

Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

NBA Accredited, NAAC Accredited with A+ Grade, ISO 21001:2018



DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus of T.Y. B. Tech. – Mechanical Engineering

**(With effect from - Academic Year 2026 - 27)
(2024 Pattern)**

VISION OF THE INSTITUTE

To be a premier institute in technical education by imparting academic excellence, research, social and entrepreneurial attitude.

MISSION OF THE INSTITUTE

- To achieve academic excellence through innovative teaching and learning process.
 - To imbibe the research culture for addressing industry and societal needs.
 - To inculcate social attitude through community engagement initiatives.
 - To provide conducive environment for building the entrepreneurial skills.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION:

To be recognized as center for quality education in the field of mechanical engineering, integrating top-tier teaching, innovative research, and fostering socially conscious and entrepreneurial engineers.

MISSION:

- M1:** To impart value-added education by creating an ambiance of academic excellence in teaching-learning processes.
- M2:** To inculcate research approach through innovation and skill development centers.
- M3:** To inculcate a strong sense of social responsibility and empathy among the students.
- M4:** To imbibe the entrepreneur skill amongst the students by strengthening Industry- Institute interaction.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

- PEO1:** Mechanical Engineering graduates excel in solving industrial challenges, innovating for society, and leveraging core engineering principles for industry advancement.
- PEO2:** Graduates will apply technical expertise, leadership, and entrepreneurship, to establish ethical organizations to address societal needs and pursue higher studies.
- PEO3:** Graduates will work effectively as individuals and as team members with high ethical values and motivation for life-long learning for the benefit of society.

PROGRAM OUTCOMES (POs):

- PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).
- PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

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- PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.
- PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
- PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs):

- PSO1:** Identify, formulate and analyze real-life mechanical engineering problems by applying the principles of thermal, design, manufacturing, interdisciplinary and allied engineering.
- PSO2:** Select and apply appropriate materials, metallurgical processes, measurement techniques, feedback control systems, hydraulic and pneumatic control systems to develop appropriate solutions to mechanical engineering problems.
- PSO3:** Select and apply appropriate manufacturing technologies and tools, and develop competencies for working in manufacturing and allied industries.
- PSO4:** Apply acquired knowledge, skills, and hands-on experiences to work professionally in mechanical and related systems.

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LIST OF ABBREVIATIONS

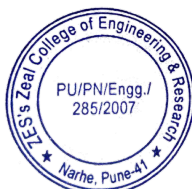
Abbreviation	Description
BSC	Basic Science Course
ESC	Engineering Science Course
PCC	Program Core Course
PEC	Program Elective Course
MDM	Multidisciplinary Minor
OE	Open Elective - Other than a particular program
VSEC	Vocational and Skill Enhancement Course
AEC	Ability Enhancement Course
ENTR	Entrepreneurship
EC	Economics
MC	Management Courses
IKS	Indian Knowledge System
VEC	Value Education Courses
RM	Research Methodology
CEP	Community Engagement Project
FP	Field Project
PROJ	Project
INT	Internship
OJT	On Job Training
CC	Co-curricular Courses
HSSM	Humanities Social Science and Management
ELC	Experiential Learning Course
B. Tech	Bachelor of Technology
L	Lecture
P	Practical
T	Tutorial
H	Hours
CR	Credits
CIE	Continuous Internal Evaluation
ETE	End Term Evaluation
TW	Term Work
OR	Oral
PR	Project

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Third Year B. Tech. – Mechanical Engineering: Semester - V

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			CIE	ETE	TW	PR	OR	Total
							TH	PR/Tut	Total						
MEPC509	PCC	Heat Transfer	4	-	-	3	4	-	4	40	60	-	-	-	100
MEPC509P	PCC	Heat Transfer Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
MEPC510	PCC	Machine Design – I	3	-	-	3	3	-	3	40	60	-	-	-	100
MEPC510P	PCC	Machine Design – I Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
MEPC511	PCC	Computer Aided Design & Analysis	3	-	-	3	3	-	3	40	60	-	-	-	100
MEPC511P	PCC	Computer Aided Design & Analysis Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
MEPE501	PEC	Program Elective Course - I*	3	-	-	3	3	-	3	40	60	-	-	-	100
MEMD503	MDM	Project Management System - II	-	2	-	2	-	1	1	-	-	25	-	-	25
ALOE503	OE	Open Elective - III #	2	-	-	2	2	-	2	-	-	50	-	50	100
MEAE503	AEC	Metrology Laboratory	-	2	-	2	-	1	1	-	-	25	-	-	25
MEIN504	ELC - INT	Internship - IV	4 Weeks				-	2	2	-	-	25	-	-	25
Total			15	10	-	25	15	7	22	160	240	125	100	75	700

BoS Chairman



Adhikari

Director

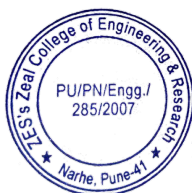
ZES's Zeal College of
Engineering & Research
Narhe, Pune - 411041.

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* - Select any one course from the given Program Elective Courses		
Course Code	Course Type	Program Elective-I
MEPE501A	PEC	Advanced Casting, Forming and Joining Processes
MEPE501B		Automobile Engineering

# - Select any one course from the given Open Elective Courses		
Course Code	Course Type	Open Elective - III
ALOE503A	OEC	Data Analytics
ALOE503B		Green Building
ALOE503C		Electric Mobility
ALOE503D		Introduction to Stock Market
ALOE503E		Patent Law for Engineers and Scientist

BoS Chairman



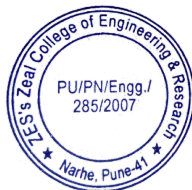

Director

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Third Year B. Tech. – Mechanical Engineering: Semester - VI

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			CIE	ETE	TW	PR	OR	Total
							TH	PR/Tut	Total						
MEPC612	PCC	Applied Thermal Engineering	3	-	-	3	3	-	3	40	60	-	-	-	100
MEPC612P	PCC	Applied Thermal Engineering Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
MEPC613	PCC	Machine Design - II	3	-	-	3	3	-	3	40	60	-	-	-	100
MEPC613P	PCC	Machine Design – II Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
MEPC614	PCC	Computer Integrated Manufacturing Lab	-	4	1	5	-	3	3	-	-	25	-	50	75
MEPE602	PEC	Program Elective Course - II*	2	-	-	2	2	-	2	40	60	-	-	-	100
MEPE603	PEC	Program Elective Course - III*	2	-	-	2	2	-	2	40	60	-	-	-	100
MEMD604	MDM	Mechatronics	3	-	-	3	3	-	3	40	60	-	-	-	100
MEMD604P	MDM	Mechatronics Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
MEVS607	VSEC	Quality Management System – III	-	2	-	2	-	1	1	-	-	25	-	-	25
MEIN605	ELC - INT	Internship – V	4 Weeks				-	2	2	-	-	25	-	-	25
Total			13	12	1	26	13	9	22	200	300	75	-	125	700

BoS Chairman



Adhikari

Director

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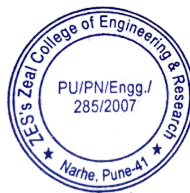
*** - Select any one course from the given Program Elective Courses**

Course Code	Course Type	Program Elective-II
MEPE602A	PEC	Tribology
MEPE602B		Electric and Hybrid Vehicles

*** - Select any one course from the given Program Elective Courses**

Course Code	Course Type	Program Elective-III
MEPE603A	PEC	Industrial Hydraulics and Pneumatics
MEPE603B		Design of Transmission Systems

BoS Chairman




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SYLLABUS
SEMESTER - V

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Heat Transfer							Code: MEPC509		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
04	-	-	04	40	60	-	-	-	100
Prerequisites:									
First and Second Law of Thermodynamics, Fluid properties, Ordinary differential and Partial Differential Equations, Engineering Physics.									
Course Objectives:									
1. To familiarize the students with the fundamental concept of Heat Transfer. 2. To understand the students principles/laws of heat transfer by conduction, convection, and radiation. 3. To enable students to analyze practical heat transfer problems involving extended surfaces, thermal insulation, transient conduction, and radiation networks. 4. To familiarize students with advanced heat transfer applications such as heat exchangers, heat pipes, electronic cooling, phase change materials, and Nano fluids.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Understand the modes of heat transfer, governing laws and boundary conditions.								
CO2	Apply lumped system analysis to solve numerical problems on transient heat conduction.								
CO3	Evaluate fin efficiency and fin effectiveness for different fin configurations.								
CO4	Apply non-dimensional numbers to calculate heat transfer coefficient.								
CO5	Evaluate radiative heat transfer processes using radiation laws and radiation shields.								
CO6	Evaluate the suitability of advanced heat transfer technologies.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Basic concepts of heat transfer & Conduction: Basic concepts of heat transfer: Modes of heat transfer, Governing laws of heat transfer, Boundary and initial conditions, Steady state and unsteady state. Conduction: Thermal conductivity & Thermal diffusivity, electrical analogy, Thermal contact Resistance, Concept of 1-D steady state heat conduction and 3-D heat conduction equation in Cartesian coordinates (simplified equations, no derivation) Heat conduction without heat generation in plane wall, composite wall, composite cylinder (Numerical), Concept of Heat conduction with heat generation.								10
2.	Thermal Insulation & Transient heat conduction: Thermal Insulation: Critical thickness of insulation, Types and properties of insulating materials, Economic and cost considerations, Payback period.								8

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	Transient heat conduction: Validity and criteria of lumped system analysis(Numerical), Biot Number, Fourier Number, Time Constant and Response of thermocouple.	
3.	Fins (Heat Transfer through Extended Surfaces): Introduction of fins, Need and significance of extended surfaces (fins), Types of fins and its applications, Governing Differential Equation for Fins, adequately long fin with insulated end tip and short fins (no derivation), Temperature Distribution and Heat Transfer Rate Fin Efficiency & Effectiveness of fins.	8
4.	Convection: Types of Convection: Free (natural) convection and forced convection. Physical significance of non-dimensional numbers, in free and forced, Heat Transfer Coefficient (Numerical), Hydrodynamic and Thermal boundary layer. Boiling and Condensation: Regimes of pool boiling, Film wise condensation, Drop wise condensation (No Numerical treatment)	8
5.	Radiation: Radiation Properties of Surfaces, Stefan Boltzmann laws of radiation, Planck's law, Kirchhoff's law, Wien's displacement law, Radiation intensity, shape factor (view factor), irradiation, and radiosity, Radiation network analysis using radiosity and irradiation. Radiation Shield: Concept and applications. Numerical.	8
6.	Heat Transfer Applications: Heat Exchangers -Introduction and classification, LMTD and NTU methods, Industrial applications. Heat Pipe and Heat Pump -Introduction and working principle, Industrial applications. Electronic Cooling -Introduction to electronic cooling, Active and passive cooling methods. Phase Change Materials (PCM) -Introduction and working principle, Types and thermo physical properties, Applications in thermal energy storage and heat transfer enhancement. Nanofluids -Introduction and properties, Industrial applications.	10
TOTAL		52
Text Books:		
1. R. K. Rajput, "Heat and Mass Transfer", S. Chand Publications. 2. P. K. Nag, "Heat and Mass Transfer", McGraw Hill Education. 3. Mahesh M. Rathore and R. B. Khot, "Engineering Heat and Mass Transfer", Laxmi Publications.		
Reference Books:		
1. Incropera et al. – Fundamentals of Heat and Mass Transfer, Wiley India. 2. Yunus A. Çengel & Afshin J. Ghajar – Heat and Mass Transfer: A Practical Approach, McGraw Hill. 3. S.P. Sukhatme & J.K. Nayak – A Textbook of Heat Transfer, Universities Press. 4. J.P. Holman – Heat Transfer, McGraw Hill.		

