management System (BMS): Functionality, technology and topology (centralized, modular, master-slave, distributed).	06

4.	**Design of Battery Management System** BMS Application Specific Integrated Circuit (ASIC) selection, Analog BMS design, Digital BMS design, BMS deploying: Installing, testing and troubleshooting.	06
5.	**Thermal Management** Types of temperature sensors, types of thermal management system, Thermal model of battery pack, Drive cycle simulation and vehicle range estimation, Cooling materials and methods.	06
6.	**Recent Trends and Economy** Communication systems for battery pack, Review of electric car battery pack, Important considerations, Recent trends: Grid level energy storage, Solar & wind integration, Recycling and pricing.	06

References:

Text Books:

- Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, Thermal Management of Electric Vehicle Battery Systems, John Wiley & Sons.
- James Larminie, Electric Vehicle Technology Explained, John Wiley & Sons.

Reference Books:

- Mehrdad Ehsani, Yimin Gao, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press.
- Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 429**	Course Name: **Foundry Technology (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

Foundry Technology is a course focused on the processes, materials, and techniques involved in metal casting and the production of metal components in a foundry. The course also covers special molding processes and foundry practices for steels, cast iron and copper alloy castings.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Explain the technology, variables and complexity involved in producing a casting.
2. Design suitable gating system for a given casting.
3. Select suitable type of furnace for given application and finalize pattern requirements.
4. Select suitable sand, mould, core and moulding process.
5. Explain special casting processes
6. Describe scope of modernization, mechanization and quality control in foundries.

Prerequisite:

Materials Science and Engineering, Thermodynamics, Heat Transfer and Basic Calculus & Algebra.

Course Content

Unit No	Description	Hrs.
1.	**Trends and scope of Foundry Industry** Position of Foundry industry worldwide and in India, analysis if the data in respect of production and demand, recent trends in quality specifications like dimensional accuracy, surface finish and property requirement, specifications, properties and applications of modern cast alloys- SG iron, Al-alloys, Cu-Alloys, Zn-alloys **Design Considerations in Pattern manufacturing** Computer Aided pattern design and manufacturing, pattern making machines and Equipments, computer aided design of dies in die casting and centrifugal casting, materials used and allowances.	06
2.	**Design of Gating system** Elements and types of gating systems, gating ratio, pressurized and non-pressurized gating systems, applications, Risers- types, functions, directional solidification- factors affecting and significance, use of exothermic sleeves, bricks, chills and their types, types and uses of filters, computer aided design for gating and Risering systems.	06
3.	**Melting Practices and Furnaces** Melting practices of Al-alloys, Mg alloys, Cu-Alloys and Zn based alloys and SG Iron: Degassing process and methods in Al-alloys, modification treatment in Al-	06

	alloys, use of covering fluxes to avoid oxidation, furnaces: oil and gas fired, , induction, rotary, arc furnaces, desulfurization, spheriodization, inoculation practices, de oxidation and alloy addition, principle of working of spectrometer, and C.E. Meters , applications, use of pyrometers for temperature measurement and control, energy saving in melting practices.	
4.	**Modern Molding and Core Making Processes** Various types of sands used for molding and core making, testing of sand, high pressure line molding, chemically bonded sand, shell molding binder , hardener and types of sand used in shell molding, procedure used for making shell sand, plants used, properties and tests on shell sand, stick point strength, advantages and applications; Resin bonded sand, alkyl resin, phenol resins and furnace sands, cold box method of core making-advantages and applications , ceramic molding, vacuum molding, sand reclamation importance and methods.	**06**
5.	**Special Casting processes** Investment casting processes and applications; Continuous casting, principle, processes and applications, die casting, low pressure/ gravity, pressure and squeeze casting advantages, limitations and applications, Centrifugal casting Calculation of various parameters in centrifugal casting, die temperature, rotational speeds, advantages, limitations and applications of centrifugal casting, defects in centrifugal casting.	**06**
6.	**Mechanization, Modernization and Quality Control in foundries**: Introduction to modernization, Mechanization of foundry and its advantages, Mechanization of sand plant, molding and core making mechanization in melting, pouring and shake out units, Material handling equipments and conveyor systems, Quality control in foundries, productivity improvement techniques in foundries.	**06**

References:

Text Books:

- R. W. Heine, C. R. Loper, and P. C. Rosenthal, Principles of Metal Casting, Tata McGraw-Hill.
- P. L. Jain, Principles of Foundry Technology, TMH Publications.

Reference Books:

- P. Beeley, Foundry Technology, Elsevier (reprint by: Butterworth-Heinemann).
- K. Chakrabarti, Casting Technology and Cast Alloys, PHI Ltd.
- B. Ravi, Metal Casting: Computer-Aided Design and Analysis, PHI Learning Pvt. Ltd.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 431**	Course Name: **Enterprise Resource Planning (ERP) and Product Life Cycle Management (PLM) (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course introduces students to the concepts and applications of Enterprise Resource Planning (ERP) and Product Lifecycle Management (PLM), focusing on their roles in modern industries. Students will learn about the architecture, features, and implementation of ERP and PLM systems, as well as their integration to streamline business processes and product management. The course covers advanced topics, including Industry 4.0, IoT, AI, and cloud-based solutions, while exploring case studies from manufacturing, aerospace, and automotive sectors. By the end of the course, students will gain the skills to analyze, design, and implement ERP and PLM strategies to enhance organizational efficiency and product innovation.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate understanding of the concepts, objectives, and evolution of ERP and PLM systems.
2. Analyze the architecture and modules of ERP systems for enterprise integration.
3. Apply PLM tools to manage product data across the product lifecycle.
4. Evaluate strategies for ERP and PLM integration to optimize industrial processes.
5. Design solutions using IoT, AI, and blockchain to enhance ERP and PLM systems.
6. Assess real-world ERP and PLM case studies and recommend improvements.

Prerequisite:

Manufacturing Processes and Systems, CAD, Basics of Project Management and Data Management.

Course Content

Unit No	Description	Hrs.
1.	**Introduction to ERP and PLM** Definition and need for ERP and PLM, historical evolution of ERP and PLM, key features and functionalities of ERP and PLM, benefits of ERP and PLM in manufacturing industries, comparison of ERP and PLM with examples, challenges and limitations in ERP and PLM adoption, real-world examples highlighting the importance of ERP and PLM in modern industries.	06
2.	**ERP Systems** Modules of ERP: finance, manufacturing, supply chain, and human resources, architecture and components of ERP systems, ERP implementation lifecycle: planning, selection, design, and testing, challenges and risks in ERP implementation, major ERP software solutions: SAP, Oracle, Microsoft Dynamics, role of ERP in integrating business processes, industrial case studies	06

	of ERP implementation.	
3.	**PLM Systems** Stages of product life cycle: concept, design, manufacturing, use, and disposal, PLM framework and its role in managing product data and processes, integration of PLM with CAD/CAM/CAE tools, popular PLM software: Siemens Teamcenter, PTC Windchill, Dassault Systems ENOVIA, benefits of PLM in enhancing product innovation and reducing time-to-market, case studies on PLM adoption in automotive and aerospace industries.	**06**
4.	**ERP and PLM Integration** Need for integrating ERP and PLM systems, challenges in integration: data consistency, compatibility, and cost, data synchronization and workflows between ERP and PLM, role of cloud computing in ERP-PLM integration, benefits of integrated ERP and PLM systems in product design and manufacturing, examples of successful ERP-PLM integration in various industries, strategies for effective implementation.	**06**
5.	**Emerging Trends in ERP and PLM** Impact of Industry 4.0 on ERP and PLM systems, applications of IoT in manufacturing data management, role of artificial intelligence and machine learning in predictive analytics, digital twin technology for real-time monitoring and simulations, blockchain technology for secure and traceable product data, cloud-based ERP and PLM solutions, future directions and innovations in ERP and PLM systems.	**06**
6.	**Case Studies and Practical Applications** ERP implementation in manufacturing: case study of automotive industry, PLM adoption in aerospace: reducing design errors and time-to-market, cost-benefit analysis of ERP and PLM implementation, lessons from failed implementations: challenges and resolutions, impact of ERP and PLM on organizational productivity, group discussions and presentations on hypothetical case studies, roadmap for future integration of ERP and PLM in emerging technologies.	**06**

References:

Text Books:

- O'Leary D. E., Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk, Cambridge University Press.
- Kroenke D. M. & Auer D. J., Database Processing: Fundamentals, Design, and Implementation, Pearson.
- Grieves M., Product Lifecycle Management: Driving the Next Generation of Lean Thinking, McGraw-Hill Education.
- Venkataramanan A. & Tan K. C., Operations Management: Integrating Manufacturing and Services, Pearson.

Reference Books:

- Monk E. F. & Wagner B. J., Concepts in Enterprise Resource Planning, Cengage Learning.
- Browning T. R. & Heath R. A., Product Lifecycle Management: A Guide to New Product Development, Springer.
- Lasseter D., ERP: Making it Happen: The Implementers' Guide to Success with

Enterprise Resource Planning, Wiley.

- Gartner, Magic Quadrant for ERP.
- Shtub A. & Karni R., ERP: The Dynamics of Supply Chain and Process Management, Springer.
- Raj S. P. & Sharma R., Product Lifecycle Management: Modern Day Challenges and Solutions, Wiley.
- Martin J. & Duvall L., Agile Product Lifecycle Management: A Guide to IT-enabled Transformation in the Automotive Industry, CRC Press.
- Chandra A. & Krishnan R., Digital Transformation in Industry 4.0: ERP, PLM, and IoT Synergies, Elsevier.
- Huang G. Q. & Zhang A. L., Advances in ERP and PLM: Innovations in Systems and Technology, Springer.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 433**	Course Name: **Sustainable Manufacturing (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

This course explores the principles and practices of sustainable manufacturing to minimize environmental impact while maintaining economic viability and social responsibility. Social and environmental sustainability are addressed through ethical labor practices, waste reduction and minimizing environmental impact Students will learn About sustainable practices such as green manufacturing and circular economy.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Discuss the importance of sustainability.
2. Describe the importance of sustainable practices.
3. Identify drivers and barriers for the given conditions.
4. Design strategy in sustainable manufacturing.
5. Plan for sustainable operations of industry with environmental, cost consciousness.

Prerequisite:

Engineering Materials, Manufacturing Processes and Machine Tools.

Course Content

Unit No	Description	Hrs.
1.	**Economic sustainability** Industrial revolution and economic sustainability, globalization and international issues, sustainability status, emerging issues, innovative products, reconfiguration of manufacturing enterprises, competitive manufacturing strategies, performance evaluation, management for sustainability, assessments of economic sustainability.	06
2.	**Social and environmental sustainability** Social sustainability introduction, work management, human rights, societal commitment, customers, business practices modelling and assessing social sustainability. Environmental issues in the manufacturing sector: pollution, use of resources, pressure to reduce costs. Environmental management: processes that minimize negative environmental impacts, environmental legislation and energy costs, need to reduce the carbon footprint of manufacturing operations, modelling and assessing environmental sustainability.	06
3.	**Sustainability practices** Sustainability awareness, measuring industry awareness, drivers and barriers, availability of sustainability indicators, analysis of sustainability practices, modelling and assessment of sustainable practices, designing questionnaires, optimizing sustainability indexes, elements cost and time mode.	06

4.	**Manufacturing strategy for sustainability** Concepts of competitive strategy and rnanufacturing strategies, development of a strategic improvement program, manufacturing strategy in business success, strategy formation and formulation, structured strategy formulation, sustainable manufacturing system design options, approaches to strategy formulation, realization of new strategies or system designs.	**06**
5.	**Sustainable manufacturing system design** Sustainable manufacturing system design options, approaches to strategy formulation, realization of new strategies or system designs.	**06**
6.	**Trends and advances in sustainable operations** Principles of sustainable operations, life cycle assessment for manufacturing and service activities, influence of product design on operations, process analysis, capacity management, quality management, inventory management, just-in-time systems, resource-efficient design, consumerism and sustainable well-being.	**06**

References:

Text Books:

- G. Atkinson, S. Dietz, and E. Neumayer, Handbook of Sustainable Manufacturing, Edward Elgar Publishing Limited.
- J. P. Davim, Sustainable Manufacturing, John Wiley & Sons.

Reference Books:

- Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses, and Assessments for Industry 4.0, Springer International Publishing.
- F. Jovane, W. Ępper, and D. J. Williams, The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing, Springer.
- M. Kutz, Environmentally Conscious Mechanical Design, John Wiley & Sons.
- G. Seliger, Sustainable Manufacturing: Shaping Global Value Creation, Springer.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 435**	Course Name: **Digital Manufacturing (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:

Digital Manufacturing is an advanced course designed for Mechanical Engineering students, focusing on the integration of digital technologies in modern manufacturing systems. The course covers key concepts such as Industry 4.0, CAD/CAM/CAE integration, Additive Manufacturing, Industrial Internet of Things (IIoT), Digital Twin technology, and AI-driven data analytics. Students will gain hands-on experience with smart manufacturing tools, robotics, and cybersecurity practices. By bridging traditional manufacturing with digital innovations, the course prepares students for the evolving demands of smart factories and sustainable industrial practices.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Explain the role and scope of digital manufacturing in modern industries.
2. Apply CAD/CAM/CAE tools for digital design and simulation.
3. Use IoT and digital twin technologies for real-time manufacturing optimization.
4. Analyze manufacturing data for performance improvement.
5. Implement Industry 4.0 principles in manufacturing scenarios.

Prerequisite:

CAD/CAM tools, Manufacturing Processes, and Industrial Automation, Engineering Mathematics, Material Science and Programming Basics.

Course Content

Unit No	Description	Hrs.
1.	**Introduction to Digital Manufacturing** Evolution from traditional to digital manufacturing, Concepts of Smart Manufacturing and Industry 5.0, Key technologies: IoT, Big Data, Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), Cyber-Physical Systems, Benefits and challenges of digital manufacturing.	06
2.	**CAD, CAM, and CAE Integration** CAD in digital manufacturing (Design and Modeling Tools), CAM: Tool path generation, machining simulation, CAE: Finite Element Analysis (FEA) and optimization, Case studies on integrated CAD/CAM/CAE workflows.	06
3.	**Additive Manufacturing and 3D Printing** Introduction to Additive Manufacturing (AM), Types of 3D Printing technologies, Applications in prototyping and production, Digital workflow in AM.	06
4.	**Industrial Internet of Things (IIoT)** Basics of IoT and IIoT in manufacturing, Sensors, actuators, and data acquisition, Real-time monitoring and predictive maintenance, Case studies on IIoT-enabled	06

	smart factories.	
5.	**Digital Twin Technology** Introduction to Digital Twins, Architecture and working principles, Applications in product lifecycle management (PLM), Case studies on digital twin implementations.	**06**
6.	**Robotics & Cyber-security in Digital Manufacturing** Human-robot collaboration (Cobots), Automated material handling systems, Case studies on robotics in smart factories, Importance of cybersecurity in smart factories, Threats and vulnerabilities in manufacturing systems, Cybersecurity frameworks and best practices.	**06**

References:

Text Books:

- M. P. Groover, *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson.

Reference Books:

- D. W. Rosen, Y. Wang, and D. Schaefer, Cloud-Based Design and Manufacturing (CBDM), Springer.
- M. Koc and J. Lee, Digital Manufacturing: Concepts, Methods, and Tools, Springer.
- Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4394**	Course Name: **Mechanical Vibration (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course provides an in-depth understanding of mechanical vibrations, focusing on single and multi-degree-of-freedom (SDOF, MDOF) systems and continuous systems. It covers the equations of motion for free and forced vibrations, damping characteristics, vibration absorbers, and methods for determining natural frequencies and mode shapes. The course explores lateral, longitudinal, and torsional vibrations, including critical speed analysis. Students will learn about vibration measurement techniques, transducers, FFT analysis, and condition monitoring. Applications include vehicle dynamics, structural testing, and human vibration effects. Emphasis is placed on practical measurement, fault diagnosis, and vibration isolation using commercial materials and fluid dampers.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply fundamental vibration terms in engineering design.
2. Calculate natural frequencies and mode shapes of Two-Degree-of-Freedom (2-DOF) and Multi-Degree-of-Freedom (MDOF) systems.
3. Implement appropriate vibration control methods for engineering systems.
4. Select and justify suitable instruments and transducers for vibration measurement.
5. Analyze and interpret vibration data for fault diagnosis and condition monitoring.