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5. R.C. Sachdeva – Engineering Heat Transfer, New Age International

E-Resources:

Links of NPTEL / related videos

1. <https://nptel.ac.in/courses/112106315>
2. <https://nptel.ac.in/courses/112105271>
3. <https://nptel.ac.in/courses/112108149>
4. <https://nptel.ac.in/courses/112101097>
5. <https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785>
6. <https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785>

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Heat Transfer Lab							Code: MEPC509P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	50	-	50
Prerequisites:									
First and Second Law of Thermodynamics, Fluid properties, Ordinary differential and Partial Differential Equations, Engineering Physics.									
Course Objectives:									
1. To develop practical skills in conducting heat transfer experiments and measurements. 2. To analyze experimental results using fundamental heat transfer principles. 3. To develop problem-solving skills through practical and industrial applications of heat transfer.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Select appropriate heat transfer methods and experimental techniques for given engineering problems.								
CO2	Evaluate experimental results to make informed decisions regarding thermal system performance.								
CO3	Recommend suitable heat transfer solutions based on performance, efficiency, and practical requirements.								
List of Experiments:									
The student shall complete the following activities as a part of Term Work. Complete any Eight Experiments from the following list:									
1. Determination of Thermal Conductivity of Insulating Powder. 2. Determination of Thermal Conductivity of Metal Rod. 3. Determination of Local and Average Heat Transfer Coefficient in Natural Convection. 4. Determination of Local and Average Heat Transfer Coefficient in Forced Convection. 5. Determination of Temperature Distribution, Fin Efficiency and Effectiveness in Natural/Forced Convection. 6. Determination of Emissivity of a Test Surface. 7. Determination of Stefan–Boltzmann Constant. 8. Determination of Effectiveness of Parallel Flow and Counter Flow Heat Exchangers. 9. Study of Pool Boiling Phenomenon and Determination of Critical Heat Flux (CHF). 10. Assignment on Solving a Transient Heat Transfer Problem. 11. Design of a Heat Exchanger for a Simple Engineering Application. 12. Industrial Visit to a Heat Treatment Industry / Heat Exchanger Manufacturing Industry and Submission of Report. 13. Determination of Thermal Performance of a Solar Water Heater. 14. Determination of Thermal Energy Storage Characteristics of a Phase Change Material (PCM). 15. Virtual Laboratory: • Study of the Performance of a Heat Exchanger.									

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- Study of Variation of Thermal Conductivity.

Virtual Lab Links:

- [Virtual Labs \(National Mission on Education through ICT\)](#)
- [Heat Exchanger Virtual Lab \(IIT Kharagpur\)](#)
- [Heat Transfer by Conduction Simulator \(Amrita Virtual Lab\)](#)

Text Books:

Reference Books:

1. Incropera et al. – Fundamentals of Heat and Mass Transfer, Wiley India.
2. Yunus A. Çengel & Afshin J. Ghajar – Heat and Mass Transfer: A Practical Approach, McGraw Hill.
3. S.P. Sukhatme & J.K. Nayak – A Textbook of Heat Transfer, Universities Press.
4. J.P. Holman – Heat Transfer, McGraw Hill.
5. R.C. Sachdeva – Engineering Heat Transfer, New Age International

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Machine Design - I							Code: MEPC510		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Engineering Mathematics, Engineering Mechanics, Mechanics of Solids, Theory of Machines, Engineering Drawing, and Geometric Dimensioning and Tolerance.									
Course Objectives:									
1. To understand the principles of machine design, engineering materials, and design standards. 2. To analyze and design machine components subjected to static and dynamic loading using standard design procedures. 3. To develop practical skills in the design, analysis, and documentation of machine components using design data books, standards, and CAD tools.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamentals of machine design, engineering materials, standardization, and design procedures.								
CO2	Apply design principles for machine components subjected to static and fatigue loading conditions.								
CO3	Analyze and design bolted, riveted, and welded joints for engineering applications.								
CO4	Design transmission shafts, keys, rigid flange couplings, and power screws using standard design procedures and engineering standards.								
CO5	Design springs and flexible power transmission elements such as belt, rope, and chain drives for engineering applications								
CO6	Apply reliability, manufacturability, maintenance, and safety considerations in machine design.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Fundamentals of Machine Design: Introduction to machine design, design philosophy, design procedure, design considerations, engineering materials and material selection, preferred numbers, standardization, engineering standards, and design codes.								6
2.	Design Against Static and Fatigue Failure: Design stresses, application of failure theories in machine design, stress concentration and stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, Soderberg and Goodman criteria.								7
3.	Design of Mechanical Joints: Design of bolted joints under static and eccentric loading, riveted joints, and welded joints.								7

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4.	Design of Shafts, Couplings, and Power Screws: Design of transmission shafts using the ASME code, design of keys, rigid flange couplings, and power screws.	6
5.	Design of Springs and Flexible Power Transmission Elements: Helical compression and tension springs, leaf springs, spring materials, belt drives, rope drives, and chain drives.	7
6.	Design for Reliability and Manufacturability: Reliability in machine design, design for manufacturability and assembly (DFMA), maintenance considerations, safety considerations, product interchangeability, and statistical considerations in design.	6
TOTAL		39
Text Books:		
1. V. B. Bhandari, "Design of Machine Elements", McGraw Hill Education. 2. R. S. Khurmi and J. K. Gupta, "A Textbook of Machine Design", S. Chand Publications. 3. Hall, Holowenko, and Laughlin, "Machine Design", Schaum's Outline Series, McGraw Hill.		
Reference Books:		
1. Richard G. Budynas and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill Education. 2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", Wiley India. 3. Joseph Edward Shigley and Charles R. Mischke, "Mechanical Engineering Design", McGraw Hill Education. 4. PSG College of Technology, "PSG Design Data Book", Kalaikathir Achchagam. 5. Maleev and Hartman, "Machine Design", CBS Publishers.		
E-Resources:		
1. https://www.youtube.com/watch?v=SL21aDqgs8Q 2. https://www.youtube.com/watch?v=TPURJnlekeo		

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Machine Design – I Lab							Code: MEPC510P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Engineering Mathematics, Engineering Mechanics, Mechanics of Solids, Theory of Machines, Engineering Drawing, and Geometric Dimensioning and Tolerance.									
Course Objectives:									
1. To guide students in applying machine design principles for the design and analysis of machine components and assemblies. 2. To develop students’ ability to select suitable materials, perform design calculations, and prepare CAD models/working drawings considering strength, safety, and manufacturability. 3. To facilitate the analysis of real-world machine design problems through case studies, failure analysis, and evaluation of reliability, safety, and performance.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply machine design principles to design and analyze machine components.								
CO2	Analyze design calculations, material selection, and CAD models of machine components.								
CO3	Evaluate machine design alternatives based on safety, reliability, and performance.								
List of Experiments:									
A. Design Project									
Students shall complete any two of the following design projects and submit a report including design calculations, material selection, CAD model/working drawing, and conclusions .									
1. Design of Cotter Joint or Knuckle Joint. 2. Design of Flange Coupling. 3. Design of Power Screw. 4. Design of any real-life machine component within the scope of the course.									
B. Case Study / Assignment									
Students shall prepare a detailed report and presentation on any three of the following:									
1. Case study on machine design fundamentals, material selection, standardization, and design codes. 2. Case study on failure analysis of machine components with suitable industrial applications. 3. Comparative study of bolted, riveted, and welded joints with design and strength analysis. 4. Case study on Transmission Shaft/ Machine Tool Spindle/ Agitator/Mixer Shaft 5. Design and stress analysis of helical compression springs/ leaf springs. 6. Design calculations and performance analysis of flat belt and V-belt drives. 7. Case study on reliability, manufacturability, safety, and maintainability in machine design.									
Reference Books:									
1. Richard G. Budynas and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill Education.									

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2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", Wiley India.
3. Joseph Edward Shigley and Charles R. Mischke, "Mechanical Engineering Design", McGraw Hill Education.
4. PSG College of Technology, "PSG Design Data Book", Kalaikathir Achchagam.
5. Maleev and Hartman, "Machine Design", CBS Publishers.

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Computer Aided Design & Analysis							Code: MEPC511		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Fundamentals of Solid Modeling and 3D Geometric Modeling, Strength of Materials and Engineering Mechanics, Basic knowledge of Numerical Methods and Matrix Algebra.									
Course Objectives:									
1. To introduce students to the fundamentals of Computer Aided Design (CAD), Computer Graphics, and Geometric Modeling. 2. To develop students' understanding of transformation techniques, solid modeling, and Computer Aided Engineering (CAE) tools used in product development. 3. To impart knowledge of Finite Element Analysis (FEA) methods for modeling and solving engineering problems. 4. To enable students to perform modeling, analysis, interpretation, and validation of engineering components using FEA software.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the concepts of CAD/CAM, CAE, product cycle, and applications of computer graphics in engineering.								
CO2	Apply 2D and 3D geometric transformations and projection techniques in computer graphics.								
CO3	Develop geometric models using curves, surfaces, and solid modeling techniques.								
CO4	Understand discretization methods, finite element terminology, and formulation procedures used in CAE.								
CO5	Analyze one-dimensional and two-dimensional engineering problems using Finite Element Analysis techniques								
CO6	Perform modeling, simulation, post-processing, and interpretation of engineering problems using commercial FEA software								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction: Computers in Industrial Manufacturing, Product cycle, Basic structure and functioning of CAD systems, Role of CAD in automation and manufacturing, CAD software and its types, Integration of CAD with CAM and CAE, Applications of CAD in Mechanical Engineering.								6
2.	Computer Graphics: Transformations (2D & 3D): Introduction, Formulation, Translation, Shear, Rotation, Scaling and reflection (Numerical), Homogeneous representation,								7

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	Concatenated transformation, Orthographic and perspective projections. Concept of Coordinate Systems.	
3.	Geometric Modeling : Curves – Introduction, Analytical curves Synthetic curves. Surface representation , Analytic surfaces, Synthetic Surfaces. Solids - Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Constructive Solid Geometry (CSG), Boolean operation for CSG.	7
4.	Introduction to Computer Aided Engineering (CAE) Use of CAE in Product development, Discretization methods, CAE Tools. Element Shapes, Nodal Unknowns and field variables, Coordinate Systems. Introduction : Brief History of FEM, Finite Element Terminology, General FEM procedure, Applications of FEM in various fields, meshing, p and h, Advantages and disadvantages of FEM.	6
5.	Finite Element Analysis (FEA) One Dimensional Problem: Finite element modeling, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Temperature Effects. Trusses: Introduction, 2D Trusses, Assembly of Global Stiffness Matrix.	7
6.	2D Finite Element Analysis Plane Stress-Strain problem. Constant Strain Triangle (CST) Element Stiffness matrix, Assembling stiffness equation, Load vector, Stress and reaction forces calculations. Post Processing Techniques, CAE reports. Introduction to Artificial Intelligence (AI) in CAD/CAE Systems.	6
TOTAL		39
Text Books:		
1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM: Theory and Practice", Tata McGraw Hill Publishing Co., 2009. 2. T. R. Chandrupatla and A. D. Belegunda, "Introduction to Finite Elements in Engineering", Prentice Hall India. 3. N. S. Gokhale, S. S. Deshpande, S. V. Bedekar, and A. N. Thite, "Practical Finite Element Analysis", 1st Edition, Finite to Infinite, Pune, 2008. 4. Nitin S. Gokhale, "Practical Finite Element Analysis", Finite to Infinite, Pune.		
Reference Books:		
1. Ibraim Zeid, Mastering CAD/CAM – Tata McGraw Hill Publishing Co. 2000 2. Segerling L. J. - Applied Finite Elements Analysis, John Wiley and Sons 3. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India (P) Ltd., New Delhi, 1996. 4. Chandrupatla T A and Belegundu A D, Introduction to Finite Elements in Engineering, PHI. 5. Logan D, A First Course in the Finite Element Method, Cengage.		

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E-Resources:

1. Prof. Anoop Chawla and Prof. P. V. Madhusudan Rao, "Computer Aided Design and Manufacturing", NPTEL, <https://nptel.ac.in/courses/112102101>
2. Prof. Nachiketa Tiwari, "Basics of Finite Element Analysis", NPTEL, <https://nptel.ac.in/courses/112104193>
3. Dr. R. Krishnakumar, "Advanced Finite Element Analysis", NPTEL, <https://nptel.ac.in/courses/112106130>

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Computer Aided Design & Analysis Lab							Code: MEPC511P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Fundamentals of Solid Modeling and 3D Geometric Modeling, Strength of Materials and Engineering Mechanics, Basic knowledge of Numerical Methods and Matrix Algebra.									
Course Objectives:									
1. To facilitate the application of FEA techniques for structural and thermal analysis. 2. To develop students' proficiency in modeling and analyzing engineering components using FEA software. 3. To guide students in interpreting FEA results for assessing strength, deformation, and thermal performance.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Select appropriate FEA methods for solving engineering analysis problems.								
CO2	Interpret FEA results for assessing component performance and safety.								
CO3	Recommend suitable design modifications based on FEA analysis.								
List of Experiments:									
Students shall perform any 7 Experiments out of Experiments No. 1 to 9. Experiment No.10, Mini Project on Applications of FEA, is compulsory for all students.									
1. Stress analysis of 1D bar element. 2. Structural analysis of a 1D truss element. 3. Stress Analysis of a Plate With a Central Hole Under Tensile Loading 4. Determination of static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software. 5. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software. 6. Modal analysis of any machine component using FEA software. 7. Steady state heat transfer through composite wall thermal mixed boundary (Conduction /Convection/Insulation) using FEA software. 8. Coupled Thermal-Structural Analysis using FEA software. 9. Contact Stress Analysis of Mating Mechanical Components Using FEA 10. Mini Project on applications of FEA.									
Reference Books:									
1. Ibraim Zeid, Mastering CAD/CAM – Tata McGraw Hill Publishing Co. 2000 2. Segerling L. J. - Applied Finite Elements Analysis, John Wiley and Sons 3. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India (P) Ltd., New Delhi, 1996. 4. Chandrupatla T A and Belegundu A D, Introduction to Finite Elements in Engineering, PHI.									

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PROGRAM ELECTIVE - I

**(Select any one course from the given
Program Elective Courses)**

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Program Elective – I (Advanced Casting, Forming and Joining Processes)							Code: MEPE501A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes.									
Course Objectives:									
1. To develop an understanding of advanced manufacturing processes, including modern casting, welding, metal forming, and hybrid machining techniques used in industrial applications. 2. To provide knowledge of micro- and nano-manufacturing methods, their process parameters, material removal mechanisms, and fabrication challenges. 3. To familiarize students with microscopic and spectroscopic characterization techniques for analyzing, evaluating, and improving the properties and performance of engineering materials for engineering applications.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the principles, working, and applications of advanced casting processes.								
CO2	Compare advanced welding techniques based on process capability, performance, and applications.								
CO3	Analyze hybrid machining processes and select suitable techniques for specific manufacturing requirements.								
CO4	Apply micro and nano-manufacturing methods by selecting appropriate process parameters, material removal mechanisms, and recognizing process limitations for given applications.								
CO5	Interpret material characterization results using microscopic, spectroscopic, and diffraction-based techniques.								
CO6	Apply knowledge of advanced manufacturing and characterization methods to solve practical engineering and industrial problems.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Advanced Casting: Recap of conventional casting processes and casting metallurgy. Advanced casting processes: Continuous casting, Investment casting, Vacuum casting, Squeeze casting and Stir Casting, Directional solidification process, Rapid solidification processes.								6
2.	Advanced Welding Processes: Plasma Arc welding, solid-state welding processes. Friction stir welding, Electron Beam welding, Laser beam welding, Ultrasonic welding, Under water welding,								6

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	Cryogenic welding, Thermal spray coatings, Welding of plastics and composites, Explosive joining, Adhesive bonding.	
3.	Advanced Forming Processes: Deformation mechanisms. Severe plastic deformation and High energy rate forming-Electro-magnetic forming, explosive forming, Hydro forming, Electro-hydraulic forming, Stretch forming, Contour roll forming and roll bonding. Applications and case studies.	7
4.	Finishing and Precision Manufacturing of Casted and Joined Components: Advanced machining and finishing processes: abrasive flow machining, magnetic abrasive finishing, abrasive water-jet machining, advanced EDM techniques, electrochemical machining and finishing processes, and hybrid non-conventional machining methods.	7
5.	Advanced Fabrication of Miniature Components: Study of machine configurations/setups, operating parameters, material removal mechanisms, applications, and recent developments in diamond turning machining, ultrasonic micromachining, focused ion beam machining, lithography, and photochemical machining; overview of key challenges associated with micro and nano fabrication processes.	6
6.	Defect Characterization of Cast and Formed Products: Advanced characterization techniques: electron and scanning probe microscopy (SEM, TEM, STM, AFM) for microstructural and surface analysis; elemental, crystallographic, and surface characterization using EDS, XRD, XPS, NMR, and EBSD for material structure, composition, and property evaluation.	7
TOTAL		39
Text Books:		
1. V. K. Jain, "Advanced Machining Processes", Allied Publishers Pvt. Ltd. 2. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", 6th Edition, Wiley, 2015. 3. A. Ghosh and A. K. Mallik, "Manufacturing Science", Affiliated East-West Press Pvt. Ltd., New Delhi.		
Reference Books:		
1. ASM International, "Metal Handbook, Vol. 6: Welding, Brazing and Soldering", Metal Park, Ohio. 2. ASM International, "Metal Handbook, Vol. 14: Forming", Metal Park, Ohio. 3. R. Balasubramaniam, R. V. Sarepaka, and S. Subbiah, "Diamond Turn Machining: Theory and Practice", CRC Press. 4. V. K. Jain, "Micro Manufacturing Processes", CRC Press. 5. S. Zhang, L. Li, and A. Kumar, "Materials Characterization Techniques", CRC Press, Boca Raton. 6. D. B. Murphy, "Fundamentals of Light Microscopy and Electronic Imaging", Wiley-Liss Inc., USA, 2001.		

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7. A. J. Schwartz, M. Kumar, B. L. Adams, and D. P. Field (Eds.), "Electron Backscatter Diffraction in Materials Science", Springer US, 2009.

E-Resources:

1. <https://www.youtube.com/watch?v=0iezQ4IeXsc>
2. <https://www.youtube.com/watch?v=Fr0oFSX8Uwg>
3. <https://www.youtube.com/watch?v=X53jGLPC69s>
4. <https://www.youtube.com/watch?v=ifZpBN1KABI&list=PLbMVogVj5nJTHuWr9HO1Uns1g8IBeyFFa>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Program Elective – I (Automobile Engineering)							Code: MEPE501B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic knowledge of engineering mechanics, thermodynamics, machine elements, and manufacturing processes.									
Course Objectives:									
1. Understand automobile design, construction, and vehicle architecture. 2. Study transmission systems and drive mechanisms. 3. Understand steering, suspension, and braking systems. 4. Familiarize with automotive electrical systems, maintenance, and emission control. 5. Understand vehicle performance parameters and standard automobile testing procedures. 6. Introduce modern automotive technologies and intelligent vehicle systems.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain automobile design, construction, and vehicle architecture.								
CO2	Analyze transmission systems and drive mechanisms.								
CO3	Explain steering, suspension, and braking systems.								
CO4	Apply automotive electrical systems, maintenance, and emission control techniques.								
CO5	Evaluate vehicle performance using standard testing procedures and instrumentation.								
CO6	Describe modern automotive technologies and intelligent vehicle systems.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Automobile Engineering: Scope, evolution and applications of automobiles in modern transportation, Vehicle dimensions and terminology, Engine location and drive arrangements, Automobile body types, Chassis and frame construction (Ladder frame, Monocoque and Space frame), Vehicle architecture and packaging, Materials used in automobile manufacturing (Steel, Aluminum and Composite materials), Vehicle design considerations (NVH and crashworthiness).								7
2.	Transmission System: Clutch: Types and working, Gearbox: Sliding mesh, Constant mesh and Synchromesh gearbox, Automatic transmission basics (AT, CVT, DCT), Propeller shaft and Universal joint, Differential and Rear axle, Final drive, Front-wheel drive, Rear-wheel drive and All-wheel drive systems.								7
3.	Steering, Suspension and Braking Systems: Steering geometry, Steering characteristics, Power steering and Electronic Power Steering (EPS), Suspension systems, Shock absorbers, Wheel alignment and								7