Prerequisite:

Engineering Mathematics.

Course Content

Unit No	Description	Hrs.
1.	**Vibration of Single Degree of Freedom (SDOF) System** Equation of motion for free and forced vibration of damped SDOF system, Motion and force transmissibility, Types of damping, equivalent viscous damping, Quality factor and band width, dampers in series and parallel, Design parameters of fluid dashpot, commercial vibration isolation materials.	06
2.	**Two Degrees of Freedom Systems** Equation of motion for Free and forced vibrations of two DOF systems and its applications, Torsional systems, Co-ordinate coupling and principal coordinates, Dynamic vibration absorbers.	06
3.	**Many Degrees of Freedom Systems** Modelling of multi-DOF systems, Influence coefficients, Methods of determination of natural frequencies and mode shapes, Dunkerley's method, Rayleigh's Method, Holzer's Method, Matrix Iteration Method.	06
4.	**Vibration of Continuous Systems**	06

	Lateral vibration of a string, Longitudinal Vibration of Rods, Torsional vibration of uniform shaft, Euler's equation of beams, Effect of axial force on lateral vibration of bars, Critical speed of the shaft	
5.	**Vibration Measuring Instruments** Vibration Transducers, Piezoelectric accelerometers, Selection criteria for sensors, Practical accelerometer design and mounting, accelerometer characteristic and frequency range, Vibration pickups, Frequency measuring instruments, Filter bandwidth considerations, Logarithmic and decibel scales, Vibration exciters, Fast Fourier Transformer (FFT)	**06**
6.	**Vibration Measurement and Applications** Measurement of machine vibrations: methods and vibration standards, Vibration based condition monitoring and fault diagnosis, Vibration Signature Analysis, Dynamic testing of vehicle bodies and structures, Effect of vehicle vibrations on human body, Experimental modal analysis.	**06**

References:

Text Books:

- Singiresu S. Rao, Mechanical Vibrations, Pearson Education.
- W. T. Thompson, Theory of Vibration, CBS Publishers.
- Clarence W. de Silva, Vibration: Fundamentals and Practice, CRC Press LLC.
- R. Venkatachalam, Mechanical Vibrations, PHI.

Reference Books:

- L. Meirovich, Elements of Vibration Analysis, Tata McGraw-Hill.
- G.K. Groover, Mechanical Vibrations, Nemchand & Brothers, Roorkee.
- Thammaiah Gowada, Jagadeesha, Mechanical Vibrations, McGraw-Hill
- S Graham Kelly, Fundamentals of Mechanical Vibrations, McGraw-Hill
- H. Timoshenko & D. H. Young, Vibration Problems in Engineering, East West Edition
- F Shrinivasan, Mechanical Vibration Analysis, Tata McGrath Hill New Delhi
- Shrikant Bhave, Mechanical Vibrations: Theory & practice, Pearson
- Rao V. Dukkipati, J. Shhrinivas, Mechanical Vibrations, PHI Publications

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4414**	Course Name: **Experimental Stress Analysis (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course provides a comprehensive understanding of stress analysis methods, including analytical, numerical, and experimental approaches. It covers transmission and three-dimensional photoelasticity, exploring concepts like stress optic law, fringe analysis, and digital photoelasticity techniques such as Three Fringe Photoelasticity (TFP) and refined TFP. The course delves into photoelastic and brittle coatings for stress visualization in industrial applications. Additionally, strain measurement using strain gauges is covered, focusing on strain sensitivity, bridge circuits, rosette analysis, material selection, bonding techniques, and temperature compensation. Emphasis is placed on practical implementation, calibration, and modern data processing techniques for stress evaluation. This course equips students with essential skills for structural integrity assessment and failure analysis in engineering applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Select the appropriate method of stress analysis to solve the mechanical engineering problem.
2. Estimate principle stress of 2D/3D component using transmission photoelasticity.
3. Estimate principle stress of 2D/3D component using digital photoelasticity.
4. Determine stresses and strain by using photoelastic coating or brittle coating technique.
5. Design the experimental methodology to measure the strain by employing strain gauge technology.

Prerequisite:

Physics, Strength of Material and Machine design.

Course Content

Unit No	Description	Hrs.
1.	**Methods of stress analysis** Overview of experimental stress analysis, Stress analysis approach using analytical, numerical and experimental methods, Limitations. Stress and strain field for various problems, Beam under pure bending, Analytical solution, Fringe contours from various experimental methods, Analytical solutions for disc under diametrical compression.	06
2.	**Transmission Photoelasticity** Introduction to transmission photoelasticity, Ordinary and extraordinary rays, Light ellipse, Passage of light through a crystal plate, Retardation plates, Stress optic law, Plane Polariscope, Jones calculus, Circular Polariscope, Determination of photoelastic parameters at an arbitrary point, Tardy's method of compensation,	06

	Calibration of photo elastic materials, Fringe thinning methodologies, Fringe ordering in photoelasticity.	
3.	**Three-dimensional photoelasticity** Introduction to 3D photoelasticity, Stress freezing, Slicing, Application to complex problem, Integrated photoelasticity, Principle of optical equivalence.	**06**
4.	**Digital photoelasticity** Introduction to digital photoelasticity, Use of color information for quantitative analysis, Three Fringe Photoelasticity (TFP), Refined TFP (RTFP) to solve variant problems, Paradigm shift in data processing, Processing of intensity data for photo elastic data extraction, Ten step method, Phase maps.	**06**
5.	**Photoelastic coating and brittle coating** Introduction to photoelastic coating, correction factor, Selection of coating material and its thickness, Industrial application of photoelastic coating, Calibration of photoelastic coating, Introduction to brittle coating, Analysis of brittle coating.	**06**
6.	**Strain Measurement using strain gauges** Introduction to strain gauges, Strain sensitivity of strain gauge, Bridge sensitivity, Rosettes, Strain gauge alloys, Carriers and adhesive, Performance of strain gauge system, Temperature compensation, Two-wire and three wire circuits, Strain gauge selection, Bonding of strain gauge, Soldering, Accounting for transverse sensitivity, Correction factor for special applications, Special Gauges.	**06**

References:

Text Books:

- Sadhu Singh, Experimental Stress Analysis, Khanna Publishers.
- J. Srinivas, Stress Analysis and Experimental Techniques, Narosa Publishing House Pvt. Ltd.
- J. W. Dally, W. F. Riley, Experimental Stress Analysis, McGraw-Hill.
- Abdul Muben, Experimental Stress Analysis, Dhanpat Rai & Co.

Reference Books:

- Perry, Lissner, The Strain Gauge Primer, McGraw-Hill Publications.
- A. L. Window, Strain Gauge Techniques, Springer Publications.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4434**	Course Name: **Engineering Tribology (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

The study of friction, wear, and lubrication has long been of enormous practical importance, since the functioning of many mechanical, electromechanical and biological systems depends on the appropriate friction and wear values. In recent decades, this field, termed tribology, has received increasing attention as it has become evident that the wastage of resources resulting from high friction and wear is greater than 6% of the Gross National Product. The potential savings offered by improved tribological knowledge, too, are great.
Tribology deals with design of fluid containment systems like seals and gasket, Lubrication of surfaces in relative motion to achieve reduced friction and wear. The structure of the bearing and the nature of fluid flow determine the loads that can be supported. Modelling systems as hydrostatic, squeeze film and elasto-hydrodynamic lubrication will be studied as infinite and later finite structures. Gas (air) lubricated and rolling contact type motions with deformation at contact will be studied as special systems.

Course Learning Outcom1 0 0 1 s:

After succ0 1 ssful completion of the course, students will be able to,

1. Analyze the principles of tribology & lubrication and compare different types of bearings.
2. Examine the laws and theories of friction and wear and propose strategies for effective friction control and wear prevention in engineering applications.
3. Analyze the principles of hydrostatic and squeeze film lubrication.
4. Analyze the performance parameters of hydrodynamic thrust.
5. Apply the principles of elasto-hydrodynamic lubrication.
6. Evaluate the principles, advantages, limitations, and applications of gas-lubricated bearings, including hydrostatic, hydrodynamic, and thrust bearings with air lubrication.

Prerequisite:

Engineering Chemistry, Fluid Mechanics and Strength of Material.

Course Content

Unit No	Description	Hrs.
1.	**Lubrication Theory** Introduction to Tribology, Tribology in Design, Tribology in industry, Lubricants properties, physical and chemical, lubricants standards, types of additives, extreme pressure lubricants. Lubrication – introduction, basic modes of lubrication. Types of sliding contact bearings. Comparison of sliding and rolling contact bearing.	06
2.	**Friction and Wear**	06

	Friction - Laws of friction, Friction classification, causes of friction, Theories of Dry Friction, Friction Measurement, Stick-Slip Motion. Wear - Wear classification, Wear between solids, Wear between solid and liquid, wear Measurement of wear, Theories of Wear, Approaches to Friction Control and Wear Prevention.	
3.	**Hydrostatic and Squeeze Film Lubrication** Hydrostatic Lubrication – Basic concept, Advantages and limitations, Viscous flow through rectangular slot, Load carrying capacity and flow requirement, Energy losses, Optimum design. Squeeze Film Lubrication - Basic concept, Squeeze action between circular and rectangular plates, Squeeze action under variable and alternating loads.	**06**
4.	**Hydrodynamic Thrust Bearing** Introduction - Flat plate thrust bearing, tilting pad thrust bearing, Pressure Equation - Flat plate thrust bearing, tilting pad thrust bearing, Load, Flat plate thrust bearing, tilting pad thrust bearing, Centre of Pressure - Flat plate thrust bearing - Tilting pad thrust bearing, Friction - Flat plate thrust bearing - Tilting pad thrust bearing.	**06**
5.	**Elasto-Hydrodynamic Lubrication:** Principles and Applications, Pressure viscosity term in Reynold's equation, Hertz's Theory, Ertel-Grubin equation, Lubrication of spheres, Gear teeth bearings, Rolling element bearings.	**06**
6.	**Gas (Air-) Lubricated Bearings:** Introduction, Merits, Demerits and Applications, Hydrostatic bearings with air lubrication, Hydrodynamic bearings with air lubrication, Thrust bearings with air lubrication.	**06**

References:

Text Books:

- B. C. Majumdar, Introduction to Tribology of Bearings, S. Chand and Company Ltd.
- Prasanna Sahoo, Engineering Tribology, PHI Learning Pvt. Ltd.
- Mervin H. Jones and Douglas Scott, Industrial Tribology: The Practical Aspects of Friction, Lubrication and Wear, Elsevier Scientific Publishing Company.

Reference Books:

- M. J. Neale, Butterworth's Tribo'ogy Handbook, Butterworth-Heinemann.
- Bharat Bhushan, Handbook of Tribology, Krieger Publishing Company.
- D. Dowson, History of Tribology, Longman, London.

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K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2022-26 Batch
Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 447**	Course Name: **Heating Ventilation and Air Conditioning (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course covers essential concepts in refrigeration, air conditioning, heating systems, and HVACR electrical components. Students will learn about refrigeration cycles, key components (compressors, condensers, evaporators), and refrigerants, as well as HVACR electrical systems including safety, motors, and control systems. The course also delves into air conditioning systems, focusing on psychrometric properties, processes, and calculations. Heating systems, combustion principles, and troubleshooting techniques for gas and oil-fired systems will be explored. Students will also learn to perform building load calculations and optimize air-conditioning systems through control loops and energy-efficient strategies. Practical applications and numerical treatments will be incorporated throughout the course.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Explain the fundamental principles and applications of HVAC systems in residential, commercial, and industrial buildings.
2. Design efficient HVAC system by analyzing building requirements, climatic conditions, and energy demands.
3. Evaluate psychrometric properties and processes involved in air conditioning to determine optimal solutions for cooling, heating, humidification, and dehumidification.
4. Apply knowledge of HVAC components such as heat exchangers, fans, filters, and air handling units to develop functional systems.
5. Analyze the performance of HVAC systems, including energy efficiency, using various design techniques, control strategies, and sustainable practices.
6. Propose solutions for enhancing HVAC system performance by integrating smart technologies, energy-saving measures, and building management systems (BMS).

Prerequisite:

Thermodynamics, fluid mechanics, and heat transfer.

Course Content

Unit No	Description	Hrs.
1.	**Refrigeration systems and components** Types of refrigeration systems, refrigeration cycle, compressors, condensers, metering devices, evaporators, refrigerants, P-h and T-s diagram.	06
2.	**HVACR electrical systems and components** Electrical safety, basic electricity, alternating current fundamentals, electrical measuring and test instruments, electrical components, electric motors, electrical diagrams, control systems, communicating control systems.	06

3.	**Air Conditioning Systems** Properties of moist air, Psychometric properties and relations, psychrometer, psychometric chart, mixing Process, thermodynamic WBT, bypass factor, psychometric processes in air conditioning equipment (Numerical Treatment).	**06**
4.	**Heating Systems** Principles of combustion and safety, gas furnaces, gas furnace controls, gas furnace installation, troubleshooting gas, oil-fired heating systems, oil furnace and boiler, space heaters, humidifiers.	**06**
5.	**Building Load Calculations** Sensible heat gain and latent heat gain sources, coil ADP, Room ADP, various types of sensible heat factors (SHF) like Room SHF, Grand SHF and Effective SHF. (Numerical Treatment), select the air conditioner from domestic market.	**06**
6.	**Control and optimization of air- conditioning systems** Typical control loops of the air- conditioning process, control of CAV systems, control of VAV systems, outdoor air ventilation control and optimization, an overview of optimal control methods used for HVAC systems, Optimal control of air- side systems.	**06**

References:

Text Books:

- Refrigeration and Air Conditioning, S.C. Arora, S. Domkundwar, 8th Edition, Dhanpat Rai & Co., 2017.
- Refrigeration and Air Conditioning, C.P. Arora, 3rd Edition, Tata McGraw-Hill, 2017.
- Refrigeration and Air Conditioning, R.K. Rajput, 2nd Edition, S. Chand Publishing, 2016.
- Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, 4th Edition, McGraw-Hill, 2013.
- Refrigeration and Air Conditioning, Manohar Prasad, 3rd Edition, New Age International, 2011.

Reference Books:

- Principles of Refrigeration, Roy J. Dossat, Thomas J. Horan, 5th Edition, Pearson Education, 2001.
- Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, Eugene Silberstein, 7th Edition, Cengage Learning, 2012.
- ISHRAE Handbook – 2015
- ASHRAE Handbook – Fundamentals, ASHRAE, Latest Edition.
- Handbook of Air Conditioning and Refrigeration, Shan K. Wang, 2nd Edition, McGraw-Hill, 2000.
- Refrigeration and Air Conditioning, Wilbert F. Stoecker, Jerold W. Jones, 2nd Edition, McGraw-Hill, 1982.

Online Resources:

- Refrigeration and Airconditioning Prof. M. Ramgopal Department of Mechanical Engineering Indian Institute of Technology, Kharagpur
  https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PLE2DA184A2E479885

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4494**	Course Name: **Internal Combustion Engines (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

The aim of this course is to provide students with a working knowledge and application of the fundamentals of how the operation of internal combustion engines affect their working, performance, fuel requirements and environmental impact on both SI and CI engines.

The focus is on explaining engine performance in terms of power, energy utilization and exhaust emissions, its relation to internal processes like combustion and gas exchange, and varying engine-operating conditions.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Differentiate between various configurations of engine and engine cycles and explain valve timing and port timing diagram.
2. Calculate the design and operating parameters of fuel-supply system of SI and CI engine and analyse mixture requirements at different loads and speeds.
3. Explain methods of measurement of different performance parameters and compare performance of engines.
4. Explain the stages of combustion in SI and CI engines and effect of various operating parameters on combustion.
5. Recognize alternative fuels for IC engines with properties and compare different pollution norms.
6. Correlate various recent trends in I C Engines.

Prerequisite:

Basic Mechanical Engineering, and Applied Thermodynamics.

Course Content

Unit No	Description	Hrs.
1.	**Basics of I.C. Engines** Engine types, Theoretical cycles (Air standard cycles and Fuel Air cycles), Deviation of actual cycles from theoretical cycles, Various losses in actual cycles, Valve timing diagram for high and low speed engine, Port timing diagram.	06
2.	**S.I. Engines and CI Engine Fuel Systems** A/F ratio, Mixture requirements at different loads and speeds, Simple carburetor, Complete carburetor, Approximate and exact analysis of simple carburetor, Petrol injection system, Requirements of injection system, type of injection	06

	system, Injection pumps, injectors, nozzles, Quantity of fuel injected and size of nozzle orifice	
3.	**Combustion in S.I. Engines** Stages of combustion, Factors affecting ignition lag, Abnormal combustion, effects of detonation, factors affecting detonation, Requirement of good combustion chambers in SI engines, Types of combustion chambers, Properties of SI engine fuels, Knock rating of SI fuels, Additives, alternative fuels for SI engine. Emissions in SI engines and its control methods.	**06**
4.	**Combustion in C.I. Engines** Combustion of a fuel drop, Stages of combustion, Factor affecting delay period, Diesel Knock, Comparison of knock in SI and CI engines, Combustion chambers in CI engines, Properties of CI engine fuel, rating of CI engine fuel, alternative fuels for CI engines. Emissions in CI engines and its control methods, Standard pollution norms like EURO, BHARAT etc.	**06**
5.	**Testing and Performance of I.C. Engines** Performance parameters, Measurement of IHP, BHP, FHP, air consumption and fuel consumption, Performance curves of SI and CI engines, Heat balance sheet	**06**
6.	**Recent trends in I. C. Engines** Alternative ls, hydrogen fuels and its Performance, Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Stratified Charge Engine, Surface Ignition Engine, Valve and rhead am Engines, Electronic Engine Management, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Hybrid vehicles, Electric vehicles types and layouts	**06**

References:

Text Books:

- Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai Publications.
- V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publications.
- Ramlingam, Internal Combustion Engines, SciTech Publication Pvt. Ltd.

Reference Books:

- Domkundwar, A Course on Internal Combustion Engines (SI Units), Dhanpat Rai Publications.
- J. B. Heywood, amentals of Internal Combustion Engines, McGraw Publications.
- Gills and Smith, Internal Combustion Engines, Oxford & IBH Publishing Co. Pvt Ltd.
- E. . ert, Internal Combustion Engines and Air Pollution, Harper & Ro Publications.

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Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4514**	Course Name: **Refrigeration and Air Conditioning (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course covers the principles of refrigeration and air conditioning systems, focusing on cooling load components such as sensible and latent heat gains, SHF (Room SHF, Grand SHF, Effective SHF), and ADP (Apparatus and Room ADP). Students will learn numerical methods for cooling load calculations and evaluate human comfort conditions through thermal exchange, effective temperature, and comfort charts. The course emphasizes optimizing system designs for energy efficiency and comfort, preparing students to address real-world HVAC challenges in modern buildings.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Explain the single and multistage refrigeration cycles.
2. Select the appropriate refrigerant for given application.
3. Identify methods to reduce spoilage, and recommend suitable refrigeration solutions for domestic, commercial, and industrial food storage applications.
4. Analyse various air conditioning process by using psychrometric chart.
5. Determine the cooling load of a given confined space and select the air conditioner from domestic market.
   Select the appropriate air outlets and design a duct.

Prerequisite:

Thermodynamics, fluid mechanics, and heat transfer.

Course Content

Unit No	Description	Hrs.
1.	**Refrigeration Cycles** Vapour Compression Cycle (VCC), limitations of single stage VCC, classify multistage systems, flash gas removal using flash tank, intercooling in multi-stage vapour compression refrigeration systems, multi-stage system with flash gas removal and intercooling, use of flash tank for flash gas removal, use of flash tank for intercooling only.	06
2.	**Refrigerants** Classification, properties, designation, impact of refrigerants on environment, selection of refrigerant for various applications – refrigerator, air conditioner, automobile, cold storage, cascade system, alternative and future refrigerants.	06
3.	**Food Preservation** Advantages of food preservation, causes of food spoilage, methods of food preservation, domestic refrigerators for food preservation, commercial refrigerators for food preservation, cold storages for food preservation, frozen	06

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	storages for food preservation methods of food preservation, selection food preservation method for various applications. Use of artificial intelligence (AI) in food preservation.	
4.	**Psychrometry** Definition and necessity of air conditioning, Properties of moist Air, Psychometric Properties and relations, psychrometer, Psychometric Chart, Mixing Process, Thermodynamic WBT, Bypass Factor, Psychometric Processes in Air conditioning Equipment (Numerical Treatment).	**06**
5.	**A. Components of cooling load** Sensible heat gain and latent heat gain sources, coil ADP, Room ADP, various types of sensible heat factors (SHF) like Room SHF, Grand SHF and Effective SHF. (Numerical Treatment), select the air conditioner from domestic market. **B. Comfort conditions** Thermal exchange of body with environment, Factors affecting human comfort Effective temperature and comfort chart.	**06**
6.	**Air Distribution Systems** Factors considered in air distribution systems, types of supply air outlets, location of return air openings, closed perimeter system, extended plenum system, radial duct system, Duct materials, losses in ducts, duct design procedures. Use of artificial intelligence (AI) in air distribution systems.	**06**

References:

Text Books:

- Refrigeration and Air Conditioning, S.C. Arora, S. Domkundwar, 8th Edition, Dhanpat Rai & Co., 2017.
- Refrigeration and Air Conditioning, C.P. Arora, 3rd Edition, Tata McGraw-Hill, 2017.
- Refrigeration and Air Conditioning, R.K. Rajput, 2nd Edition, S. Chand Publishing, 2016.
- Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, 4th Edition, McGraw-Hill, 2013.
- Refrigeration and Air Conditioning, Manohar Prasad, 3rd Edition, New Age International, 2011.

Reference Books:

- Principles of Refrigeration, Roy J. Dossat, Thomas J. Horan, 5th Edition, Pearson Education, 2001.
- Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, Eugene Silberstein, 7th Edition, Cengage Learning, 2012.
- ISHRAE Handbook – 2015
- ASHRAE Handbook – Fundamentals, ASHRAE, Latest Edition.
- Handbook of Air Conditioning and Refrigeration, Shan K. Wang, 2nd Edition, McGraw-Hill, 2000.
- Refrigeration and Air Conditioning, Wilbert F. Stoecker, Jerold W. Jones, 2nd Edition, McGraw-Hill, 1982.

Online Resources:

- Refrigeration and Airconditioning Prof. M. Ramgopal Department of Mechanical Engineering Indian Institute of Technology, Kharagpur https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PLE2DA184A2E479885

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 5434**	Course Name: **Automotive Engineering (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course provides students with a comprehensive understanding of various automotive systems, including engines, transmission systems, braking systems, suspension, and vehicle dynamics. Students will explore advanced topics such as hybrid and electric vehicles, autonomous driving technologies, and automotive electronics. The course emphasizes the integration of modern diagnostic tools, safety systems, and emission norms. By the end of the course, students will have the technical knowledge and skills to innovate and contribute to the rapidly evolving automotive sector, preparing them for careers in design, manufacturing, research and development, and automotive testing.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Develop a comprehensive understanding of automobile basics, including classification, layout, and major components.
2. Explore the principles, types, and cycles of internal combustion (IC) engines and their performance parameters.
3. Evaluate drivetrain components and compare different drive systems for efficiency and performance.
4. Evaluate braking systems, including drum, disc, ABS, EBD, and regenerative braking.
5. Assess automotive electrical and electronic systems for their impact on performance and safety.
6. Enhance proficiency in vehicle testing and validation processes.

Prerequisite:

Engineering Mechanics, Thermodynamics, Fluid Mechanics, Manufacturing Processes, Materials Science, Basics of Electrical and Electronics Engineering.

Course Content

Unit No	Description	Hrs.
1.	**Automobile Engineering** Basics of Automobiles, Overview and classification of automobiles, Layout of automotive vehicles, Chassis and Body Components (Aerodynamic Introduction), Types of chassis frames, Materials used in body design, Powertrain Components, Introduction to engines, clutches, gearboxes, propeller shafts, and differentials, Types of drive systems, Vehicle Dynamics Basics, Concepts of weight distribution, stability, and aerodynamics, Trends in Automobile Design, Electric and autonomous vehicles	06
2.	**Automotive Engines and Fuel Systems** IC Engines, Types of engines (petrol, diesel, hybrid), Engine cycles and	06

	performance parameters, Fuel Supply Systems, Carburetors, fuel injection systems, Common rail direct injection (CRDI), gasoline direct injection (GDI), Alternative Fuels, Biofuels, LPG, CNG, hydrogen, and electric powertrains., mission Standards and Control, Euro and Bharat stage standards.	
3.	**Transmission Systems** Clutches and Gearboxes, Types of clutches (single plate, multi-plate, centrifugal), Manual and automatic transmissions, CVT, DCT, Drivetrain Components, Propeller shaft, universal joints, and differential, Types of drive systems: FWD, RWD, AWD, Advanced Transmission Systems, Hybrid powertrains, e-axles, Intelligent transmission control systems.	06
4.	**Vehicle Dynamics and Control** Basics of Vehicle Dynamics, Stability and handling, Longitudinal, lateral, and vertical dynamics, Suspension and Steering Systems, Types of suspension systems, Steering geometry and systems (rack-and-pinion, hydraulic, and electric power steering), Braking Systems, Types of brakes (drum, disc, ABS, EBD), Regenerative braking, Tires and Wheels, Tire construction, types, and properties, Factors affecting traction and wear.	06
5.	**Automotive Electrical and Electronics Systems** Electrical Systems, Battery types, alternators, and starters, Lighting systems and auxiliary electrical components, Electronic Systems, Engine control units (ECUs), Sensors and actuators in modern vehicles, Infotainment and Safety Systems, Navigation, telematics, and entertainment systems, Airbags, electronic stability control (ESC), and advanced driver-assistance systems (ADAS).	06
6.	**Manufacturing, Testing, and Maintenance** Automotive Manufacturing Processes, Assembly line processes, Materials used in manufacturing automotive components, Vehicle Testing and Validation, Emission testing, crash testing, and NVH testing, Simulation tools and virtual prototyping, Maintenance and Troubleshooting, Preventive and corrective maintenance, Diagnostic tools and fault analysis in vehicles.	06

References:

Text Books:

- Kirpal Singh, Automobile Engineering – Volume 1 & 2, Standard Publishers Distributors.
- William H. Crouse, Donald L. Anglin, Automotive Mechanics, McGraw Hill Education.
- James D. Halderman, Automotive Technology: Principles, Diagnosis, and Service, Pearson Education.
- V. Ganesan, Internal Combustion Engines, McGraw Hill Education.
- R. K. Rajput, A Textbook of Automobile Engineering, Laxmi Publications.

Reference Books:

- Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, SAE International.
- J. Y. Wong, Theory of Ground Vehicles, Wiley.
- K. Newton, W. Steeds, T. K. Garrett, The Motor Vehicle, Butterworth-Heinemann.
- Heinz Heisler, Vehicle and Engine Technology, Butterworth-Heinemann.
- Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4554**	Course Name: **Industrial Hydraulics and Pneumatics (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

Fluid power has the highest power density of all conventional power-transmission technologies. Learn the benefits and limitations of fluid power, how to analyse fluid power components and circuits, and how to design and simulate fluid power circuits using Automation Studio for applications.

In this course, you will be introduced to the fundamental principles and analytical modelling of fluid power components, circuits, and systems. You will learn the benefits and limitations of fluid power compared with other power transmission technologies; the operation, use, and symbols of common hydraulic & pneumatic components; how to formulate and analyse models of hydraulic & pneumatic components and circuits; and how to design and predict the performance of fluid power circuits.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Describe the structure and function of common hydraulic and pneumatic components such as cylinders, valves, pumps, and motors etc.
2. Model and analyze common hydraulic and pneumatic components such as cylinders, valves, pumps, and motors.
3. Create & simulate basic hydraulic and pneumatic circuit diagrams for different applications.
4. Design, develop & analyze simple hydraulic and pneumatic systems for given task.

Prerequisite:

Fluid mechanics, Basic Electrical Engineering and Engineering Mechanics.

Course Content

Unit No	Description	Hrs.
1.	**Fluid Power Systems and Fundamentals** Introduction to fluid power, Advantages of fluid power. Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids, General types of fluids. Fluid power symbols. (ISO/JIC) Use of Automation studio to draw circuits.	06
2.	**Hydraulic System and Components (Pumps and Actuators)** Pumping theory, Pump classification. Gear pump, Vane Pump, construction and working of pumps, pump performance, piston pump, Variable displacement pumps. Linear hydraulic actuators, Types of hydraulic cylinders, Single acting, Double acting cylinders. special cylinders like tandem, Rod less, Telescopic - Construction and application, cushioning mechanism, Mounting of actuators. Rotary actuators - Gear, Vane and Piston motors.	06

3.	**Hydraulic Valves, Accumulators and Circuits** Directional control valve 4/2, 4/3, 5/2, 5/3-way valves. Shuttle valve check valve, Pressure control valves, Flow control valve, Fixed and adjustable, Electrical control solenoid valves, Types of accumulators, Accumulators circuits, Intensifier Circuit and Application, Speed control circuits, synchronizing circuit and industrial application circuits copying circuit and press circuit, regenerative circuit.	**06**
4.	**Pneumatic Systems, Components and Circuits** Properties of air Compressors, Filter, Regulator, and Lubricator Unit, Air control valves, Quick exhaust valves and pneumatic actuators, Pneumatic motors, hydraulic circuit time delay circuits, Sequential circuit design for simple applications using cascade method.	**06**
5.	**Fluid Logic Control Systems** Hydro Mechanical servo systems, Electro-hydraulic and Electro-pneumatic systems and proportional valves, Electro-hydraulic and Electro-pneumatic systems and proportional valves, Introduction to fluidic devices, simple circuits, PLC applications in fluid power control, Failure and trouble shooting in fluid power systems.	**06**
6.	**Hydraulic/Pneumatic Circuit Design** Steps in circuit design, circuit design and simulation using Automation Studio. Steps in circuit design, circuit design and simulation using Automation Studio.	**06**

References:

Text Books:

- Anthony Esposito, Fluid Power, Prentice Hall Publications.
- Stewart, Industrial Hydraulics and Pneumatics.
- H. P. Garg, Industrial Hydraulics and Pneumatics.
- S. R. Mujumdar, Oil Hydraulic Systems: Principles and Maintenance.

Reference Books:

- Vickers, Industrial Hydraulics, Vickers Handbook.
- FESTO, Hydraulics - Basic Level TP501 Handbook, FESTO Publications.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4574**	Course Name: **Mechatronics System Design (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

Most mechanical engineering systems today involve significant amounts of electrical and electronic control systems. Effectively, most modern mechanical engineering systems are mechatronic systems. Mechatronics is the discipline that results from the synergetic application of electrical, electronic, computer, and control engineering in mechanical engineering systems. Thus, it is essential for the mechanical engineer to have a strong understanding of the composition and design of mechatronic systems, which is the goal of this course. This course will represent a gateway into the world of electrical, electronic, and control engineering. It is one of the few courses in the mechanical engineering major that heavily relies on electrical, electronic, and computer engineering.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Identify mechatronic systems and their real-world applications.
2. Analyze electrical and electronic circuits using basic components and Boolean logic principles.
3. Select appropriate actuators and feedback devices based on system requirements.
4. Design signal processing circuits and evaluate system dynamics for mechatronic applications.
5. Develop ladder logic programs for PLC-based automation systems.
6. Apply mechatronics system design principles to solve industrial automation problems.