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	Wheel balancing, Hydraulic and Pneumatic braking systems, Disc and Drum brakes, Anti-lock Braking System (ABS), Electronic Brake Distribution (EBD).	
4.	Automotive Electrical Systems, Maintenance and Emission Control: Battery, Starting and Charging systems, Ignition systems, Automotive sensors and Electronic Control Unit (ECU), Vehicle instrumentation and dashboard systems, Preventive maintenance of automobiles, Vehicle diagnostics using OBD-II, BS-VI emission norms, Emission control techniques.	6
5.	Vehicle Performance and Testing: Vehicle Performance parameters: Fuel economy, acceleration, gradability, top speed and handling. Vehicle Testing: CMVR physical verification, free acceleration test, Brake test, Turning circle diameter test, Speedometer calibration, Gradability test, High speed performance test.	6
6.	Modern Automotive Technologies and Intelligent Vehicles: Introduction to Advanced Driver Assistance Systems (ADAS), Adaptive Cruise Control (ACC), Lane Departure Warning System (LDWS), Automatic Emergency Braking (AEB), Parking assist systems, Blind spot monitoring, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication, Autonomous and semi-autonomous vehicles, Connected vehicles and smart mobility, Future trends in automobile engineering	6
TOTAL		39
Text Books:		
1. Kirpal Singh, "Automobile Engineering", 13th Edition, Standard Publishers Distributors, 2014. 2. R. B. Gupta, "Automobile Engineering", 9th Edition, Satya Prakashan, 2017. 3. William H. Crouse and Donald L. Anglin, "Automotive Mechanics", 10th Edition, McGraw-Hill Education, 2007. 4. Tom Denton, "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, 2017. 5. James D. Halderman, "Advanced Hybrid and Electric Vehicles", 2nd Edition, Pearson Education, 2022.		
Reference Books:		
1. R. K. Rajput, "A Textbook of Automobile Engineering", 2nd Edition, Laxmi Publications, 2010. 2. V. A. W. Hillier and Peter Coombes, "Hillier's Fundamentals of Motor Vehicle Technology", 6th Edition, Nelson Thornes, 2011. 3. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", 1st Edition, SAE International, 1992. 4. Tom Denton, "Advanced Automotive Fault Diagnosis", 4th Edition, Routledge, 2020. 5. Hermann Winner, Stephan Hakuli, Felix Lotz, and Christina Singer, "Handbook of Driver Assistance Systems", 2nd Edition, Springer, 2016. 6. Robert Bosch GmbH, "Bosch Automotive Handbook", Robert Bosch GmbH.		
E-Resources:		
1. Prof. Ashish Tewari, <i>Automotive Chassis and Body Engineering</i>, Indian Institute of Technology		

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Kanpur, <https://nptel.ac.in/courses>

2. Prof. S. Thirumalini, *Automotive Engines*, Indian Institute of Technology Madras, <https://nptel.ac.in/courses>
3. Prof. Ashish Tewari, *Automotive Transmission Systems*, Indian Institute of Technology Kanpur, <https://nptel.ac.in/courses>
4. Prof. Ashish Tewari, *Vehicle Dynamics*, Indian Institute of Technology Kanpur, <https://nptel.ac.in/courses>
5. Prof. Ashish Tewari, *Automotive Systems and Controls*, Indian Institute of Technology Kanpur, <https://nptel.ac.in/courses>
6. Prof. S. Williamson, *Electric Vehicles – Part 1*, Indian Institute of Technology Madras, <https://nptel.ac.in/courses>

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Project Management System – II							Code: MEMD503		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Project Management System - I									
Course Objectives:									
1. To curate all project tasks to meet the needs of the company, consumers, and stakeholders.									
2. To schedule and divide different tasks and work among team members.									
3. To set the quality standard in a project.									
4. To use various PMS Software’s as per specific domain.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain various lifecycle models used in project management.								
CO2	Perform feasibility analysis and apply CPM & PERT Techniques.								
CO3	Understand project audit methodologies and scrum scheduling using Delphi Technique.								
CO4	Learn various project management software’s like JIRA, MSP, Teamwork.com, Trello etc.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Project Life cycle Management: Traditional project activity planning, agile project planning, coordination through integration management, project feasibility analysis, estimating project budget, project risk management, CPM, PERT, resource loading, resource leveling								08
2.	Project execution: Planning-monitoring-controlling cycle, earned value analysis, agile tool for tracking project, methods of project controlling, project audit, essentials of audit, evaluation, project closure, benefit realization, change management.								08
3.	Industry trends and software’s in project management: Enterprise project management, project success factor, standish factor of success, talent triangle, project governance, Change management, PMI’S code of conduct, software for project management, simulations software for project management.								10
TOTAL								26	
Text Books:									
1. Gary Richard Son, Brad Jackson, "Project Management Theory & Practice" CRC Press.									
2. John M. Nicholas, Herman Steyn, "Project Management for business engineering and technology", Elsevier.									
3. Arun Kanda, "Project Management: A Lifecycle Approach", PHI.									

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Reference Books:

1. “A Guide to the Project Management Body of Knowledge (PMBOK Guide)”, Project Management Institute.
2. B. B. Goel, “Project Management: Principles and Techniques”, Deep & Deep Publications Pvt. Ltd.

E-Resources:

1. Dr. Nimisha Singh, “Introduction to Project Management: Principles & Practices”, NPTEL Course - https://onlinecourses.swayam2.ac.in/imb25_mg167/preview
2. Prof. Raghu Nandan Sengupta, “Project Management”, NPTEL Course - https://onlinecourses.nptel.ac.in/noc25_mg78/preview
3. Project management for beginners by Ramesh Kumar
https://youtu.be/gnkjcRDQkw0?list=PLLy_2iUCG87CBuNhvti0h6W54ZmqrSDMJ

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OPEN ELECTIVE - III

**(Select any one course from the given Open
Elective Courses)**

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Open Elective – III (Data Analytics)							Code: ALOE503A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic knowledge of Mathematics and Statistics, Fundamentals of Computer Science									
Course Objectives:									
1. To introduce the types and applications of data analytics across domains. 2. To apply descriptive statistics and visualization techniques to summarize data. 3. To apply inferential statistics and hypothesis testing for decision-making. 4. To analyze relationships in data using correlation, regression, and ANOVA. 5. To build predictive models using classification and clustering techniques. 6. To familiarize students with prescriptive analytics and Big Data concepts.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the types of data analytics and their applications across domains.								
CO2	Apply descriptive statistics and visualization techniques to summarize data.								
CO3	Analyze data using inferential statistics and hypothesis testing methods.								
CO4	Apply correlation, regression, and ANOVA techniques for data-driven decisions.								
CO5	Design predictive models using classification and clustering approaches.								
CO6	Evaluate prescriptive analytics approaches and Big Data platforms for applications.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Data Analytics: Types of analytics — descriptive, diagnostic, predictive, and prescriptive; Analytics vs. reporting; Key applications across domains: business, healthcare, finance, and marketing; Overview of analytics tools landscape: Excel, Python, R, and Power BI (comparative overview); KPIs and metrics for decision-making.								04
2.	Descriptive Analytics: Frequency distributions, outliers; Measures of central tendency and dispersion; Interquartile range; Skewness and kurtosis; Normal distribution and z-scores; Data visualization principles: bar chart, histogram, box plot, scatter plot, and heat map.								05
3.	Inferential Statistics: Population vs. sample, random sampling; Sampling distribution, standard error; Hypothesis testing: null and alternate hypothesis, z-test, t-test; One-tailed and two-tailed tests; Confidence intervals and level of confidence; Type I and Type II errors.								05

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4.	Correlation, Regression & ANOVA: Correlation and scatter plots; Simple linear regression, least squares method; Multiple regression; Coefficient of determination (R^2); One-way and two-way ANOVA; Chi-square test of independence.	04
5.	Predictive Analytics: Introduction to predictive modeling; Classification techniques: logistic regression, decision trees; Clustering: k-means; Model evaluation: accuracy, confusion matrix; Time series analysis basics: moving averages, trend analysis.	04
6.	Prescriptive & Big Data Analytics: Prescriptive analytics: optimization and simulation for decision-making; Introduction to Big Data: the 5 V's, sources of big data; Overview of the Big Data ecosystem: Hadoop, Spark (conceptual only); Applications: business analytics, web analytics, and social media analytics.	04
TOTAL		26

Term Work:

Sr. No.	Title	Proposed Tutorial Activities
1	Introduction to Data Analytics	Identify descriptive, diagnostic, predictive, and prescriptive analytics using real-world case studies. Compare Excel, Python, R, and Power BI for analytics tasks.
2	Descriptive Statistics – I	Calculate mean, median, mode, range, variance, and standard deviation using a given dataset in Excel/Python.
3	Descriptive Statistics – II	Detect outliers using IQR and visualize distributions using histograms and box plots.
4	Data Visualization	Create bar charts, scatter plots, heat maps, and box plots. Interpret insights from visualizations.
5	Sampling & Probability	Perform random sampling, calculate standard error, and differentiate between population and sample using datasets.
6	Hypothesis Testing	Perform z-test and t-test for given scenarios and interpret Type I and Type II errors.
7	Correlation & Regression	Calculate correlation coefficients, build simple linear regression models, and interpret R^2 values.
8	ANOVA & Chi-Square	Perform one-way ANOVA and Chi-square tests using statistical software and interpret results.

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9	Predictive Analytics	Build basic classification models (Logistic Regression/Decision Tree) and perform K-Means clustering using Python.
10	Model Evaluation	Evaluate predictive models using confusion matrix and accuracy metrics.
11	Time Series Analytics	Apply moving averages and identify trends in time-series datasets.
12	Big Data & Prescriptive Analytics	Explore Hadoop and Spark concepts through case studies and discuss optimization-based decision-making.