Prerequisite:

Mechanics, Electromagnetism, Measurements, System Design & Dynamics and Control Engineering.

Course Content

Unit No	Description	Hrs.
1.	**Introduction to Mechatronics** Definition of Mechatronics, examples of mechatronics systems, components of mechatronics system, the multi-disciplinary process. Applications of Mechatronics in real world.	06
2.	**Electrical & Electronics Principles** Basic electrical components (resistors, capacitors inductors), analysing and solving simple electrical circuits, basics of Boolean logic, logic gates, designing basic logic circuits.	06
3.	**Actuators & Feedback Devices** Introduction to actuators, analogy between electrical and magnetic circuits, motor and generator principle, types of actuators-general introduction to motors, brushed	06

	Dc motors brushless DC motors, Stepper motor, Servo motor, criteria for actuator selection, sizing of actuators, feedback devices -shaft encoders-incremental and absolute encoders, LVDT, Accelerometer.	
4.	**Signal Processing & System Dynamics** Operational amplifier circuits, Oscillator Circuit, filtering circuits, Analog and digital signal conversion, system dynamics, First order system and Second order system design.	**04**
5.	**Controllers** Programmable Logic controllers: Introduction of PLC, PLC architecture, Input-Output Modules, Memory structure of PLC. Ladder Diagram and PLC programming Fundamentals: Basic I/O symbols, Fundamentals of ladder diagram, machine control terminology, scan cycle (Update- solve ladder - update), physical components Vs. program components Microprocessor (8085) and Microcontroller (8051): Microcontroller: Comparison between microprocessor and micro controller, organization, architecture, pin diagram.	**10**
6.	**Mechatronics System Design** User requirement specifications (URS), Steps in mechatronics system design, Case Studies of Mechatronics System: Tank Filling System. Automatic Staircase Lightning System, Dairy Automation, Industrial Automation	**04**

References:

Text Books:

- Bolton W., Mechatronics, Pearson Education.
- Mahalik, Mechatronics, TATA McGraw Hill.
- Hackworth J., Hackworth J., Programmable Logic Controller, Pearson Education.
- Alciatore D., Histand M. B., Introduction to Mechatronics & Measurement Systems, McGraw Hill.

Reference Books:

- Gaokar, Microprocessor 8085, Penram Publication.
- Appu Kuttam, Mechatronics, Oxford Publications.
- Morris S. Brain, Automated Manufacturing Systems, McGraw Hill.
- Webb Reis, Principles and Applications of Programmable Logic Controllers, Prentice Hall.
- Ramchandran, Mechatronics and Microprocessor, Wiley India.
- Ramchandran, Mechatronics: Integrated Mechanical Electronic System, Wiley India.
- Braga N. C., Mechatronics Source Book, Cengage Learning.
- Shetty Devdas, Kolk R. A., Mechatronics System Design, Cengage Learning.

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2022-26 Batch
Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 459**	Course Name: **Additive Manufacturing (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

This course provides a comprehensive understanding of Additive Manufacturing (AM) technologies, covering their principles, applications, and key considerations in design, material selection, and process optimization. It explores the entire AM process chain, including CAD modeling, STL file generation, software manipulation, machine setup, and post-processing techniques such as support material removal, surface texture improvement, and accuracy enhancement. The course delves into the significance of material selection and its impact on product quality, performance, and cost, while addressing challenges in process planning and control. Additionally, students will examine quality control methods, inspection techniques, and common software issues related to STL files. By the end of the course, students will be equipped with the skills to effectively select AM processes and materials, optimize production workflows, and apply AM technologies in various industries, including aerospace, automotive, and medical sectors.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Recognize the Importance of additive manufacturing technologies and their applications.
2. Evaluate the AM process chain and post-processing for improved component quality and accuracy.
3. Analyze and categorize different additive manufacturing processes, assessing their suitability for various applications.
4. Optimize designs for additive manufacturing by employing advanced design principles.
5. Assess the impact of process and material selection additive manufacturing and address software issues.
6. Explore the integration of reverse engineering with additive manufacturing for industrial solutions.

Prerequisite:

Basic Engineering Principles, CAD software (e.g., AutoCAD, SolidWorks), Materials Science and Manufacturing Processes.

Course Content

Unit No	Description	Hrs.
1.	**Basic Principles of Additive Manufacturing** Introduction to Additive Manufacturing, Distinction between Additive Manufacturing & CNC machining, Importance of Additive Manufacturing, Additive Manufacturing in Product Development, Issues in layered manufacturing, Advantages of Additive Manufacturing Additive Manufacturing Applications: Aerospace, Defense, Automobile, Bio-	08

	medical and general engineering industries.	
2.	**Additive Manufacturing Process Chain** Steps in Additive manufacturing, CAD Modelling for 3D printing, Conversion to STL, Additive Manufacturing Software, STL file manipulation, Machine setup. **Post Processing:** Overview of support material removal, Surface texture improvement, Accuracy improvements, Aesthetic improvements and heat treatments, Quality Control in AM: Standards and inspection techniques.	**04**
3.	**Additive Manufacturing Processes** Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.	**06**
4.	**Design for Additive Manufacturing** Design Principles: Exploring design freedoms and unique capabilities, Process Parameters and Optimization, Part orientation and support generation; Design of support structure for Additive Manufacturing, Topology Optimization: Hollowing out parts, Inclusion of Undercuts, Interlocking Features, Reduction of Assembly Components, Identification of markings/ numbers etc., Tool and techniques for DFMA.	**06**
5.	**Process & Material Selection** Introduction, Impact on product quality, performance, and cost, selection methods for a part, selection challenges, Significance of material selection in AM, Factors Influencing Material Selection, production planning and control, Software issues in Additive Manufacturing, problems with STL file, STL file manipulation.	**06**
6.	**Integration of Reverse Engineering with Additive Manufacturing** Basics of Reverse Engineering: Definitions, importance, and applications, Reverse Engineering Techniques: 3D scanning, point cloud data processing, and CAD model generation, Applications in repairing, prototyping, and legacy part reproduction, Future Trends	**06**

References:

Text Books:

- Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, World Scientific.
- Kamrani A.K., Nasr E.A., Rapid Prototyping: Theory and Practice, Springer.
- Liou L.W., Liou F.W., Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press.

Reference Books:

- Gibson I., Rosen D.W., Stucker B., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.

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Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 461**	Course Name: **Mechatronics and IoT (PE-IV)**

L	T	P	Credits
3	--	--	3

Course Description:

Most mechanical engineering systems today involve significant amounts of electrical and electronic control systems. Effectively, most modern mechanical engineering systems are mechatronic systems. Mechatronics is the discipline that results from the synergetic application of electrical, electronic, computer, and control engineering in mechanical engineering systems. Thus, it is essential for the mechanical engineer to have a strong understanding of the composition and design of mechatronic systems, which is the goal of this course. Mechatronic systems are around us everywhere. In mechanical engineering, the Internet of Things (IoT) plays a crucial role. Real-time data and efficiency: IoT enables the networking of machines and systems, allowing real-time data collection and analysis. This data opens new possibilities to make industrial production more sustainable, efficient, and productive.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Identify mechatronic systems, their components, and Boolean logic principles.
2. Analyze electrical circuits, actuators, and feedback devices for mechatronic applications.
3. Design signal processing circuits and develop PLC programs for automation.
4. Compare microprocessor and microcontroller architectures and their interfacing techniques.
5. Implement IoT-based hardware platforms and interface sensors, actuators, and communication protocols.
6. Apply mechatronics and IoT technologies to real-world applications in smart systems and automation.

Prerequisite:

Mechanics, Electromagnetism, Measurements, System Design & Dynamics and Control Engineering, Computer Programming.

Course Content

Unit No	Description	Hrs.
1.	**Basics of Mechatronics** Definition of Mechatronics, examples of mechatronics systems, components of mechatronics system, the multi-disciplinary process. Applications of Mechatronics in real world. basics of Boolean logic, logic gates, designing basic logic circuits.	06
2.	**Electrical & Electronics Principles** Basic electrical components (resistors, capacitors inductors), analyzing and solving simple electrical circuits, Introduction to actuators, analogy between	06

	electrical and magnetic circuits, motor and generator principle, types of actuators-general introduction to motors, feedback devices -shaft encoders-incremental and absolute encoders, LVDT, Accelerometer.	
3.	**Signal Processing & Controllers** Operational amplifier circuits, filtering circuits, Analog and digital signal conversion, system dynamics, Programmable Logic controllers: Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Ladder Diagram and PLC programming, Microprocessor (8085) and Microcontroller (8051): Microcontroller: Comparison between microprocessor and micro controller, organization, architecture, pin diagram, addressing modes, instruction types and sets, elementary programs, interfacing input and output ports, serial and parallel interfacing requirements, buffers, handshaking, polling and interrupts, Applications -microprocessor and microcontroller based, data acquisition system.	06
4.	**Introduction to the Internet of Things (IoT)** Overview, History, Definition and Characteristics, Connectivity Terminologies, building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine (M2M) communications, IoT Vs M2M, IoT Levels and Templates, Design Methodology, Various Platforms for IoT, Real time Examples of IoT.	06
5.	**IoT Simulation Environment Hardware platforms and Endpoint Interfacing** IoT supported Hardware platforms: Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Raspberry Pi, ESP), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I2C), Programming with LED interfacing, Key interfacing, LCD interfacing, Sensor interfacing, Relay interfacing. Combined programming with sensors, actuators, LCD and relay.	06
6.	**Applications and case studies of Mechatronics and IoT** Future Factory Concepts, Smart Homes, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring, Retail, Logistics, Security, Health, Legal challenges, IoT in Environmental Protection Modern Day IoT Applications, Smart Grid, Smart Cities Data Aggregation for the IoT in Smart Cities	06

References:

Text Books:

- Bolton W, Mechatronics, Pearson Education.
- Mahalik Mechatronics, TATA McGraw Hill.
- Hackworth W, Hackworth J, Programmable Logical Controller, Pearson Education.
- Alciatore D, Histand MB, Introduction to Mechatronics & Measurement Systems, McGraw Hill.
- Bahga A, Madisetti V, Internet of Things - A Hands-on Approach, Universities Press.
- Hajjaj SSH, Gsangaya KR, The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers, CRC Press.
- Raj P, Raman AC, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Auerbach Publications/CRC Press.
- McEwen A, Cassimally H, Designing the Internet of Things, John Wiley & Sons.

Reference Books:

- Gaokar, Microprocessor 8085, Penram Publication.
- Appu Kuttam, Mechatronics, Oxford Publications.
- Morris SB, Automated Manufacturing Systems, McGraw Hill.
- Webb R, Principles Applications Programmable Logical Controller, Prentice Hall India.
- daCosta F, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications.
- Waher P, Learning Internet of Things, Packt Publishing.
- Ovidiu V, Friess P, Internet of Things - From Research and Innovation to Market Deployment, River Publishers.
- Ida N, Sensors, Actuators and Their Interfaces, SciTech Publishers.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4074**	Course Name: **Mechanical System Design Lab**

L	T	P	Credits
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Course Description:

This lab course is introduced to have insight of complete design procedure of mechanical system involving design, drafting. It is very important at this stage to understand, appreciate and integrate all design activities for designing and developing successful mechanical system.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Design a mechanical system using standard design procedure.
2. Apply appropriate standards for engineering design and analysis.
3. Develop production drawing with standard conventions.
4. Carry out structural analysis of mechanical component.

Prerequisite:

Strength of Material, Failure Theories and Design of Mechanical Components.

Course Content

Unit No	Description	Hrs.
1.	**Introduction to Mechanical Systems** A visit to workshop/lab is to be arranged to show actual mechanical systems/sub systems like gearbox, clutch, brake, machine tools, shaft arrangements, bearings and bearing housings etc. to understand relative arrangement of different mechanical components.	02
2.	**Design of Mechanical System** 1. Selection of mechanical system and complete design. System may be selected from following list. i) Gear box ii) Concrete mixture A detailed design report giving all necessary calculations of the design of components and assembly is to be prepared. Design data book and design standards must be used to select materials and standard components.	12
3.	**Preparing Production Drawing** The production drawings are to be prepared using a suitable drafting/modelling software. Detailed drawings of individual components must have manufacturing tolerances, surface finish symbols and geometric tolerances to make it a production drawing. Assembly drawing should have a parts list and overall dimensions. Printouts of the detailed and assembly drawings are to be taken on A3 size sheets.	06

4.	Structural analysis of selected components of designed system.	4

References:

Text Books:

- V. B. Bhandari, Design of Machine Elements, Tata McGraw hills.

Reference Books:

- Robert L Norton, Machine Design Integrated Approach, Tata McGraw-Hill.
- PSG, Design Data Book, Kalaikathir Achchagam.
- RK Jain, Machine Design, Khanna Publications.
- Gitin M Maitra, Handbook of Gear Design, Tata McGraw-Hill.
- Pandya Shah, Machine Design, Charotar Publishing House.
- MF Spotts, Design of Machine Elements, Prentice Hall.
- H Burr, Cheata, Mechanical Analysis and Design, Tata McGraw-Hill.
- Machine Design Data Book, Tata McGraw-Hill.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4094**	Course Name: **Industrial Engineering and Quality Control**

L	T	P	Credits
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Course Description:

The courses in industrial engineering are designed to produce engineers specializing in problem solving and decision-making functions. This lab course gives a practical orientation to the industrial engineering methodologies with particular reference to classical industrial engineering and ergonomics. This lab course also covers some modern tools used by industrial engineers along with traditional methods for work system design, inventory management and quality management techniques.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Perform work and method study at given work station by using suitable industrial engineering tools.
2. Design the work system for the given application.
3. Apply inventory management principles for controlling the inventory.
4. Conduct process capability analysis.
5. Use modern tools and techniques for solving industrial engineering problems.

Prerequisite:

Industrial Engineering.

Course Content

Unit No	Description	Hrs.
1.	Time Study using stop watch and video-based timer pro software.	02
2.	Method study using traditional method and using timer pro software.	02
3.	Performance rating for various case studies.	02
4.	Two handed process flow charts.	02
5.	Multiple activity chart.	02
6.	Treadmill and Ergo cycle Experiment.	02
7.	Ergonomic study using anthropometric kit.	02
8.	Work Sampling study.	02
9.	Process capability study.	02
10.	Use of Lingo Software for solving Inventory models.	02
11.	Use of Lingo Software for solving Assembly line balancing problems.	02

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12.	Use of Lingo Software for solving Scheduling problems.	**02**

References:

Text Books:

- KC Jain and LN Agarwal, Production Planning and Control, Khanna Publishers.
- M Mahajan, Production Planning and Control, Dhanpat Rai & Co.
- Martand Telsang, Industrial Engineering and Production Management, S Chand & Co.

Reference Books:

- R Paneerselvam, Production and Operations Management, PHI Publications.
- OP Khanna, Industrial Engineering and Management, Dhanpat Rai & Co.
- HB Maynard, Industrial Engineering Handbook, McGraw Hill Book Company.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4114**	Course Name: **Metrology and Measurement Lab**

L	T	P	Credits
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Course Description:

Metrology and quality control is offered as the Lab course at the seventh semester of Engineering undergraduate program in Mechanical Engineering. It focuses on Metrology; a knowledge of engineering Metrology & its practice is of ever-increasing importance in industry. Metrology concerns the establishment of units of measurement, the development of new measurement methods and realization of measurement. Also, it consists of the principle and working of precise Machines as CMM and its application in engineering industry. Another part of the lab Mechanical measurement introduces students to the principles and applications of measurement techniques used in engineering. It includes hands on experiments such as force measurement, temperature measurement calibration of thermocouples etc. which emphasizes understanding sensor operation, data acquisition and instrument calibration, providing practical skills essential for engineering applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Use Vernier Calliper, Vernier Height Gauge, and Micrometre, V-block for accurate linear and angular Measurement
2. Measure screw thread terminology by using use the Tool Makers Microscope.
3. Measure the straightness using Autocollimator
4. Measurement of screw thread parameter using floating carriage micrometre.
5. Determine amount of variation in the process by using Measurement System Analysis
6. Use load cell for measurement of Force.
7. Select suitable tachometer for speed measurement.

Prerequisite:

Metrology and Measurement techniques.

Course Content		
Unit No	**Description**	**Hrs.**
1.	Use of linear and angle measuring instruments.	**02**
2.	Use of Tool Maker's microscope.	**02**
3.	Use of Autocollimator for measurement straightness.	**02**
4.	Use of floating carriage diameter measuring machine.	**02**
5.	Use of MSA.	**02**

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6.	Force measurement using load cell.	**02**
7.	Temperature measurement using Thermocouple, RTD, and Thermistors.	**02**
8.	Calibration of Thermocouple.	**02**
9.	Pressure gauge calibration using dead weight pressure gauge tester Speed.	**02**
10.	Displace measurement using LVDT.	**02**
11.	Speed measurement using Inductive pick up, Drag cup tachometer and stroboscope.	**02**
12.	Measurement of vibration.	**02**

References:

Text Books:

- IC Gupta, Engineering Metrology, Dhanpat Rai Publications.
- RK Jain, Engineering Metrology, Khanna Publisher.
- DS Kumar, Mechanical Measurement and Control, Metropolitan Book.

Reference Books:

- P Narayana, Engineering Metrology, SciTech Publication.
- P Narayana et al., Metal Working and Metrology, SciTech Publication.
- KR Nambiar, Lasers: Principles, Types and Applications, New Age International Limited Publishers.
- C Dotson, R Harlow, and R Thompson, Fundamentals of Dimensional Metrology, Thomson Delmar Learning, Singapore.
- John A Bosch, Coordinate Measuring Machines and Systems, Marcel Dekker Inc.
- JM Juran and FM Gryna, Quality Planning and Analysis, Tata McGraw Hill.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4134**	Course Name: **Workshop Practice III (IR4)**

L	T	P	Credits
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Course Description:

This course provides hands-on experience in advanced manufacturing technologies, focusing on robotics, automation, 3D printing, and precision machining. Students will learn to model mechanical components using CAD software, generate STL files, and simulate CAD data in CURA software for G-code generation. The course also covers the fabrication of 3D-printed parts, including post-processing techniques. Students will explore the operation and programming of industrial robots, including 6-axis and 7-axis articulated robots for tasks like pick-and-place and welding applications. Additionally, the course includes practical exposure to laser cutting machines, bending machines, powder coating processes, and the operation of retrofit CNC machines.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Model mechanical components using CAD software and simulate CAD data to create G-code for 3D printing.
2. Fabricate 3D-printed parts and apply post-processing techniques to enhance component quality and functionality.
3. program industrial robots (6-axis and 7-axis) to execute motion tasks, including pick-and-place operations and welding applications.
4. Perform machining operations on retrofit CNC machines and measure machining responses.
5. Use laser cutting machines and bending machines to produce precision components, applying proper techniques and safety protocols.
6. Apply theoretical and practical knowledge of modern manufacturing processes aligned with Industry 4.0 standards.

Prerequisite:

Machine tools, Machine Drawing, CAD.

Course Content

Unit No	Description	Hrs.
1.	Modeling Mechanical Components using CAD Software	02
2.	Simulation of CAD Data in CURA Software and G-Code Generation for Mechanical Components	02
3.	Fabrication of a 3D-Printed Part and Post-Processing Techniques	02
4.	Introduction to Industrial Robots: Structure, Components, and Demonstration of	02

	6-Axis and 7-Axis Articulated Robots	
5.	Programming Linear and Circular Motion Tasks with a 6-Axis Articulated Robot for Pick-and-Place Operations	**02**
6.	Development of Welding Application Programs Using a 7-Axis Articulated Robot	**02**
7.	Programming of Laser Cutting Machine and operating for the precision fabrication.	**02**
8.	Sheet Metal Forming: Hands-On Experience with Bending Machines	**02**
9.	Programming and Executing Basic Machining Operations on a Retrofit CNC Machine	**02**
10.	Measurement of responses like surface roughness and tool wear during Retrofit CNC operations.	**02**

References:

Text Books:

- JC Brown, Engineering Design Graphics: Sketching, Modeling, and Visualization, Pearson Education.
- WC Oakes, CAD for Engineers: An Introduction to Computer-Aided Design and Modeling, Wiley.
- MP Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson.
- JJ Craig, Introduction to Robotics: Mechanics and Control, Pearson Education.

Reference Books:

- JC Brown and JS McGhee, Industrial Robotics: Technology, Programming, and Applications, Prentice Hall.
- MW Spong, S Hutchinson, and M Vidyasagar, Robot Modeling and Control, Wiley.
- J Jones and D Roth, Robot Programming: A Practical Guide to Behavior-Based Robotics, McGraw-Hill.
- RR Smith, Welding Robots: The New Industrial Revolution, Industrial Press.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4634**	Course Name: **Mechanical Vibration Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

This laboratory course emphasizing the importance of hands-on learning in the field of vibration analysis, particularly within a laboratory setting. By allowing students to verify fundamental design principles experimentally, they're not only gaining theoretical knowledge but also understanding how those principles translate to real-world applications. This kind of practical experience is crucial for anyone working in fields like mechanical engineering, civil engineering, or product design. The focus on experimental dynamic analysis techniques is key as well—understanding how vibration affects different systems can be crucial for designing products that are durable, efficient, and safe.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Estimate natural frequencies and mode shapes of given machine component.
2. Find modal parameters of vibratory system.
3. Control the vibration by using principle of DVA
4. Apply vibration measurement techniques for fault diagnosis and machinery health monitoring

Prerequisite:

Applied Mechanics, Mechanical Vibration, Engineering Mathematics.

Course Content

Unit No	Description	Hrs.
1.	Find the natural frequencies of an automobile component	02
2.	Find the equivalent stiffness of a spring-mass system of SDOF	02
3.	Find shear modulus of a rod by natural frequency measurement of torsional system	02
4.	Estimate the damping factor of a given spring-mass-damper system	02
5.	Find equivalent viscous damping for structural damping	02
6.	Verification of principle of dynamic vibration absorber	02
7.	Estimation of mode shapes and natural frequencies of a circular plate	02
8.	Measurement of overall vibration level of a machine	02
9.	Diagnosis of fault by vibration measurement of a machine	02
10.	Find vibration isolation efficiency of a machine	02

References:

Text Books:

- Singiresu S Rao, Mechanical Vibrations, Pearson Education.
- WT Thompson, Theory of Vibration, CBS Publishers.
- Clarence W de Silva, Vibration: Fundamentals and Practice, CRC Press LLC.
- R Venkatachalam, Mechanical Vibrations, PHI.

Reference Books:

- L Meirovich, Elements of Vibration Analysis, Tata McGraw-Hill.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4654**	Course Name: **Experimental Stress Analysis Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

This course is intended to develop skill sets namely critical thinking, evaluating and decision making regarding the fail-safe design of mechanical component within the purview of experimental stress analysis techniques. Under graduate students of final year mechanical shall work on casting techniques of photo-elastic model, use of plane polariscope, circular polariscope, reflection polariscope and employ strain gauge technique to determine the state of stress at the point of interest.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply photoelastic technique to measure state of stress in the machine component.
2. Apply strain gauge technique to determine state of strain at the critical location in the structural member.

Prerequisite:

Physics, Strength of Material and Machine design.

Course Content

Unit No	Description	Hrs.
1.	Sheet casting and preparation of photo elastic model.	02
2.	Calibration of photo elastic materials and determining the material stress fringe value parameter	02
3.	Determination of fractional fringe order using transmission Polariscope	02
4.	Separation of stresses using oblique incidence method.	02
5.	Determination of strain/stresses in photo elastic coating by using reflection Polariscope	02
6.	Bonding of strain gauge as per manufacturer guidelines and checking the correctness of installation	02
7.	Determination of gauge factor for one arm sensitive and two arm sensitive configurations.	02
8.	Determination of gauge factor for four arm sensitive and two linear and two lateral configurations.	02
9.	Transducer applications of strain gauge-determination of unknown weight using load cell.	02
10.	Transducer applications of strain gauge–determination of unknown torque using torque transducer.	02

11.	Validation of experimental and numerical results for a given structural member (beam or plate with a hole)	

References:

Text Books:

- Sadhu Singh, Experimental Stress Analysis, Khanna Publishers.
- J Srinivas, Stress Analysis and Experimental Techniques, Narosa Publishing House Pvt. Ltd.
- JW Dally and WF Riley, Experimental Stress Analysis, McGraw Hill.
- Abdul Muben, Experimental Stress Analysis, Dhanpat Rai & Co.

Reference Books:

- Perry Lissner, The Strain Gauge Primer, McGraw Hill Publications.
- AL Window, Strain Gauge Techniques, Springer Publications.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 467**	Course Name: **Engineering Tribology Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

This Lab provides hands-on experience with advanced experimental setups such as the pin-on-disk apparatus, abrasive wear test rig, four-ball tester, and modular compact rheometer. Students will conduct experiments to analyze friction, wear, and lubrication characteristics under various operating conditions. This course emphasizes understanding tribological behavior, evaluating material performance, and applying principles of tribology to solve real-world engineering problems.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Evaluate the friction and wear characteristics of different materials under various conditions.
2. Assess the performance of lubricants and additives using the four-ball tester and understand their role in minimizing wear and friction.
3. Measure the rheological properties of materials and interpret their behavior in tribological systems.

Prerequisite:

Engineering Chemistry, Fluid Mechanics, Strength of Material.

Course Content (Any **TEN** Experiments from below list)

Unit No	Description	Hrs.
1.	Study the effect of load on dry adhesive wear test.	02
2.	Study the effect of rotational speed of disk on dry adhesive wear test.	02
3.	Study the effect of load on adhesive wear under lubricating conditions.	02
4.	Study the effect of rotational speed of disk on the adhesive wear of specimen under lubricating conditions.	02
5.	Characterize the given engineering material by using MCR-52 Rheometer.	02
6.	Synthesis and characterize given smart material by using MCR-52 Rheometer.	02
7.	Measure the viscosity and compare Newtonian and Non-Newtonian fluids.	02
8.	Study the effect of abrasive particle size on wear rate.	02
9.	Study the temperature-dependent friction and wear.	02
10.	Study the phase transformation due to frictional heating.	02

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11.	Measure the performance of lubricants with respect to wear.	**02**
12.	Study the slurry-erosion wear of ductile and brittle materials.	**02**
13.	Determine ability of lubricants to function under extreme pressure conditions.	**02**

References:

Text Books:

- BC Majumdar, Introduction to Tribology of Bearings, S. Chand and Company Ltd.
- Prasanna Sahoo, Engineering Tribology, PHI Learning Pvt. Ltd.
- Mervin H Jones and Douglas Scott, Industrial Tribology - The Practical Aspects of Friction, Lubrication and Wear, Elsevier Scientific Publishing Company Amsterdam-Oxford-New York.
- Cameron, A Basic Lubrication Theory, Wiley Eastern Ltd.

Reference Books:

- MJ Neale, Tribology Handbook, Butterworth's.
- Bharat Bhushan, Handbook of Tribology, Krieger Publishing Company.
- D Dowson, History of Tribology, Longman London.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 471**	Course Name: **Heating Ventilation and Air Conditioning Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

The HVAC Lab course provides students with hands-on experience in analyzing and evaluating various heating, ventilation, air conditioning, and refrigeration (HVACR) systems. Through a series of experiments, students will explore the performance of refrigeration systems, heat pumps, air conditioning setups, and humidification systems, using data acquisition systems and psychrometric tools. The course covers essential topics such as cooling load calculations, psychrometric analysis, and the evaluation of advanced HVAC technologies like Variable Refrigerant Flow (VRF) systems and desiccant dehumidifiers. Students will also study the impact of these systems on indoor air quality (IAQ) and energy efficiency in real-world industrial settings. This course equips students with practical knowledge to design, analyze, and optimize HVAC systems for diverse applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Analyze the Performance of HVAC Systems
2. Apply Psychrometric and Load Calculation Principles
3. Evaluate the Impact of Advanced HVAC Technologies on Indoor Air Quality (IAQ)

Prerequisite:

Thermodynamics, Fluid Mechanics and Heat Transfer.

Course Content		
Unit No	**Description**	**Hrs.**
1.	Performance Analysis of Refrigeration Systems.	02
2.	Performance Analysis of Heat Pump.	02
3.	Psychrometric Analysis of Psychrometric Test rig.	02
4.	Calculation of Cooling Load in a Room.	02
5.	Performance Analysis of Air Conditioning Setup with Computerized data acquisition system.	02
6.	Demonstration on Variable Refrigerant Flow (VRF) air conditioning System.	02
7.	Performance analysis of isothermal humidification system.	02
8.	Performance analysis of adiabatic humidification system.	02
9.	Performance analysis of solid desiccant dehumidification system.	02

10.	Study the IAQ of desiccant dehumidification system.	**02**
11.	Industrial Visit to a dairy plant/ice plant/cold storage.	**02**

References:

Text Books:

- Refrigeration and Air Conditioning, S.C. Arora, S. Domkundwar, 8th Edition, Dhanpat Rai & Co., 2017.
- Refrigeration and Air Conditioning, C.P. Arora, 3rd Edition, Tata McGraw-Hill, 2017.
- Refrigeration and Air Conditioning, R.K. Rajput, 2nd Edition, S. Chand Publishing, 2016.
- Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, 4th Edition, McGraw-Hill, 2013.
- Refrigeration and Air Conditioning, Manohar Prasad, 3rd Edition, New Age International, 2011.

Reference Books:

- Principles of Refrigeration, Roy J. Dossat, Thomas J. Horan, 5th Edition, Pearson Education, 2001.
- Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, Eugene Silberstein, 7th Edition, Cengage Learning, 2012.
- ISHRAE Handbook – 2015
- ASHRAE Handbook – Fundamentals, ASHRAE, Latest Edition.
- Handbook of Air Conditioning and Refrigeration, Shan K. Wang, 2nd Edition, McGraw-Hill, 2000.
- Refrigeration and Air Conditioning, Wilbert F. Stoecker, Jerold W. Jones, 2nd Edition, McGraw-Hill, 1982.

Online Resources:

- Refrigeration and Airconditioning Prof. M. Ramgopal Department of Mechanical Engineering Indian Institute of Technology, Kharagpur https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PLE2DA184A2E479885

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4734**	Course Name: **Internal Combustion Engines Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

The aim of this course is to provide students with a working knowledge and application of the I C Engines. During laboratory work hands on experience is given to handle engine by staring it, changing operating conditions and measure various parameter on both SI and CI engines. The focus is on explaining engine performance in terms of power, energy utilization and exhaust emissions.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Recognize the various parts, systems of IC engine, and disassemble an IC engine.
2. Perform various tests on different engines; plot various operating characteristics and compare it with standards.
3. Demonstrate and differentiate between fuel system of SI and CI engines.
4. Measure and correlate various engine emissions with standards.

Prerequisite:

Basic Mechanical Engineering, and Applied Thermodynamics.

Course Content		
Unit No	**Description**	**Hrs.**
1.	Engine systems (Air intake, exhaust, Cooling, Lubrication systems.)	02
2.	Ignition and starting systems.	02
3.	Carburetor and Petrol injection system.	02
4.	Fuel injection system of diesel engine.	02
5.	Test on four stroke petrol engines.	02
6.	Morse Test on multi cylinder Engine.	02
7.	Test on VCR I.C. Engine and measure engine emissions	02
8.	Trial on alternative fuel engine.	02
9.	Measurement of engine emissions	02
10.	Visit to an engine manufacturing company / repairing unit.	02

References:

Text Books:

- Mathur Sharma, Internal Combustion Engines, Dhanpat Rai Publications.
- V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publications.
- Ramlingam, Internal Combustion Engines, SciTech Publication Pvt. Ltd.