Text Books:

1. Anil Maheshwari, "Data Analytics", McGraw Hill Education
2. Robert S. Witte and John S. Witte, "Statistics", Wiley Publications
3. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley India

Reference Books:

1. Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", Wiley India
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press

E-Resources:

1. NPTEL Course on "Introduction to Data Analytics" (IIT Madras Track)
Link: nptel.ac.in
2. NPTEL Course on "Data Analytics with Python" (IIT Roorkee Track)
Link: <https://nptel.ac.in/courses/106107220>
3. NPTEL Course on "Business Intelligence & Analytics" (IIT Madras Track)
Link: https://onlinecourses.nptel.ac.in/noc25_cs09/preview
4. NPTEL Course on "Business Analytics for Management Decision" (IIT Kharagpur Track)
Link: <https://nptel.ac.in/courses/110105089>
5. Coursera: "Google Data Analytics Professional Certificate" Link: [coursera.org](https://www.coursera.org)
6. edX: "Data Science: Statistics and Machine Learning" by Harvard University
Link: edx.org

EBooks

1. Allen B. Downey – Think Stats: Exploratory Data Analysis in Python (Open Access)
Link: greenteapress.com
2. EMC Education Services – Data Science and Big Data Analytics (Open Academic Archive)
Link: archive.org

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Open Elective – III (Green Building)							Code: ALOE503B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic environmental engineering, building materials & construction, engineering chemistry/ environmental science, basic knowledge of energy and sustainability concepts									
Course Objectives:									
1. To equip students with the principles of sustainable building design, resource-efficient construction, and green building practices.									
2. To provide students with knowledge of energy-efficient technologies, water and waste management, sustainable materials, and green building rating systems.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the concepts, principles, benefits, and environmental impacts associated with green buildings and sustainable development.								
CO2	Assess building orientation, climate-responsive planning, landscaping, green roofs, and green walls for improving environmental performance.								
CO3	Evaluate building energy consumption and recommend energy-efficient strategies, HVAC optimization, renewable energy systems, and conservation measures.								
CO4	Design suitable water conservation, rainwater harvesting, greywater recycling, waste management, and sustainable drainage solutions for buildings.								
CO5	Select appropriate sustainable building materials and assess indoor environmental quality based on thermal comfort, indoor air quality, lighting, and acoustics.								
CO6	Compare major green building rating systems such as IGBC, GRIHA, and LEED and apply their principles to assess building sustainability.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Green Buildings: Definition, concept, and need of green buildings, Sustainable development principles, Environmental impacts of conventional buildings, Benefits of green buildings.								05
2.	Sustainable Planning & Architecture: Sustainable planning, Orientation and climate-responsive design, Landscape planning, Green roofs and walls.								05
3.	Energy Efficiency in Buildings: Energy consumption in buildings, Energy-efficient building design, HVAC optimization, Renewable energy systems (solar, wind), Energy audit and conservation techniques.								04

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4.	Water & Waste Management: Water conservation techniques, Rainwater harvesting systems, Greywater recycling, Waste management in buildings, Sustainable drainage systems.	04
5.	Sustainable Materials & Indoor Environmental Quality: Eco-friendly building materials, Low embodied energy materials, Recycled and locally available materials, Indoor air quality (IAQ), Thermal comfort, lighting, and acoustics.	04
6.	Green Building Rating Systems & Regulations: Overview of rating systems: Indian Green Building Council (IGBC) Green Rating for Integrated Habitat Assessment (GRIHA) Leadership in Energy and Environmental Design (LEED)	04
TOTAL		26
Teamwork : (Any 10)		
1. Study any IGBC/GRIHA certified building and identify the sustainable features adopted. 2. Study how sustainable development principles have been implemented in any residential, commercial, or institutional building. 3. Study a construction project and identify its environmental impacts. Suggest green alternatives to reduce these impacts. 4. Analyze building designed using passive architectural principles. 5. Study the site planning of a green campus, township, or commercial complex. 6. Study an existing building incorporating green roofs or vertical gardens. 7. Study an energy-efficient building and identify passive design strategies adopted. 8. Study a building utilizing renewable energy systems and evaluate their benefits. 9. Analyze an energy audit report (or published case study) and summarize the recommended energy-saving measures. 10. Study water conservation measures implemented in any green building. 11. Study a residential or institutional building with rainwater harvesting and grey water reuse systems. 12. Study the waste management practices of a smart city, residential township, or institutional campus. 13. Study a building that has extensively used sustainable building materials. 14. Perform a literature review on the life cycle assessment of one construction material. 15. Study an office, hospital, educational building, or green building focusing on indoor environmental quality improvements. 16. Compare two certified buildings, each evaluated under different rating systems (e.g., IGBC vs LEED or GRIHA vs IGBC). 17. Study the certification journey of an IGBC or GRIHA certified building.		

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Text Books:

1. K.S. Jagadeesh, "Alternative Building Materials and Technologies", New Age International.
2. C.J. Kibert, "Sustainable Construction: Green Building Design and Delivery", Wiley.
3. Charles J. Kibert, "Green Buildings: Principles and Practices", Island Press.

Environmental Legislations & Standards:

Indian Regulations

1. Environment (Protection) Act, 1986
2. Energy Conservation Act, 2001
3. National Building Code (NBC) of India
4. Eco-Niwas Samhita (Energy Conservation Building Code – Residential)

Standards & Guidelines

1. Energy Conservation Building Code (ECBC)
2. GRIHA & IGBC rating guidelines
3. LEED certification standards
4. Bureau of Energy Efficiency (BEE) norms

Reference Books:

1. O.H. Koenigsberger, "Manual of Tropical Housing and Building", Orient BlackSwan
2. G.Z. Brown and Mark DeKay, "Sun, Wind & Light", Wiley
3. Laurie Baker, "Building with Earth", Centre for Science and Environment
4. Indian Green Building Council, "IGBC Manuals and Guidelines", CII – Indian Green Building Council

E-Resources:

1. Indian Green Building Council - <https://igbc.in>
2. Green Rating for Integrated Habitat Assessment - <https://grihaindia.org>
3. U.S. Green Building Council - <https://usgbc.org>
4. NPTEL Green Building courses - <https://nptel.ac.in>
5. Ministry of Environment, Forest and Climate Change - <https://moef.gov.in>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Open Elective – III (Electrical Mobility)							Code: ALOE503C		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic Electrical and Electronics Engineering.									
Course Objectives:									
1. To apply fundamental principles of electric mobility to interpret EV architectures, components and applications. 2. To utilize energy storage and battery management concepts to evaluate battery performance, charging, and safety. 3. To implement basic concepts of EV powertrains, electric drives, regenerative braking, and charging infrastructure. 4. To integrate smart charging, vehicle-to-grid, IoT, and emerging technologies for sustainable electric mobility.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the concepts, architecture, and applications of Electric and Hybrid Electric Vehicles.								
CO2	Identify the suitable energy storage systems used in electric vehicles.								
CO3	Illustrate battery charging methods, battery management systems, and SoC estimation techniques.								
CO4	Interpret hybrid powertrain configurations, operating modes, and regenerative braking.								
CO5	Demonstrate the use of electric drives, charging levels, charging standards, and EV charging equipment.								
CO6	Describe EV charging technologies and grid integration concepts such as G2V, V2G, V2H, V2B, and V2V.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Electric Mobility: Need for electric mobility, evolution of EVs, advantages and challenges, environmental and economic aspects, EV vs conventional vehicles, types of EVs: BEV, HEV, PHEV and fuel-cell vehicles, basic EV architecture and major components.								04
2.	Energy Storage Systems: Energy storage requirements, battery terminology and specifications, Li-ion batteries and their types, basic battery characteristics, battery alternatives: solid-state, Aluminium-air, fuel cell and supercapacitor, battery–supercapacitor hybrid system, selection of energy storage system.								04

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3.	Battery Charging and Management: EV charging basics, AC and DC charging, charging methods and levels, charging time and factors affecting charging, Battery Management System (BMS), functions of BMS, State of Charge (SoC), State of Health (SoH), State of Power (SoP), cell balancing, battery thermal management and safety.	05
4.	EV Powertrain and Electric Drives: EV powertrain architecture, energy flow in EVs, vehicle performance and basic tractive effort, electric motors used in EVs: BLDC and PMSM, motor selection, basic drive control, regenerative braking and its benefits.	04
5.	EV Charging Infrastructure: EV charging infrastructure, charging levels, AC/DC chargers, EVSE, charging connectors and standards: CCS, CHAdeMO, SAE J1772, Bharat AC/DC, basic charging station components, installation and safety considerations.	04
6.	Smart and Emerging Electric Mobility: Grid-to-Vehicle (G2V), Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Vehicle-to-Building (V2B), Vehicle-to-Vehicle (V2V), smart charging, wireless charging, battery swapping, energy management, IoT and digital technologies in EVs, future trends and challenges.	05
TOTAL		26
Termwork :		
- Study the architecture of an Electric Vehicle (EV) and identify the functions of major components such as battery, BMS, motor, inverter, charger, controller and sensors. - Compare 3–5 EVs available in India based on battery capacity, motor power, driving range, charging time, efficiency, cost and other key specifications. - Study and compare different energy storage technologies such as Li-ion batteries, solid-state batteries, fuel cells and supercapacitors based on energy density, charging time, life, cost, safety and applications. - Visit an EV charging station and study the charger type, AC/DC charging, charging level, connector/standard, power rating, and charging time and safety provisions. - Prepare a basic layout of an EV charging station showing charging points, power supply, protection system, parking area, cable routing, safety provisions and user facilities. - Study smart EV charging and Vehicle-to-Grid (V2G) concepts, including G2V, V2G, V2H and V2B, and identify their applications in smart grids and buildings. - Collect and analyze EV performance or charging data using Excel/Python/MATLAB and study parameters such as battery capacity, range, charging time and energy consumption. - Design a conceptual IoT-based EV monitoring system showing sensors, communication network, cloud platform and user interface for monitoring SoC, temperature, charging status and energy consumption. - Study regenerative braking in EVs and prepare an energy-flow diagram. Analyze energy recovery under different braking conditions using numerical calculations or simulation. - Study an emerging EV technology such as battery swapping, wireless charging, solid-state batteries, autonomous EVs, solar charging or second-life batteries and evaluate its technical, economic and environmental benefits.		

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Text Books:
1. James Larminie and John Lowry, "Electric Vehicle", John Wiley & Sons, 2012. 2. Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE International. 3. K. T. Chau, "Energy Systems for Electric and Hybrid Vehicles", The Institution of Engineering and Technology. 4. D. A. J. Rand, R. Woods, and R. M. Dell, "Batteries for Electric Vehicles", Research Studies Press Ltd., New York, John Wiley & Sons. 5. "Electric & Hybrid Vehicles – Design Fundamentals", CRC Press.
Reference Books:
1. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009. 2. Junwei Lu and Jahangir Hossain et al. (Eds.), "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library. 3. Tom Denton, "Automobile Electrical and Electronic Systems", SAE International Publications. 4. C. Mi, M. A. Masrur, and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011. 5. Mark Warner, "The Electric Vehicle Conversion Handbook", HP Books, 2011.
E-Resources:
1. https://www.theiet.org/resources/books/transport/vehicle2grid.cfm 2. https://www.sae.org/publications/books/content/pt-143.set/ 3. http://nptel.ac.in/courses/108103009/

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Open Elective – III (Introduction to Stock Market)							Code: ALOE503D		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
- Basic knowledge of economics and financial systems. - Familiarity with percentage calculations and simple mathematics. - Interest in investing and financial markets.									
Course Objectives:									
- To understand the structure and functioning of financial and stock markets along with investor psychology. - To apply candlestick patterns and indicators for identifying market trends. - To understand the fundamentals of option trading and option pricing concepts. - To develop short-term and long-term investment strategies using fundamental and technical analysis.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the functioning of financial markets using fundamental analysis								
CO2	Analyze stock price movements using candlestick patterns for trading decisions.								
CO3	Analyze stock price movements using technical indicators for trading decisions.								
CO4	Describe the concepts of derivatives and option trading.								
CO5	Apply the strategies for option trading.								
CO6	Apply investment strategies based on market analysis.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Fundamental Analysis and Investor Psychology: Introduction to Financial Markets, Primary and Secondary Markets, Market Participants, Stock Exchanges, SEBI and Regulatory Framework, Investment vs Trading, Understanding Business Models, Reading Financial Statements (Balance Sheet, Profit & Loss Account, Cash Flow Statement), Fundamental Ratios (EPS, PE Ratio, PB Ratio, ROE, ROCE, Debt-Equity Ratio), Sector Analysis, Economic Indicators, Investor Psychology, Market Emotions (Fear & Greed), Behavioral Biases, Risk Management Principles.								06
2.	Technical Analysis using Candlestick Charts: Introduction to Technical Analysis, Dow Theory, Support and Resistance, Trend Analysis, Price Action Concepts Candlestick Anatomy: Single Candlestick Patterns (Doji, Hammer, Shooting Star, Marubozu, Spinning Top), Double Candlestick Patterns (Bullish & Bearish Engulfing, Harami, Piercing Pattern, Dark Cloud Cover), Triple Candlestick								04

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	Patterns (Morning Star, Evening Star, Three White Soldiers, Three Black Crows), Gap Analysis, Trend Reversal and Continuation Patterns.	
3.	Technical Analysis using Indicators: Technical Indicators : Moving Averages (SMA, EMA), MACD, RSI, Stochastic Oscillator, Bollinger Bands, VWAP, ADX, ATR, Volume Analysis, Fibonacci Retracement, Pivot Points, Trend Confirmation, Indicator-Based Trading Strategies, Combining Multiple Indicators, Entry and Exit Rules, Backtesting Concepts.	04
4.	Introduction to Derivatives and FNO: Introduction to Derivatives, Futures and Options, Types of Options (Call and Put), Option Terminology (Strike Price, Expiry, Premium, Lot Size, Open Interest), Intrinsic and Time Value, ITM, ATM, OTM Options, Option Chain Analysis, Greeks (Delta, Gamma, Theta, Vega, Rho - Basic Concepts), Option Pricing Factors, Option Expiry and Settlement Process.	04
5.	Introduction to Option Trading Strategies: Option Buying vs Option Selling, Risk and Reward Analysis, Long Call, Long Put, Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread, Bull Put Spread, Bear Call Spread, Iron Condor (Basic Concept), Straddle and Strangle (Introduction), Position Sizing, Stop Loss Techniques, Capital Management, Risk Management in Options Trading.	04
6.	Short-Term and Long-Term Trading & Investment Strategies: Swing Trading, Positional Trading, Intraday Trading (Overview), Momentum Trading, Breakout Trading, Trend Following Strategies, Portfolio Building, Value Investing, Growth Investing, Dividend Investing, SIP in Equity, Asset Allocation, Diversification, Trading Plan Development, Trading Journal, Performance Evaluation, Common Mistakes Made by Traders and Investors, Ethics in Financial Markets.	04
Total		26

Term Work:

Perform Any 10:

Sr No	Title	Proposed Activities
1	Stock Market Basics & Trading Platform	Introduction to NSE & BSE, SEBI, Demat & Trading Accounts, Market Participants, Creating a Paper Trading Account.
2	Fundamental Analysis – I	Reading Financial Statements, EPS, PE Ratio, Book Value, Market Capitalization, Sector Analysis
3	Fundamental Analysis – II & Investor Psychology	Company Comparison, Economic Indicators, Market Cycles, Fear & Greed, Trading Discipline

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4	Candlestick Analysis – I	Candlestick Anatomy, Doji, Hammer, Shooting Star, Marubozu, Trend Identification
5	Candlestick Analysis – II	Bullish/Bearish Engulfing, Morning Star, Evening Star, Support & Resistance using Charts
6	Technical Indicators – I	SMA, EMA, Volume Analysis, Trend Identification using TradingView
7	Technical Indicators – II	RSI, MACD, Bollinger Bands, VWAP, Indicator-based Entry & Exit
8	Option Trading Fundamentals	Call & Put Options, Strike Price, Premium, Expiry, Option Chain Analysis
9	Option Buying Strategies	Long Call, Long Put, Break-even Calculation, Risk & Reward Analysis
10	Option Selling Strategies	Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread
11	Short-term Trading Strategies	Intraday (Concept), Swing Trading, Breakout Trading, Risk Management
12	Long-term Investment Strategies	Value Investing, Growth Investing, Dividend Investing, Portfolio Diversification

Students should spend most of the session on:

- Live chart analysis using TradingView or similar platforms.
- Analyzing real companies using NSE/BSE financial data.
- Paper trading (no real money involved).
- Maintaining a trading journal.
- Presenting and reviewing trading decisions.

Reference Books:

1. John J. Murphy, "Technical Analysis of the Financial Markets", Pearson.
2. Benjamin Graham, "The Intelligent Investor", Harper Business.
3. Martin J. Pring, "Technical Analysis Explained", McGraw-Hill.
4. Sheldon Natenberg, "Option Volatility and Pricing", McGraw-Hill.
5. Aswath Damodaran, "Investment Valuation", Wiley.
6. Alexander Elder, "Trading for a Living", Wiley.

E-Resources:

1. National Stock Exchange (NSE) Learning Portal – <https://www.nseindia.com> learn tab
2. Bombay Stock Exchange (BSE) Investor Education – <https://www.bseindia.com>
3. SEBI Investor Education – <https://investor.sebi.gov.in>
4. NISM (National Institute of Securities Markets) – <https://www.nism.ac.in>
5. Zerodha Varsity – <https://zerodha.com/varsity>
6. Investopedia – <https://www.investopedia.com>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Open Elective – III (Patent Law for Engineers and Scientists)							Code: ALOE503E		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	-	-	50	50	-	100
Prerequisites:									
Basic understanding of engineering/scientific concepts and technological innovation, Basic skills in technical reading, documentation, and report writing.									
Course Objectives:									
1. To understand the importance of Intellectual Property Rights (IPR) and patents. 2. To identify patentable and non-patentable inventions based on patentability criteria. 3. To conduct prior-art and patent searches using public patent databases. 4. To draft a basic patent specification, including claims and abstract. 5. To understand and apply the complete patent filing, examination, and granting process in India. 6. To analyze engineering case studies involving patents, innovation, and commercialization.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply the provisions of the Indian Patent Law to engineering inventions.								
CO2	Perform prior-art and patent searches using standard patent databases.								
CO3	Analyze the patentability, filing, examination, and grant process under the Indian Patent Act.								
CO4	Evaluate patent infringement, licensing, technology transfer, and commercialization issues.								
CO5	Draft a patent specification, including claims and abstract, in compliance with patent law.								
CO6	Develop a patent application for an innovative engineering solution following legal and procedural requirements.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Intellectual Property Rights and Patents: Introduction to Intellectual Property Rights (IPR), significance of IPR in engineering, innovation and entrepreneurship, types of IPR, concept and objectives of patents, patentability criteria (novelty, inventive step and industrial applicability), patentable and non-patentable inventions under the Indian Patent Act, 1970, patents versus research publications and products, role of patents in technology commercialization and startup ecosystem. Case Study: Patentability analysis of a simple engineering innovation.								05
2.	Indian Patent Law and Prior-Art Search: Overview of the Indian Patent Act, 1970 and its amendments, objectives and scope of patent law, rights and duties of inventors, overview of WIPO, Patent Cooperation Treaty (PCT) and international patent systems, prior-art search techniques, patent classification systems, patent search using Google Patents, InPASS, Espacenet, and WIPO PATENTSCOPE								04

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	novelty assessment and patent landscape analysis. Case Study: Prior-art search and novelty analysis of an engineering invention.	
3.	Patent Drafting: Structure and components of a patent specification including title, field of invention, background, prior art, problem statement, objectives, summary of invention, brief description of drawings, detailed description, claims, abstract, and drawings. Principles of claim drafting, dependent and independent claims, patent drafting guidelines, common drafting errors, and patent documentation for engineering innovations. Case Study: Drafting of a patent specification for a smart engineering product.	05
4.	Patent Filing, Examination and Grant: Patent filing procedure in India, provisional and complete specification, online filing process, statutory forms, publication of patent application, request for examination, First Examination Report (FER), response to objections, hearing process, patent grant, renewal, restoration, opposition, and maintenance of patents under the Indian Patent Act. Case Study: Patent filing and grant timeline of an Indian engineering patent.	04
5.	Patent Commercialization and Legal Issues: Patent ownership, licensing, assignment, technology transfer, patent valuation, startup and university patents, patent infringement, remedies and dispute resolution, freedom-to-operate (FTO), patent analytics, commercialization strategies, and ethical issues in patent protection. Case Study: Commercialization of a patented engineering innovation.	04
6.	Emerging Technologies and Patent Case Studies: Patents in Artificial Intelligence, Machine Learning, Internet of Things (IoT), Robotics, Semiconductor Technology, Biotechnology, Software, Green Technologies, and Industry 4.0, AI-generated inventions, recent developments in patent law, international patent trends, patent portfolio management, and innovation-driven entrepreneurship. Case Study: Analysis of landmark patent disputes such as Apple vs Samsung or an Indian engineering innovation, along with preparation of a basic patent draft for an engineering solution.	04
Total		26

Term Work:

Students shall complete the following practical, activity-oriented assignments based on a selected engineering innovation/project:

1. Identify suitable IP protection for an engineering innovation and assess basic patentability criteria.
2. Conduct patent searches using Google Patents, IP India, WIPO PATENTSCOPE and Espacenet and analyze the novelty of the selected innovation.
3. Identify a copyrightable work such as software, technical content or digital work and prepare/undertake the copyright registration process.