Reference Books:

- Domkundwar, A Course on Internal Combustion Engines (SI Units), Dhanpat Rai Publications.
- J. B. Heywood, Fundamentals of Internal Combustion Engines, McGraw Hill Publications.
- Gills Smith, Internal Combustion Engines, Oxford & IBH Publishing Co. Pvt Ltd.
- E. F. Obert, Internal Combustion Engines and Air Pollution, Harper & Row Publications

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4754**	Course Name: **Refrigeration and Air Conditioning Lab (PE-IV Lab)**

L	T	P	Credits
--	--	2	1

Course Description:

The Refrigeration and Air Conditioning Laboratory course provides hands-on experience in the operation, and performance analysis of refrigeration and air conditioning systems. Students will conduct experiments on variable load refrigeration systems, heat pumps, vapor absorption systems, and multi-stage refrigeration systems, while also estimating cooling loads for various applications. The course emphasizes troubleshooting, maintenance, and fault diagnosis through the use of advanced tools like fault analysis benches and Variable Refrigerant Flow (VRF) systems. Additionally, students will gain practical knowledge in refrigerant charging, leak testing, and the operation of refrigeration chambers and defrosting methods. Through these experiments, students will apply theoretical knowledge to real-world scenarios, developing practical skills essential for the field of refrigeration and air conditioning.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- Analyse refrigeration systems, to evaluate key performance indicators such as COP, temperature, pressure, and system efficiency.
- Estimate and analyse cooling loads for various applications, and evaluate the performance of air conditioning systems.
- Demonstrate troubleshooting and maintenance techniques for RAC systems, including refrigerant charging, leak testing, evacuation, and fault diagnosis with the use of refrigeration systems and fault analysis benches.

Prerequisite:

Thermodynamics, Fluid Mechanics and Heat Transfer.

Course Content (Any **TEN** Experiments from below list)

Unit No	Description	Hrs.
1.	Trial on variable load refrigeration system	02
2.	Trial on experiment on Heat Pump.	02
3.	Trial on experiment on air conditioning test rig.	02
4.	Estimate the cooling load of given application	02
5.	Trial on experiment on Vapor absorption system	02
6.	Trial on Fault Analysis Bench	02
7.	Trial on Variable Refrigerant Flow (VRF) air conditioning System	02

8.	Trial on Refrigeration Chamber and Defrosting Methods	**02**
9.	Trial on Refrigerant Filling and Evacuation Equipment	**02**
10.	Trial on Cascade system.	**02**
11.	Trial on liquid desiccant dehumidification system.	**02**
12.	Industrial Visit to a dairy plant/ice plant/cold storage	**02**

References:

Text Books:

- Refrigeration and Air Conditioning, S.C. Arora, S. Domkundwar, 8th Edition, Dhanpat Rai & Co., 2017.
- Refrigeration and Air Conditioning, C.P. Arora, 3rd Edition, Tata McGraw-Hill, 2017.
- Refrigeration and Air Conditioning, R.K. Rajput, 2nd Edition, S. Chand Publishing, 2016.
- Basic Refrigeration and Air Conditioning, P.N. Ananthanarayanan, 4th Edition, McGraw-Hill, 2013.
- Refrigeration and Air Conditioning, Manohar Prasad, 3rd Edition, New Age International, 2011.

Reference Books:

- Principles of Refrigeration, Roy J. Dossat, Thomas J. Horan, 5th Edition, Pearson Education, 2001.
- Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, Eugene Silberstein, 7th Edition, Cengage Learning, 2012.
- ISHRAE Handbook – 2015
- ASHRAE Handbook – Fundamentals, ASHRAE, Latest Edition.
- Handbook of Air Conditioning and Refrigeration, Shan K. Wang, 2nd Edition, McGraw-Hill, 2000.
- Refrigeration and Air Conditioning, Wilbert F. Stoecker, Jerold W. Jones, 2nd Edition, McGraw-Hill, 1982.

Online Resources:

- Refrigeration and Airconditioning Prof. M. Ramgopal Department of Mechanical Engineering Indian Institute of Technology, Kharagpur

  https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PLE2DA184A2E479885

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4774**	Course Name: **Automotive Engineering Lab (PE-IV Lab)**

L	T	P	Credits
--	--	2	1

Course Description:

Automobile engineering lab course covers in detail demonstration, description, selection and modelling of basic structure and various systems used in vehicles. This is application-oriented course, and it gives chance to students to apply their engineering concepts to design and select various systems and grab the latest technologies.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate practical skills by working with automotive components and systems.
2. Explain the principles of operation and evaluate the performance of vehicles.
3. Diagnose faults and perform maintenance tasks essential for the automotive industry.
4. Design solutions to address real-world automotive challenges using practical knowledge

Prerequisite:

Engineering Mechanics, Thermodynamics, Fluid Mechanics, Manufacturing Processes, Materials Science, Basics of Electrical and Electronics Engineering

Course Content (Any **TEN** Experiments from below list)

Unit No	Description	Hrs.
1.	Study of Automotive Chassis and Components	02
2.	Dismantle, inspect and reassemble the Single Plate Clutch. (Coil Spring Type/Diaphragm Type)	02
3.	Dismantle, inspect and reassemble the Synchro Mesh Gear Box.	02
4.	Dismantle, inspect and reassemble the Drum/Disc Brake.	02
5.	Dismantle, inspect and reassemble the Power Steering system. (Hydraulic/ Electronic Type)	02
6.	Construction details and working principle of suspension system of four-wheeler	02
7.	Performance test on two-wheeler using chassis dynamometer.	02
8.	Performance test on acceleration and breaking of four-wheeler.	02
9.	Study of Automotive Electrical Systems	02
10.	Emission Testing and Analysis	02
11.	Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators/Gauges etc.	02

12.	Diagnostic Tools and Troubleshooting	**02**

References:

Text Books:

- Kripal Singh, Automobile Engineering Vol. I, Standard Publisher's Distributors.
- N. K. Giri, Automobile Engineering, Khanna Publishers.
- S. Srinivasan, Automotive Mechanics, Tata McGraw Hill Publication.
- K. K. Ramalingam, Automobile Engineering, SCITECH Publication.
- R. K. Rajput, Automobile Engineering, Laxmi Publications.
- G. B. S. Narang, Automobile Engineering, Khanna Publishers.

Reference Books:

- Heinz Heisler, Advanced Vehicle Technology, Elsevier.
- Chhikara, Automobile Engineering Vol. II, Satya Prakashan.
- Newton K., Steeds W., Garrett T. K., Motor Vehicle, Society of Automobile Engineering.
- William H. Crouse, Automobile Engineering, Tata McGraw-Hill Education.
- P. W. Ketts, Motor Vehicle Science Volume 1.
- J. D. Harderman, C. D. Mitchell. Automotive Engines Theory & Servicing, Pearson Education.
- P. S. Kohali, Automobile Electrical Equipment.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 479**	Course Name: **Industrial Hydraulics and Pneumatics LAB (PE-IV Lab)**

L	T	P	Credits
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Course Description:

Hydraulic and Pneumatic operated machines and equipment are widely used in various industries due to their versatility and adaptability to automation. Mechanical engineers are required to maintain such systems in various segments of Industries This competency needs knowledge of construction and working of different components of hydraulic and pneumatic system. This course will give the students the basic skills and knowledge to use and maintain different types of hydraulic and pneumatic systems.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate various components of Hydraulics & Pneumatic System along with standard symbols.
2. Design and analyze basic hydraulic and pneumatic circuits using training kit.
3. Design and analyze electrohydraulic and electro pneumatic circuits using training kit.
4. Use software Automation Studio to design & simulate the fluid power circuits.

Prerequisite:

Fluid Mechanics, Basic Electrical Engineering and Engineering Mechanics.

Course Content

Unit No	Description	Hrs.
1.	Draw ISO symbols and identify components used in hydraulic and pneumatic circuit.	02
2.	Construct and actuate hydraulic circuit for SAC,DAC and hydraulic motor for given purpose.	02
3.	Construct and actuate meter In and Meter Out circuit for given purpose.	02
4.	Construct and actuate hydraulic circuit for given sequencing operation.	02
5.	Construct and actuate pneumatic circuit for SAC,DAC and hydraulic motor for given purpose.	02
6.	Construct and actuate speed control pneumatic circuit for given application.	02
7.	Construct and actuate indirect (pilot) controlled pneumatic circuit for given application.	02
8.	Construct and actuate pneumatic circuit for given sequencing operation.	02
9.	Construct and actuate pneumatic circuit for given Logic function,	02

	(AND,OR,TIME DELAY)	
10.	Construct and actuate electro pneumatic circuit/PLC circuit for given application.	**02**

References:

Text Books:

- Anthony Esposito, Fluid Power, Prentice Hall Publications.
- Stewart, Industrial Hydraulics and Pneumatics.
- H. P. Garg, Industrial Hydraulics and Pneumatics.
- S. R. Mujumdar, Oil Hydraulic Systems: Principles and Maintenance.

Reference Books:

- Vickers, Industrial Hydraulics Handbook.
- FESTO, Hydraulics-Basic Level TP501 Handbook.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 4814**	Course Name: **Mechatronics System Design Lab (PE-IV Lab)**

L	T	P	Credits
--	--	2	1

Course Description:

This course provides hands-on experience with industrial automation, sensors, and control systems. Students will demonstrate various sensors and their applications, develop ladder logic programming for PLC-based latching circuits, counters, and timers, and simulate motion control for a pneumatic double-acting cylinder. The course includes experiments on AC drive (VFD) speed control, stepper motor interfacing with an 8051 microcontroller, and displacement measurement using LVDT. Through practical implementation, students gain expertise in automation, motion control, and signal processing. An industrial visit enhances learning by providing real-world exposure to mechatronics applications in manufacturing and automation industries.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate the working principles and applications of various sensors used in mechatronic systems.
2. Develop ladder logic programs in PLC for latching circuits, counters, and timers.
3. Simulate the to-and-fro motion of a pneumatic double-acting cylinder using PLC programming.
4. Implement speed control of an AC drive (VFD) and stepper motor interfacing with an 8051 microcontroller for full-step and half-step resolution.
5. Analyze displacement measurement using LVDT and operational amplifiers in mechatronics applications.

Prerequisite:

Mechatronics System Design.

Course Content

Unit No	Description	Hrs.
1.	Demonstrate various sensors with applications	02
2.	Develop ladder logic in PLC programming for Latching Circuit	02
3.	Develop ladder logic in PLC programming on Counters	02
4.	simulate a program in PLC to repeat to and fro motion of a pneumatic Double acting cylinder.	02
5.	Develop ladder logic in PLC programming on timers.	02
6.	Demonstrate the Speed control of AC drive (VFD)	02

7.	Demonstrate Stepper motor interfacing with 8051 microcontroller i) Full step resolution	**02**
8.	Demonstrate Stepper motor interfacing with 8051 microcontrollers for half step resolution	**02**
9.	Demonstrate Op Amp/Displacement measurement using LVDT	
10.	Industrial Visit	

References:

Text Books:

- W. Bolton, Mechatronics, Pearson Education.
- Mahalik, Mechatronics, Tata McGraw Hill.
- Hackworth & Hackworth, Programmable Logical Controller, Pearson Education.
- David Alciatore, Michael B. Histand, Introduction to Mechatronics & Measurement Systems, McGraw Hill.

Reference Books:

- Gaokar, Microprocessor 8085. Penram Publication.
- Appu Kuttam, Mechatronics, Oxford Publications.
- S. Brain Morris, Automated Manufacturing Systems, McGraw Hill.
- Reis Webb, Principles Applications Programmable Logical Controller, Prentice Hall.
- Ramchandran, Mechatronics and Microprocessor, Wiley India.
- Ramchandran, Mechatronics: Integrated Mechanical Electronic System, Wiley.
- N. C. Braga, Mechatronics Source Book, Cengage Learning.
- Devdas Shetty & R. A. Kolk, Mechatronics System Design, Cengage Learning.

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2022-26 Batch
Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 483**	Course Name: **Additive Manufacturing Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

This course offers a comprehensive, hands-on introduction to Additive Manufacturing and Reverse Engineering. Students will learn to set up and operate FDM and DLP 3D printers, optimize print settings, and generate and manipulate STL files using Additive Manufacturing software. The course covers key post-processing techniques, including support removal, surface finishing, and quality control, ensuring high-quality prints. Students will also explore 3D scanning methods and learn to process scanned data into STL files for integration with Additive Manufacturing workflows. By the end of the course, students will gain valuable skills for careers in manufacturing, product design, prototyping, and reverse engineering.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate the setup and operation of various 3D printing technologies and optimize print settings.
2. Develop CAD models and generate STL files.
3. Manipulate STL files and adjust print settings using additive manufacturing software.
4. Implement post-processing techniques for 3D printed parts.
5. Apply 3D scanning technique, and process scanned objects into STL files for integration into 3D printing workflows.

Prerequisite:

CAD software (e.g., AutoCAD, SolidWorks), Manufacturing Processes and Material Science.

Course Content

Unit No	Description	Hrs.
1.	Demonstrate the setup and initialization of a 3D printer.	02
2.	Create 3D models using CAD software and generate STL files for 3D printing.	02
3.	Manipulate STL files and adjust print settings using additive manufacturing software.	02
4.	Conduct 3D printing on an FDM printer, utilizing both single and double nozzle arrangements.	02
5.	Execute 3D printing using a DLP printer.	02
6.	Design effective support structures and optimize print orientation.	02
7.	Apply multi-material and multi-color printing techniques.	02

8.	Perform post-processing techniques.	**02**
9.	Utilize a turntable for 3D scanning and prepare the model for further processing.	**02**
10.	Capture objects using movable mode 3D scanning.	**02**
11.	Process 3D scanned objects, refine the mesh, and prepare the STL file for subsequent 3D printing.	**02**
12.	Develop 3D printing filament using a filament extrusion machine.	

References:

Text Books:

- Chua Chee Kai & Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, World Scientific.
- Kamrani A. K. & Nasr E. A., Rapid Prototyping: Theory and Practice, Springer.
- Mohit Hemanth Kumar & Sasmita Bal, A Textbook on Additive Manufacturing Technologies, Nova Science Publishers.
- C. P. Paul & A. N. Jinoop, Additive Manufacturing: Principles, Technologies, and Applications, McGraw Hill Education.
- Wego Wang, Reverse Engineering: Technology of Reinvention, CRC Press.

Reference Books:

- Gibson I., Rosen D. W., & Stucker B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME 485**	Course Name: **Mechatronics and IoT Lab (PE-IV Lab)**

L	T	P	Credits
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Course Description:

This lab provides hands-on experience in integrating mechatronics and IoT-based systems for industrial automation and control. Students will work with various sensors, actuators, PLCs, and microcontrollers like Raspberry Pi to develop automation and monitoring solutions. Experiments include ladder logic programming for PLC-based control, motor speed regulation using VFD, and sensor interfacing for real-time data acquisition. Students will also design and implement IoT-based systems such as intrusion detection, temperature monitoring, and relay control. The course aims to enhance students' ability to develop and apply mechatronic systems for industrial and smart applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Demonstrate the working principles and applications of various sensors used in mechatronic and IoT systems.
2. Develop ladder logic programs in PLC for latching circuits, counters, and timers.
3. Simulate the to-and-fro motion of a pneumatic double-acting cylinder using PLC programming.
4. Implement speed control of an AC drive (VFD) and directional control of a DC motor using Raspberry Pi.
5. Design IoT-based systems for applications such as LED control, temperature sensing, and intrusion detection.
6. Integrate Raspberry Pi with sensors and actuators for industrial automation and control applications.

Prerequisite:

Mechatronics System Design and IoT.

Course Content

Unit No	Description	Hrs.
1.	Demonstrate various sensors with applications	02
2.	Develop ladder logic in PLC programming for Latching Circuit	02
3.	Develop ladder logic in PLC programming on Counters	02
4.	simulate a program in PLC to repeat to and fro motion of a pneumatic Double acting cylinder.	02
5.	Develop ladder logic in PLC programming on timers.	02
6.	Speed control of AC drive (VFD).	