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4. Develop a product/start-up brand, conduct trademark search, identify the appropriate class and prepare a basic trademark application.
5. Identify protectable visual features of an engineering product, conduct design search and prepare a basic design registration application.
6. Prepare a basic patent specification including title, background, objectives, description, drawings, abstract and claims for an engineering innovation.
7. Prepare a mock provisional/complete patent application and study the filing, publication, examination, FER, response and grant process in India.
8. Study the PCT route and prepare a mock PCT application based on the selected engineering invention.
9. Analyze patents in a selected emerging technology area and identify major patent holders, technology trends and basic FTO considerations.
10. Develop an IP portfolio for the selected innovation covering patent, copyright, trademark/design and propose a basic commercialization strategy.

Text Books:

1. P. Narayanan, "Patent Law", Eastern Law House.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw-Hill.
3. N. S. Gopalakrishnan and T. G. Agitha, "Principles of Intellectual Property", Eastern Book Company.
4. Government of India, "The Patents Act, 1970 (as amended) and The Patents Rules, 2003 (as amended)", Government of India.

Reference Books:

1. David Pressman, "Patent It Yourself", NOLO Publications.
2. WIPO, "WIPO Intellectual Property Handbook: Policy, Law and Use", World Intellectual Property Organization.
3. Indian Patent Office, "Manual of Patent Office Practice and Procedure", Office of the Controller General of Patents, Designs & Trade Marks (CGPDTM), Government of India.
4. Alexander I. Poltorak and Paul J. Lerner, "Essentials of Intellectual Property", John Wiley & Sons.

E-Resources:

1. **Patent Law for Engineers and Scientists** – NPTEL (IIT Madras):
<https://nptel.ac.in/courses/110106081>
2. **Intellectual Property** – NPTEL (IIT Madras): <https://nptel.ac.in/courses/109106137>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Metrology Laboratory							Code: MEAE503		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Fundamentals of Mechanical Engineering, Engineering Drawing, Basics of Manufacturing Processes									
Course Objectives:									
1. To familiarize students with the principles of engineering metrology, precision measuring instruments, and industrial measurement practices. 2. To develop students' skills in linear, angular, geometrical, surface finish, gear, and thread measurements using standard and precision measuring instruments. 3. To impart knowledge and practical competency in calibration, dimensional inspection, limit gauges, error analysis, and modern quality control techniques.									
Course Outcomes: After completion of this course, students will be able to									
CO1	Select appropriate precision measuring instruments and techniques for engineering measurements.								
CO2	Analyze measurement results and errors to determine dimensional accuracy and component quality.								
CO3	Evaluate and select suitable calibration, gauging, inspection, and quality control methods for industrial applications.								
List of Experiments:									
Experiment Nos. 1, 2, 3 and 11 are mandatory. Students shall perform any four experiments from Experiment Nos. 4 to 10.									
1. Fundamentals of Linear Measurement and the Concept of Calibration 2. Measurement of Linear and Angular Dimensions of a Component Using Measuring Instruments 3. Concept, Applications, and Design of GO and NO-GO Gauges; Numerical Problems on Gauge Design 4. Surface Roughness Measurement of a given specimen using Surface Roughness Tester 5. Determination of Geometry and Dimensions of a given component, cutting tool or thread profile using Tool Maker's Microscope or Profile Projector. 6. Comparative Measurement of Components Using a Mechanical Comparator or Pneumatic Comparator. 7. Determination of Gear Tooth Thickness using Gear Tooth Vernier. 8. Measurement of Geometrical Characteristics such as flatness, parallelism, concentricity and run-out of engineering components. 9. Measurement of Internal and External Dimensions of Engineering Components Using Bore Gauges, Outside Micrometres, Depth Micrometres, and Height Gauges.									

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10. Measurement System Analysis (MSA): Study of Repeatability of Precision Measuring Instruments Through Repeated Measurements; Determination of Mean, Standard Deviation, and Measurement Uncertainty Using Excel or Minitab.

11. Industry Visit

Visit to a NABL-accredited Calibration Laboratory or Precision Manufacturing Industry.

Exposure to advanced measurement systems such as CMM, Optical Inspection Systems, and Industry 4.0-based metrology to understand their industrial applications in manufacturing and quality control.

Reference Books:

1. Narayana K.L., Engineering Metrology.
2. Galyer J.F & Shotbolt C.R., Metrology for engineers
3. Judge A.W., Engineering Precision Measurements, Chapman and Hall
4. Jain R.K., Engineering Metrology, Khanna Publication.
5. I.C. Gupta, Engineering Metrology, Dhanpath Rai.
6. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, McGraw hill Publication

E-Resources:

1. nptel.ac.in/courses/112106179
2. www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Internship – IV							Code: MEIN504		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	-	-	02	-	-	25	-	-	25
Preamble:									
Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.									
Course Objectives:									
1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry. 2. Learn to implement the technical knowledge in real industrial situations.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.								
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.								
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.								
Internship Requirements									
1. Internship Duration: It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW). 2. Internship Opportunities: Students can explore various opportunities for internships at: a. Industries b. Research labs or organizations c. Collegiate clubs d. In-house research projects e. Online internships 3. Support and Assistance: Students can seek assistance for securing internships from: a. The Training and Placement cell, along with departmental coordinators b. Department or institute faculty members c. Personal contacts d. Directly connecting with industries or organizations 4. Request Letter: Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This letter, in the									

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standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

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SYLLABUS
SEMESTER - VI

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Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Applied Thermal Engineering							Code: MEPC612		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic knowledge of Engineering Thermodynamics, Heat Transfer, and Fluid Mechanics.									
Course Objectives:									
1. To understand the principles, construction, and operation of IC engines, steam generators, air compressors, refrigeration, and air conditioning systems. 2. To analyze the performance and thermodynamic processes of thermal engineering systems. 3. To apply engineering principles for solving numerical problems related to thermal systems. 4. To develop awareness of modern thermal technologies, emission control, energy efficiency, and sustainable engineering practices.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the construction, working, classification, and engine cycles of IC engines.								
CO2	Analyze the combustion processes and fuel systems of SI and CI engines.								
CO3	Evaluate the performance and emission characteristics of IC engines.								
CO4	Explain the construction, working, and applications of steam generators and air compressors.								
CO5	Explain the principles and operation of refrigeration and air conditioning systems.								
CO6	Apply thermal engineering concepts to solve engineering problems related to thermal systems.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Basics of Internal Combustion Engines: Introduction to Internal Combustion (IC) Engines: Definition and working principle of IC engines, construction and main components of IC engines, engine terminology, classification and applications of IC engines. Intake and exhaust systems, valve actuating mechanism, and valve timing diagram. Introduction to engine cycles including air-standard cycle, fuel-air cycle and actual cycle, comparison of air-standard and actual cycles, and losses in IC engines.								6
2.	Combustion in SI and CI Engines: Spark Ignition (SI) and Compression Ignition (CI) Engines: Carburetion, electronic fuel injection system, stages of combustion in SI engines, abnormal combustion, detonation and octane number. Fuel injection system, fuel injectors and nozzles, stages of combustion in CI engines, knocking and factors affecting knocking and cetane number.								7
3.	Testing and Performance of IC engines and Emissions: Testing and Performance: Objectives of testing, performance parameters including indicated power, brake power, friction power, specific fuel consumption								8

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	(SFC) and air-fuel ratio (AF ratio), methods for determining performance parameters, characteristic curves and heat balance sheet. Emissions: Engine pollutants (CO, HC, NO _x , and PM), their environmental impact, emission control techniques including EGR, SCR, DPF, and TWC, overview of BS-VI and Euro 6 emission standards.	
4.	Steam Generators: Introduction and classification of boilers, construction and working of fire tube and water tube boilers, Babcock and Wilcox boiler, (simple construction & working). boiler mountings, boiler accessories, boiler efficiency, boiler safety, and industrial applications of boilers. Modern trends: High-pressure boilers and fluidized bed boilers, Boiler draught system-concept and classification -steam jet draught.	6
5.	Air Compressors: Introduction to air compressors, functions, classification, and applications, single-stage reciprocating air compressor—construction and working with line diagram, expression for work done and power required (without derivation), numerical problems on work done and power required, multistage compression and its advantages, rotary compressors—construction and working, comparison between reciprocating and rotary compressors, introduction to screw compressors and their applications.	6
6.	Refrigeration and Air Conditioning: Refrigeration: Definition, unit of refrigeration, coefficient of performance (COP), vapour compression (VCR) and vapour absorption (VAR) refrigeration systems with flow diagrams; refrigerants—classification, properties, and selection criteria. Psychrometry: Introduction and psychrometric properties: dry air, saturated air, dry-bulb temperature, wet-bulb temperature, dew-point temperature, relative humidity, absolute humidity, and specific humidity. Air Conditioning: Introduction, classification, and working principles of summer, winter, and year-round air conditioning systems.	6
TOTAL		39
Text Books:		
1. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill. 2. M. L. Mathur and R. P. Sharma, "A Course in Internal Combustion Engines", Dhanpat Rai & Co. 3. H. N. Gupta, "Fundamentals of Internal Combustion Engines", PHI Learning Pvt. Ltd. 4. R. K. Rajput, "Thermal Engineering", 6th Edition, Laxmi Publications, New Delhi. 5. A. Domkundwar, "A Course in Thermal Engineering", Dhanpat Rai & Co., New Delhi.		
Reference Books:		
2. John B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill. 3. C. S. Domkundwar and S. Domkundwar, "Internal Combustion Engine", Dhanpat Rai & Co. 4. R. Yadav, "Internal Combustion Engine", Central Book Depot, Ahmedabad.		

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5. S. Domkundwar, C. P. Kothandaraman, and A. Domkundwar, "Thermal Engineering", Dhanpat Rai & Co.
6. B. K. Sarkar, "Thermal Engineering", 3rd Edition, Tata McGraw Hill, New Delhi.
7. S. C. Arora and C. S. Domkundwar, "A Course in Refrigeration and Air Conditioning", 4th Edition, New Age International (P) Ltd., New Delhi.