7.	Controlling the LED blink rate with the potentiometer interfacing with Raspberry Pi.	**02**
8.	Interfacing of temperature sensor LM35 with Raspberry Pi.	**02**
9.	Building Intrusion Detection System with Raspberry Pi and Ultrasonic Sensor.	**02**
10.	Directional Control of the DC motor using Raspberry Pi.	**02**
11.	Interfacing of the Relay with Raspberry Pi.	**02**

References:

Text Books:

- W. Bolton, Mechatronics, Pearson Education.
- Nitaigour Premchand Mahalik, Mechatronics, Tata McGraw Hill.
- Hackworth & Hackworth, Programmable Logical Controller, Pearson Education.
- David Alciatore & Michael B. Histand, Introduction to Mechatronics & Measurement Systems, McGraw Hill.
- Bahga A. & Madisetti V., Internet of Things - A Hands-on Approach, Universities Press.
- Hajjaj S. S. H. & Gsangaya K. R., The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers, CRC Press.
- Raj P. & Raman A. C., The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Auerbach Publications/CRC Press.
- Adrian McEwen & Cassimally H., Designing the Internet of Things, John Wiley and Sons.

Reference Books:

- Gaokar, Microprocessor 8085, Penram Publication.
- Appu Kuttam, Mechatronics, Oxford Publications.
- S. Brain Morris, Automated Manufacturing Systems, McGraw Hill.
- Reis Webb, Principles Applications Programmable Logical Controller, Prentice Hall India.
- daCosta F., Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications.
- Waher P., Learning Internet of Things, Packt Publishing.
- Ovidiu V. & Friess P., Internet of Things - From Research and Innovation to Market Deployment, River Publishers.
- Ida N., Sensors, Actuators and Their Interfaces, SciTech Publishers.

Class: **Final Year B. Tech**	Semester-**VII**
Course Code: **ME**	Course Name: **Capstone Project Phase-II**

L	T	P	Credits
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Course Description:

Capstone project is designed to encourage students to think critically, solve challenging problems, and develop skills such as oral communication, public speaking, research skills, media literacy, teamwork, planning, self-sufficiency, or goal setting. In most cases, the projects are also interdisciplinary, in the sense that they require students to apply skills or investigate issues across many different subject areas or domains of knowledge. Capstone projects also tend to encourage students to connect their projects to community issues or problems, and to integrate outside-of-school learning experiences. Ultimately, a capstone project represents new work and ideas, and gives the opportunity to student to demonstrate the knowledge and skills they have gained during college career. The students in a group of not more than FOUR will work under the guidance of the project supervisor on the project undertaken by them.

The project work may consist of,

1. To search and select an appropriate topic for capstone project work, in view of new innovations, new product, and solutions to long standing problems.
2. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
3. Prepare and refine project proposal to the point where student should demonstrate that it is worthy of undertaking and should be completed in the time available.
4. Prepare well defined project plan with budget linked to project activities and outcomes.
5. Apply appropriate methodology to solve critical engineering problems.
6. Design and development of equipment, components and test setup.
7. Conduct experiment and test product and processes for various parameters and interpret the results obtained.
8. Write the technical report.

The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working and to expose them to industry. Also, to provide students with an opportunity of integrating and applying knowledge from different disciplines of mechanical engineering to conduct an engineering project that is open-ended and requires team collaboration for its completion. Capstone projects can effectively consolidate and further develop generic skills in a disciplinary and interdisciplinary context

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Select and apply appropriate design of experiments, experimental set up, models, or simulation technique for project task.
2. Fabricate project or experimental set up, or model and analyze output of models/simulations to provide information for decisions

3. Perform feasibility analysis and uses results to choose candidate solutions and evaluates quality of solutions to select the best one
4. Collaborates with team members of diverse background and perspectives to achieve a common goal.
5. Write technical report and communicate effectively.

Prerequisite:

1. In-depth understanding of all the subjects learned so far.
2. Two weeks in-plant training must be completed.
3. Capstone project phase I must be completed.

Course Content

Students should complete following work during semester-VIII
Design of Product or Process, Analysis, Experimentation /Fabrication, Testing, Modification, Final Report Preparation.

Course Assessment:
Projects will be evaluated using Rubrics that assess

- interim progress presented at the end of the first semester
- the design, development and final solution assets
- the final written report
- the final oral presentation
- Interpersonal Skills Rubric

Rubrics used to assess the above are provided in appendices C. Performance of each student should be assessed individually together with the team's overall performance by the supervisor, Group chairman and committee by using using the rubrics provided in the Appendices. The project committee should consist of at least four academic staff with project supervisor. The average scores of all supervisors for each rubric are combined using the following percentages to get a weighted average grade point.

Phase-II	
Rubric	**Weight**
Design Development & Solution Assets, Interpersonal Skills Rubric	60%
Final Written Report	20%
Final Presentation	20%

Industry Internship (II)

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **OE4382**	Course Name: **Finance for Engineers (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:

In today's workplace, it is nearly impossible for an engineer to perform without considering the financial impact of every action on the organization's bottom line. Engineers need to be aware of issues such as cost reduction and capital investment and how their decisions can affect the financial statements. This course introduces basic financial management to engineers and technical personnel who need this knowledge to manage a profit center effectively. The course aims at providing students with an in-depth coverage of the various aspects of financial management.

It covers the assessing the financial health of the organization through ratio and cash flow analysis, sources of long term as well as short term finance. Decisions concern with financing, working capital and long term investment. Class will focus on both the academic theories underlying the management of funds and the practical aspects of financial management.

Course Learning Outcomes:

After successful completion of this course, students will be able to,

1. Discuss the fundamental aspects of accounting and finance.
2. Apply theoretical knowledge and information for preparing various financial statements.
3. Analyze the financial information for solving managerial problems.
4. Evaluate financial performance of the organization for effective decision making.

Prerequisite:

Basics of Mathematics

Course Contents

Unit No	Description	Hrs
1.	**Finance Terminologies & Financial Statement** Key terms of Accounting and Finance, Accounting Principles underlying Preparation of Financial Statements	4
2.	**Analyzing Health of a Firm** Techniques of Analyzing Health of a Firm, Classification of Ratios – Liquidity, Leverage, Activity, Profitability, Analysis of Cash Flows	4
3.	**The Management of Working Capital** Need of Working Capital, Operating Cycle of Working Capital, Determinants of Working Capital, Preparation of Working capital statement	4
4.	**Investment Decision Rules** Investment Decision Rules, Evaluation Criteria for Investment Decision: Payback, ARR, NPV, PI & IRR, Decision Tree Analysis	4

5.	**Long Term Financing** Long Term Finncing: Shares, Debentures, Loan capital, foreign capital, FDI, Euro issues & external borrowings, Venture capital financing.	4
6.	**Financing Decisions and Cost of Capital** Risk & Return, Cost of Capital, Cost of Equity, Cost of Debt, Weighted Average Cost of Capital	4

References:
Reference Books:

1. Paul Kimmel, J. Weygandt, D. Kieso, Financial Accounting
2. S.N. Maheshwari & S.K. Maheshwari, Problems & Solutions in Advanced Accountancy, Vikas Publishing House Pvt. Ltd., New Delhi
3. M.C. Shukla, T.C. Grewal & S. C. Gupta, Advanced Accounts, S. Chand
4. M. Y. Khan & P. K. Jain, Financial Management, Tata McGraw-Hill Publishing Company Limited, New Delhi
5. Prasanna Chandra, Financial Management, Tata McGraw-Hill Publishing Company Limited.

Note: Being ne course, lectu vidos each unit will be made available through college 1JTJETQq0.000008871

submit all assignments within specified time.
Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam.
Final exam will be held at college campus.

Class: **Final Year B. Tech.**	Semester- **VIII**
Course Code: **OE4362**	Course Name: **Engineering Management & Economics (Online Course)**

L	T	P	Credits
2	-	-	2

Course Description:
Engineering management is the integration of management principles with engineering practices. It is a specialized field that focuses on effectively leading engineering teams and managing technical projects. This course is structured into two key modules: Engineering Management and Engineering Economics. The first module is centered on building the managerial skills necessary to guide, mentor, and inspire technical professionals in their engineering roles. The second module delves into engineering economics, a vital area for engineering firms to maintain their competitive advantage and market presence, focusing on economic decision-making.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Develop administrative, organizational, and planning skills to effectively manage and execute engineering projects.
2. Create bar charts and milestone charts to track and manage project progress.
3. Analyze profit and cost data, conducting economic evaluations to make informed, optimal decisions.
4. Calculate depreciation using various methods.

Prerequisite: Basics of Mathematics

Course Content

Unit No	Description	Hrs
1	**Managerial skills** Theories of Management Principles of Management (by Henry Fayol), Functions of Management, Planning, Organizing, Staffing, Directing, Co-Ordination, Communication, Motivation and Controlling	04
2	**Organizational skills** Levels of management, Organizations-elements, types and characteristics of organization, Management by Objectives (MBO)	04
3	**Planning Tools** Methods of scientific management- Critical Path Method (CPM), Programme Evaluation & Review Techniques (PERT), Network Crashing, Bar Chart, Mile-Stone chart, Gant Chart	04
4	**Methods of Economic Analysis** Economic equivalence, Methods of comparison of alternatives- Present Worth Method, Rate of Return method, Benefit-Cost ratio method	04
5	**Make or Buy Decision** Approaches of make or buy decision-Simple cost analysis, Economic	04

	analysis, break-even analysis, Payback analysis	
6	**Depreciation** Methods of Depreciation- Straight line method, Declining balance depreciation, Sum of years digits method, sinking fund method, service output method	**04**

References:
Text Books:
1. Gilbert Daniel R, Freeman R. Edward and Stoner James A. F, "Management" Pearson Education.
2. Harold Kerzner, "Project Management- A system approach to planning, scheduling and controlling", John Wiley & Sons Inc.
3. Punmia B. C. and Khandelwal K. K, "Project Planning, Scheduling and controlling with PERT and CPM", Laxmi Publications Pvt. Ltd.
4. Paneerselvam R, "Engineering Economics", Prentice Hall India Learning Private Limited.

Reference Books:
6. Cannice Mark V, Koontz Harold and Weihrich Heinz, "Management", McGraw Hill Education (I) Pvt. Ltd.
7. Blank Leland and Tarquin Anthony, "Basics of Engineering Economy", Tata McGraw-Hill.
8. Mithani D. M, "Managerial Economics- Theory & Applications", Himalaya Publishing House-New Delhi.

Note: Being online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments as per schedule.
Weightage: 25% weightage for unit wise assignments + 75% weightage for final examination.

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **IP4024**	Course Name: **Industry Internship & Project**

L	T	P	Credits
-	-	--	12

Course Description:

Internship is designed to expand the depth and breadth of academic learning of students in their particular areas of study. It is an opportunity for students to receive experience in applying theories learned from the classroom to specific experiences with the community and work world. An internship can also heighten awareness of community issues, motivate students to create opportunities, embrace new ideas, and give direction to positive change. A successful internship can give valuable information in making decisions about the direction of future studies or employment. An internship is an opportunity not only to use and develop industry-related knowledge and skills, but also to enhance some of the skills that are transferable to any professional work setting. Students from Final year B.Tech are eligible to do this internship. Selected candidates by college will be permitted for internship of minimum 20 weeks in 8th semester. During this Internship, it is expected that students should identify the problems arising in the industry related to Engineering, and they have to give the solution to the company.

Course Learning Outcomes:

1. Internship

After the successful completion of the IIP- II the student should be able to

1. Examine the functioning of the company on the terms of inputs, transformation process and the outputs (products and services)
2. Develop an attitude to adjust with the company culture, work norms, code of conduct.
3. Recognize and follow the safety norms, Code of conduct.
4. Demonstrate the ability to observe, analyse and document the details as per the industry practices.
5. Interpret the processes, systems and procedures and to relate to the theoretical concepts- studies.
6. Develop the leadership abilities, communication.
7. Demonstrate project management and finance sense

2. Project

After the successful completion of the project, the student should be able to;

1. Identify the project/problem in the domain of a program relevant for the company.
2. Compile the information to the pertaining to the problem identified.
3. Analyse the information using the statistical tools/ techniques.
4. develop the feasible solution for given problem.
5. Analyse the impact of the project on the performance of company/department.

Course Content

I. Internship :

During Internship, Students should follow guidelines given below.

1. After joining the industry students should learn all the departments and their workings. Furthermore, student should understand how each department of industry is interlinked with one another.
2. Student should correlate the theoretical aspects learned in academics with industry practices.
3. Students should gain a knowledge of new technologies which industry follows.
4. Students should follow the professional codes and ethics.
5. Students should follow all rules and regulations of industry. Special care should be taken regarding safety.

- **Work Diary:**

  Work Diary will be provided to each student, which contains details regarding internship, do's and don'ts and evaluation scheme. Student is required to write the Diary regularly and get it signed by the industry guide periodically. During the visit of Mentor, assigned to the student should be able to go through the Diary to access the work done and write the remarks/ instruction. At the end of internship, student should submit the duly completed diary to the department.

- **Duration:**

  The internship duration is of one complete semester (approximately 20 weeks) between 1st January to 30th May of the respective academic year. Biometric attendance on working days is compulsory.

II. Project :

Students should select technical problems occurring within the industry as a project in consult with industry & Institute mentors.

- **Evaluation**

Faculty Mentor will be assigned to each student by the Institute who will monitor the progress of internship and project and help the student to sort-out any issues/ problems arising. Mentor of student from college will visit the industry as per the schedule given below.

Sr.No.	Evaluation	Period
1.	At the beginning of the program for orienting Students to the company and finalize the project	During 2nd Week
2.	Review-I (ISE-1)	During10thweek
3.	Review-II (ISE-2)	During15thweek
4.	Review-III (ESE)	During20thweek

*Review-III is End Semester Examination (ESE), which will be conducted at institute.

*During ESE, students should submit, Project & internship report, Work diary, Internship & project completion certificate issued by industry etc. to respective departments.

Research Internship (RI)

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **OE4382**	Course Name: **Finance for Engineers (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:

In today's workplace, it is nearly impossible for an engineer to perform without considering the financial impact of every action on the organization's bottom line. Engineers need to be aware of issues such as cost reduction and capital investment and how their decisions can affect the financial statements. This course introduces basic financial management to engineers and technical personnel who need this knowledge to manage a profit center effectively. The course aims at providing students with an in-depth coverage of the various aspects of financial management.

It covers the assessing the financial health of the organization through ratio and cash flow analysis, sources of long term as well as short term finance. Decisions concern with financing, working capital and long term investment. Class will focus on both the academic theories underlying the management of funds and the practical aspects of financial management.

Course Learning Outcomes:

After successful completion of this course, students will be able to,

5. Discuss the fundamental aspects of accounting and finance.
6. Apply theoretical knowledge and information for preparing various financial statements.
7. Analyze the financial information for solving managerial problems.
8. Evaluate financial performance of the organization for effective decision making.

Prerequisite:

Basics of Mathematics

Course Contents

Unit No	Description	Hrs
7.	**Finance Terminologies & Financial Statement** Key terms of Accounting and Finance, Accounting Principles underlying Preparation of Financial Statements	4
8.	**Analyzing Health of a Firm** Techniques of Analyzing Health of a Firm, Classification of Ratios – Liquidity, Leverage, Activity, Profitability, Analysis of Cash Flows	4
9.	**The Management of Working Capital** Need of Working Capital, Operating Cycle of Working Capital, Determinants of Working Capital, Preparation of Working capital statement	4
10.	**Investment Decision Rules** Investment Decision Rules, Evaluation Criteria for Investment Decision: Payback, ARR, NPV, PI & IRR, Decision Tree Analysis	4

11.	**Long Term Financing** Long Term Financing: Shares, Debentures, Loan capital, foreign capital, FDI, Euro issues & external borrowings, Venture capital financing.	4
12.	**Financing Decisions and Cost of Capital** Risk & Return, Cost of Capital, Cost of Equity, Cost of Debt, Weighted Average Cost of Capital	4

References:
Reference Books:

9. Paul Kimmel, J. Weygandt, D. Kieso, Financial Accounting
10. S.N. Maheshwari & S.K. Maheshwari, Problems & Solutions in Advanced Accountancy, Vikas Publishing House Pvt. Ltd., New Delhi
11. M.C. Shukla, T.C. Grewal & S. C. Gupta, Advanced Accounts, S. Chand
12. M. Y. Khan & P. K. Jain, Financial Management, Tata McGraw-Hill Publishing Company Limited, New Delhi
13. Prasanna Chandra, Financial Management, Tata McGraw-Hill Publishing Company Limited.

Note: Being online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.
Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam.
Final exam will be held at college campus.

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Class: **Final Year B. Tech.**	Semester- **VIII**
Course Code: **OE4362**	Course Name: **Engineering Management & Economics (Online Course)**

L	T	P	Credits
2	-	-	2

Course Description:
Engineering management is the integration of management principles with engineering practices. It is a specialized field that focuses on effectively leading engineering teams and managing technical projects. This course is structured into two key modules: Engineering Management and Engineering Economics. The first module is centered on building the managerial skills necessary to guide, mentor, and inspire technical professionals in their engineering roles. The second module delves into engineering economics, a vital area for engineering firms to maintain their competitive advantage and market presence, focusing on economic decision-making.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

5. Develop administrative, organizational, and planning skills to effectively manage and execute engineering projects.
6. Create bar charts and milestone charts to track and manage project progress.
7. Analyze profit and cost data, conducting economic evaluations to make informed, optimal decisions.
8. Calculate depreciation using various methods.

Prerequisite: Basics of Mathematics

Course Content

Unit No	Description	Hrs
1	**Managerial skills** Theories of Management Principles of Management (by Henry Fayol), Functions of Management, Planning, Organizing, Staffing, Directing, Co-Ordination, Communication, Motivation and Controlling	04
2	**Organizational skills** Levels of management, Organizations-elements, types and characteristics of organization, Management by Objectives (MBO)	04
3	**Planning Tools** Methods of scientific management- Critical Path Method (CPM), Programme Evaluation & Review Techniques (PERT), Network Crashing, Bar Chart, Mile-Stone chart, Gant Chart	04
4	**Methods of Economic Analysis** Economic equivalence, Methods of comparison of alternatives- Present Worth Method, Rate of Return method, Benefit-Cost ratio method	04
5	**Make or Buy Decision** Approaches of make or buy decision-Simple cost analysis, Economic	04

	analysis, break-even analysis, Payback analysis	
6	**Depreciation** Methods of Depreciation- Straight line method, Declining balance depreciation, Sum of years digits method, sinking fund method, service output method	**04**

References:
Text Books:
5. Gilbert Daniel R, Freeman R. Edward and Stoner James A. F, "Management" Pearson Education.
6. Harold Kerzner, "Project Management- A system approach to planning, scheduling and controlling", John Wiley & Sons Inc.
7. Punmia B. C. and Khandelwal K. K, "Project Planning, Scheduling and controlling with PERT and CPM", Laxmi Publications Pvt. Ltd.
8. Paneerselvam R, "Engineering Economics", Prentice Hall India Learning Private Limited.

Reference Books:
14. Cannice Mark V, Koontz Harold and Weihrich Heinz, "Management", McGraw Hill Education (I) Pvt. Ltd.
15. Blank Leland and Tarquin Anthony, "Basics of Engineering Economy", Tata McGraw-Hill.
16. Mithani D. M, "Managerial Economics- Theory & Applications", Himalaya Publishing House-New Delhi.

Note: Being online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments as per schedule.
Weightage: 25% weightage for unit wise assignments + 75% weightage for final examination.

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2022-26 Batch
Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **RE4044**	Course Name: **Research Internship**

L	T	P	Credits
-	-	-	**12**

Course Description:
Research experience for undergraduates is important not only for conducting research on a topic that has an impact on a current research activity, but also as a tool to enhance undergraduate education. For the engineering technology students, research experiences allow them to carry out in-depth study of engineering concepts, while emphasizing hands-on experiences and practical applications. Participating in research projects strengthens the student's resume, and fulfills the requirements of present day employers, who demand sound engineering skills in their employees.

Course Learning Outcomes:
After completion of this course, the student will be able to,

1. Investigate the technical literature.
2. Recognize and evaluate theories, practices, and/or research on a chosen topic by conducting a thorough literature review and submitting a written integrative, critical summary of the current literature.
3. Design a research problem and develop a methodology.
4. Develop and implement an advanced original research or creative project.
5. Develop the ability to explain the conceptual viability of the project and describe the major components involved.
6. Develop advanced discipline-relevant skills and competencies.
7. Write a research report and paper.

Course Content

Students should carefully discuss with their research advisor about time expectations to complete the research project.

Degree to which students meet expectations: The following is a minimum set of expectations for every student enrolled for this course for credit:

i) perform a background literature search and review,
ii.) Develop a project plan,
iii.) Perform experimental work or applied experimental work,
iv.) Write and present a research report.
iv) Write and submit research paper to any reputed journal/international conference.

- **To submit or publish the research paper in any reputed journal/international conference is a necessary criterion to become eligible for End semester Examination (ESE).**

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Quality of the final report and oral presentation: The research advisor will provide clear expectations of the desired format, content, and deadlines of the final report. The research advisors will grade the final report.

Attendance: In order to provide the measure of performance, the research advisor is expected to complete a two-mid-term evaluation with the student, accompanied by recommendations for improvement for the remainder of the term. The mid-term evaluation with the student should be accompanied by a one-on-one meeting between the research advisor and the student.

Absences and Make-up Work: Requirements for attendance is as per RR of the Institute

- **Evaluation**

Faculty guide will be assigned to each student by the Institute who will monitor the progress of research project and help the student to sort-out any issues/ problems arising. Schedule of evaluation will be as given below.

Sr.No.	Evaluation	Period
5.	Review-I (ISE-1)	During10thweek
6.	Review-II (ISE-2)	During15thweek
7.	Review-III (ESE)	During20thweek

*Review-III is End Semester Examination (ESE).

*During ESE, students should submit research Project report, proof of submission of research paper to reputed journal/international conference to respective departments.

*If student is doing research project in outside organization (Research Lab/ institutes), he/she should submit project completion certificate given by outside organization.

Entrepreneurial Internship (EI)

K.E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2022-26 Batch

Department of Mechanical Engineering

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **ED4104**	Course Name: **Project Management (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:

To improve and update knowledge of new entrepreneurs in the areas of project preparation & appraisal techniques; decision-making process in the sector of industrial, infrastructure & sustainable opportunities that would lead to improved viability, returns and effective investment decisions. Writing a business plan which can gain interest of the fund providers like venture capitalists and other sources of funding.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Develop a Comprehensive Business Plan for selected business.
2. Evaluate Project Viability Through Financial Appraisal.
3. Analyze the Environmental and Technical Aspects of a Project.
4. Apply Project Management Techniques.
5. Assess the Commercial Feasibility of a Business Opportunity.

Prerequisite:

General knowledge of economics & clear concept about own business model.

Course Content

Unit No	Description	Hrs
1.	**Project appraisal** -Project Development Cycle, Preparation of feasibility studies, project formulation, screening for pre-feasibility studies, stages of feasibility report preparation, Project Analysis including Market Analysis, Technical Analysis & Financial Analysis, Various analytical techniques and integrating the data gathered into a full-fledged business plan.	04
2.	**Project Analysis**-Environmental Analysis, Risk Analysis, Infrastructure Development & Financing, Risk Management, Risk identification, Qualitative risk analysis, Quantitative risk analysis, Risk planning and control, National Cost-Benefit Analysis, Financing Sustainable Opportunities. Sustainability and Green Business Practices	04
3.	**Business Plan:** What is business plan, Entrepreneurial opportunities and Business Plan. Preparing business plan. (Practical Exercises on preparation of business plan) Components of Business Plan, Executive summary, other components. Project report contents.	04
4.	**Commercial Appraisal:** Economic feasibility and commercial viability, market analysis, Market Research, Industry Analysis, Competitor analysis, defining the target market, market segmentation, market positioning, building a marketing plan, market strategy.	04

5.	**Technical Appraisal:** Operation and Production Plan: Types of production systems, Product design and analysis, New product development, location and layout decisions, project layout, plant and technology choices, product specification and customer needs, production planning and control, Commercializing Technologies	04
6.	**Financial Appraisal:** pro forma income statements, financial projections, working capital requirement, funds flow and Cash flow statements; Ratio Analysis. **Project Management Techniques**: Identifying organizational structures Estimating costs and budgeting Using critical path project management tools (WBS, Gantt chart, Project Network Diagram) Establishing the critical path Tracking project milestones Using the program evaluation and review technique (PERT tool) Using process improvement tools (Fishbone, SIPOC) Managing time Controlling quality	04

References :

Text Books:

1. Dwivedi, A.K.: Industrial Project and Entrepreneurship Development, Vikas Publishing House

Reference Books:

1. Bangs Jr., D.H., *The Business Planning Guide,* Dearborn Publishing Co.
2. Katz, J.A. and Green, R.P., Entrepreneurial Small Business, McGraw Hill
3. Mullins, J. and Komisar R., Getting to Plan B, Harvard Business Press
4. O'Donnell, M., The Business Plan: Step by Step, UND Center for Innovation.
5. Scarborough, N.M. and Zimmerer, T.W., Effective Small Business Management, Pearson
6. Pickle, H.B.and Abrahamson, R.L., Small Business Management, Wiley
7. Desai, V., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing
8. Kao, J., Creativity & Entrepreneurship, Prentice Hall
9. Singh, Narendra, Project Management & Control, Himalaya Publications

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **ED4044**	Course Name: **Commercial Aspects of the Project (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:

To familiarize students with accounting, mechanics of preparation of financial statements, understanding corporate financial statements, their analysis and interpretation.

The objectives of the course are to build the skills, frameworks and knowledge in entrepreneurial finance. Students will study the financing of small and medium sized businesses & Financial management from the perspective of both the entrepreneur and investors.

This course will also give overall understanding of marketing management which will help them in developing their own marketing decisions & in understanding the importance of market survey techniques. It will help them in conducting suitable market survey for their own selected products.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Interpret basic Accounting and Financial Terminologies.
2. Prepare & analyze financial statements.
3. Apply basic principles of marketing.
4. Apply knowledge of marketing mix for any organization.

Prerequisite:

General knowledge of economics & clear concept about own business model

Course Content

Unit No	Description	Hrs
7.	Accounting Terminologies: Meaning, nature, functions, types of accounting; generally accepted accounting concepts, principles and conventions; double entry system. Accounting Records: Fundamentals of record keeping, the accounting process, Computer-based accounting systems. Accounting cycle.	04
8.	**Financial Management –** Definition, nature, objectives, functions and scope of financial management, Preparation of financial plan – its objectives, essential features, consideration in formulating financial plan	04
9.	Financial Statements: Balance sheet: assets, liabilities. Income statement: concept of income, concept of expenses, concept of gain and losses. Components of the income statement. Cash flow statements: purpose, components, concept, Process.	04
10.	**Nature & Scope of Marketing –** Evolution, core marketing concepts,	04

	selling concept, marketing concept, Holistic marketing concept, portfolio approach-BCG matrix. Marketing Research- Concept & practice, Steps in Marketing Research.	
11.	**Marketing Environment and STP:** Demographic, economic, political, legal, socio cultural, technological environment (Indian context); environmental scanning to discover marketing opportunities, Segmentation, Targeting and Positioning, difference between segmentation, targeting and positioning.	**04**
12.	**Marketing Mix: Product, Price, Promotion and Place.** **Product Decisions:** Concept of Product, Levels of Product, Product Mix Decisions, Product Line Decisions, Individual Product Decisions, Branding, Product Life-cycle - Stages. **Pricing Decisions:** Meaning, Factors influencing Pricing Decisions, Methods of Pricing **Place Decisions:** Meaning, Channels of Distribution **Promotion Decisions:** Elements of Promotion Mix, Advertising, Publicity, Sales Promotion, Personal Selling, Direct Marketing and Public Relations,	**04**

References -

Text Books:

1. Maheshwari, S.N. and Maheshwari, S.K., Financial Accounting, Vikas Publishing House
2. Leach C.J. and Melicher, R.W. Entrepreneurial Finance, Thomson.
3. For B2C = Kotler, P., Keller, K.L., Koshy, A. and Jha, M.: Marketing Management, Pearson
4. For B2B = Sarin, S. Strategic Brand Management for B2B Markets, Sage

Reference Books:

1. Ghosh, T.P., Financial Accounting for Managers, Tax-mann Allied Services
2. Gupta, A., Financial Accounting for Management, Prentice Hall
3. Jain, S.P. and Narang, K.L., Advanced Accountancy, Kalyani Publishers.
4. Smith, J.K., Smith, R.L. and Bliss, R.T., Entrepreneurial Finance, Stanford University Press
5. Smith, J.K. and Smith, R.L., Entrepreneurial Finance, Wiley.
6. Rogers, S., Entrepreneurial Finance, McGraw Hill.
7. Chandra, P., Financial Management, McGraw Hill.
8. Kotler P. & Armstrong, G., Principles of Marketing, Pearson

Note:

- Lectures of this theory course will be conducted through online mode.
- Recorded videos will be made available to students on MOODLE platform.

- Faculty will upload three lectures per week and links will be shared on every Monday.
- Students need to appear in Unit Test-1, Unit Test-2 and ESE in college campus as per the regular practice.
- Faculty of concerned course will take the decision regarding modes of In-Semester Evaluation (ISE).

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **ED4064**	Course Name: **Entrepreneurship Development Program (EDP)**

L	T	P	Credits
-	-	--	1

Course Description:
Student will attend short term intensive EDP program organized either in house or by any authorized agency approved by CIIED.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Apply knowledge of engineering, economics, marketing and finance for formulation of business plan, starting & managing new business.

Prerequisite: General knowledge of business & clear concept about own business model.

Course Content:

1 Student will undergo training programs organized by CIIED.

Programs on marketing, Finance management, project report preparation by professional agencies. Students are required to apply this knowledge for preparing final project report.

2. Student will complete online certification course- **Entrepreneurial & Employability Skill Development Program** by Singapore polytechnic in association with Jugad Funda & Shivaji University, Kolhapur or any other approved agencies.

Evaluation- ISE **50** marks by mentor for-

1. Completion of online certification course- **Entrepreneurial & Employability Skill Development Program** by Singapore polytechnic in association with Jugad Funda & Shivaji University, Kolhapur or any approved agencies.

2. Active participation in programs by completing various activities/assignments in program.

Class: **Final Year B. Tech**	Semester-**VIII**
Course Code: **ED4084**	Course Name: **Entrepreneurial Internship**

L	T	P	Credits
-	-	-	**11**

Course Description:
Student will prepare technically feasible and economically viable detailed project report including market survey.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Apply knowledge of engineering, economics, marketing and finance for preparation of project report.
2. Make commercial, technical and financial appraisal of project.

Course Content

Student will start working on collection of data required for business plan. During semester he may require to visit various support organizations, similar industries , suppliers of raw materials, machinery, special service providers. He has to conduct market survey. For this student can go out of campus with prior permission of mentor. Mentor should maintain this record .Students are required to work independently by taking guidance from mentor/Head CIIED/faculty on expert panel of CIIED.

Product prototype & execution of business operation is must & it should be validated by Departmental ED committee.

Continuous efforts taken by student should be observed by mentor for ISE evaluation. At the end of semester detailed project report will be presented before Expert committee for ISE evaluation of 100 marks.

Then student will appear for ESE. Project report evaluation &assessment will be done by a panel of experts appointed by COE.

Evaluation	Weightage	Particulars	converted Marks
ISE	10%	Preliminary project report	10
	20%	Market Survey	20
	20%	Completion of Legal Aspects	20
	50%	Final Report	50
ESE	100%	ESE -Final Report	100