E-Resources:

1. Prof. Pranab K. Mondal, Prof. Vinayak N. Kulkarni, "IC Engines And Gas Turbines", IIT Guwahati - <https://nptel.ac.in/courses/112103262>
2. Prof. C. S. Shankar Ram, "Fundamentals of Automotive Systems", IIT Madras - <https://nptel.ac.in/courses/107106088>
3. Prof. Pranab K. Mondal, "Engine system and performance", https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_me19
4. <https://www.youtube.com/watch?v=1X20Rdi4Vnk>
5. Prof. Ravi Kumar, "Refrigeration and Air-conditioning", IIT Roorkee - <https://nptel.ac.in/courses/112107208>
6. Prof. R.C. Arora, Prof. M. Ramgopal, "Refrigeration and Air Conditioning", IIT Kharagpur - <https://nptel.ac.in/courses/112105128>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Applied Thermal Engineering Lab							Code: MEPC612P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Basic knowledge of Engineering Thermodynamics, Heat Transfer, and Fluid Mechanics.									
Course Objectives:									
1. To enable students to perform thermal engineering experiments effectively. 2. To guide students in analyzing experimental results and system performance. 3. To expose students to practical applications of thermal engineering systems.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply thermodynamics principles to conduct and evaluate thermal engineering experiments.								
CO2	Analyze experimental data to determine performance, efficiency, and energy balance of thermal systems.								
CO3	Evaluate the practical applications and performance of thermal engineering systems in industrial environments.								
Course Contents:									
List of Experiments:									
The student shall complete any eight experiments from the following activities.									
A. Practical Experiments:									
Complete any Six Experiments from the following list of Eight Experiments:									
1. Performance and Morse Test on Multi-Cylinder Petrol Engine. 2. Performance Test on Diesel Engine and Preparation of Heat Balance Sheet. 3. Trial on Multi-Stage Positive Displacement Air Compressor. 4. Determination of Dryness Fraction of Steam Using Combined Separating and Throttling Calorimeter. 5. Trial on Boiler to Determine Boiler Efficiency, Equivalent Evaporation and Energy Balance. 6. Performance Test on Vapour Compression Refrigeration System. 7. Performance Test on Vapour Absorption Refrigeration System. 8. Test on Ice Plant Test Rig.									
B. Study Experiments (any 1):									
9. Study of Construction and Working of Different Types of Heat Exchangers. 10. Study of Construction and Working of Solar Water Heating System. 11. Study of Construction and Working of Gas Turbine Power Plant.									
C. Industrial Visit (Compulsory):									
12. Industrial Visit: Visit to a Thermal Power Plant /HVAC and Refrigeration Industry/Boiler Manufacturing Industry./Cold Storage Plant/Heat Exchanger Manufacturing Unit, or Renewable Energy Plant to study the practical applications of thermal engineering systems.									

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Reference Books:

1. John B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill.
2. C. S. Domkundwar and S. Domkundwar, "Internal Combustion Engine", Dhanpat Rai & Co.
3. R. Yadav, "Internal Combustion Engine", Central Book Depot, Ahmedabad.
4. S. Domkundwar, C. P. Kothandaraman, and A. Domkundwar, "Thermal Engineering", Dhanpat Rai & Co.
5. B. K. Sarkar, "Thermal Engineering", 3rd Edition, Tata McGraw Hill, New Delhi.
6. S. C. Arora and C. S. Domkundwar, "A Course in Refrigeration and Air Conditioning", 4th Edition, New Age International (P) Ltd., New Delhi.

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Machine Design - II							Code: MEPC613		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	04	40	60	-	-	-	100
Prerequisites:									
Knowledge of Engineering Mechanics, Strength of Materials, Theory of Machines and Machine Design –I									
Course Objectives:									
1. To understand the design principles of advanced machine elements, machine tool gearboxes, and pressure vessels. 2. To apply engineering principles, design standards, and design data books in the analysis and design of mechanical systems. 3. To develop practical skills in machine design through design projects, case studies, and CAD-based engineering tools.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Design spur and helical gears considering strength, dynamic loading, lubrication, and material selection								
CO2	Design bevel and worm gears considering strength, efficiency, thermal effects, and operating conditions.								
CO3	Select suitable sliding and rolling contact bearings based on load, life, lubrication, and operating conditions								
CO4	Design and select suitable brakes, clutches, and flywheels for power transmission and motion control applications.								
CO5	Analyze the design and operation of machine tool gearboxes using speed charts, structural diagrams, and ray diagrams.								
CO6	Apply the principles of pressure vessel design in accordance with relevant engineering standards and safe design practices								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Spur and Helical Gear Design: Gear terminology, Spur gears, Helical gears, Lewis equation, Dynamic loading, Gear materials, Lubrication								7
2.	Bevel and Worm Gear Design: Bevel gears, Worm gears, Beam and wear strength, Efficiency, Thermal considerations, Gear failures								7
3.	Bearings: Hydrodynamic lubrication, Journal bearings, Rolling contact bearings, Static and dynamic load ratings, Bearing life, Bearing selection								6

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4.	Brakes, Clutches and Flywheel: Plate clutch, Cone clutch, Centrifugal clutch, Shoe brakes, Band brakes, Disc brakes, Introduction to flywheel	7
5.	Machine Tool Gearbox Design: Introduction to machine tool gearboxes, design considerations, variable speed range, speed chart, structural diagram, ray diagram, gearing diagram, and deviation diagram.	6
6.	Pressure Vessel Design: Thin and thick cylinders, Lame's equation, compound cylinders, pressure vessel classification, stresses, failure modes, welded joints, design of cylindrical shells, end closures, nozzles and openings, pressure vessel support	6
TOTAL		39
Text Books:		
1. V. B. Bhandari, "Design of Machine Elements", 4th Edition, McGraw Hill Education, New Delhi. 2. R. S. Khurmi and J. K. Gupta, "A Textbook of Machine Design", S. Chand & Company Ltd., New Delhi. 3. Richard G. Budynas and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", 11th Edition, McGraw Hill Education.		
Reference Books:		
1. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", 6th Edition, John Wiley & Sons. 2. PSG College of Technology, "PSG Design Data Book", Kalaikathir Achchagam, Coimbatore. 3. N. K. Mehta, "Machine Tool Design and Numerical Control", 4th Edition, Tata McGraw-Hill Education. 4. Dennis R. Moss and Michael Basic, "Pressure Vessel Design Manual", 4th Edition, Elsevier. 5. Bureau of Indian Standards (BIS), "Relevant IS Codes for Machine Design", Bureau of Indian Standards. 6. American Society of Mechanical Engineers (ASME), "Relevant ASME Standards and Boiler & Pressure Vessel Code (BPVC), Section VIII", ASME.		
E-Resources:		
1. Prof. K. Gopinath, Prof. M.M. Mayuram, "Machine Design II", IIT Madras - https://nptel.ac.in/courses/112106137		

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Machine Design – II Lab							Code: MEPC613P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Knowledge of Engineering Mechanics, Strength of Materials, Theory of Machines, Machine Design –I									
Course Objectives:									
1. To provide practical knowledge of mechanical design principles, standards, codes, and design data. 2. To develop skills in design and analysis of mechanical systems and components. 3. To familiarize students with industrial design practices through case studies, failure analysis, and component selection.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply machine design principles to gears, bearings, brakes, clutches, and pressure vessels.								
CO2	Analyze mechanical systems considering strength, efficiency, life, lubrication, and operating conditions.								
CO3	Design and select machine components using standards, design data, and CAD tools.								
List of Experiments:									
Guidelines:									
The laboratory shall focus on application-oriented design of mechanical systems through design projects and case studies/assignments. Students shall apply engineering design principles, relevant standards/codes, design data books, and CAD tools to solve practical engineering problems.									
Part A: Design Project									
Students shall undertake one design project , individually or in a group of not more than four students , and submit a comprehensive design report with a presentation. The report shall include design calculations, material selection, standard component selection, engineering drawings, CAD model, and other relevant design details.									
1. Multi-speed Gearbox for Machine Tools. 2. Belt Conveyor System for Material Handling. 3. Horizontal Pressure Vessel. 4. Vertical Pressure Vessel. 5. I.C. Engine Components.									
Part B: Case Study / Assignment									
Students shall prepare a detailed report and make a presentation on any three of the following topics. The report shall include design considerations, relevant engineering standards/codes, recent industrial practices, and conclusions, wherever applicable.									
1. Comparative study, failure analysis, lubrication, and industrial applications of spur and helical gears.									

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2. Comparative study, efficiency analysis, and industrial applications of bevel and worm gears.
3. Selection, life estimation, lubrication, and failure analysis of sliding and rolling contact bearings.

Comparative study, performance evaluation, selection criteria, and industrial applications of brakes and clutches.

Reference Books:

1. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", 6th Edition, John Wiley & Sons.
2. PSG College of Technology, "PSG Design Data Book", Kalaikathir Achchagam, Coimbatore.
3. N. K. Mehta, "Machine Tool Design and Numerical Control", 4th Edition, Tata McGraw-Hill Education.
4. Dennis R. Moss and Michael Basic, "Pressure Vessel Design Manual", 4th Edition, Elsevier.
5. Bureau of Indian Standards (BIS), "Relevant IS Codes for Machine Design", Bureau of Indian Standards.
6. American Society of Mechanical Engineers (ASME), "Relevant ASME Standards and Boiler & Pressure Vessel Code (BPVC), Section VIII", ASME.

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Computer Integrated Manufacturing Lab							Code: MEPC614		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	04	01	03	-	-	25	-	50	100
Prerequisites:									
Solid Modeling and Drafting, Computer Aided Engineering, Industrial Engineering.									
Course Objectives:									
1. To understand the fundamentals of Computer Integrated Manufacturing (CIM), factory automation, and the integration of hardware and software in manufacturing systems. 2. To develop knowledge of CNC programming, computer-aided process planning, quality control, MRP, and advanced manufacturing systems such as FMS, cellular manufacturing, and group technology. 3. To understand modern manufacturing technologies including IoT, Industry 4.0, and cloud-based manufacturing for smart and integrated production environments.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply CAD/CAM, CNC programming, assembly modeling, BOM, and coding techniques for manufacturing applications.								
CO2	Analyze ERP, FMS, CIM, machine vision, and remote monitoring systems used in automated manufacturing.								
CO3	Create and simulate manufacturing systems, factory layouts, and material-flow solutions using appropriate software tools.								
List of Experiments:									
Students shall complete the following practical assignments as part of the term work:									
1. Create a 3D model of a mechanical component using CAD software, 2. Generate the CNC turning program and perform machining on a CNC turning machine. 3. Generate the CNC milling program and execute the machining operation on a CNC milling machine. 4. Develop an assembly model and extract the Bill of Materials (BOM) and related manufacturing information using CAD software or similar tools. 5. Study and Demonstration of the Working of ERP Modules in an Industry through a Case Study. 6. Generate Barcode/QR Codes for Machine Components and Demonstrate their application in Inventory Management or any other suitable application. 7. Classify mechanical components into part families by assigning codes using the OPITZ coding and classification system. 8. Analyze the operation of a Flexible Manufacturing System (FMS) through videos or demonstrations and identify its major components along with computer-based control functions. 9. Carry out modeling and simulation of a Computer Integrated Manufacturing (CIM) system using virtual laboratory resources using simulation platforms. 10. Study and demonstrate machine vision techniques for automated inspection and quality assurance									

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using virtual laboratories or similar tools.

11. Perform remote monitoring and supervisory operation of a CIM system using virtual laboratory modules using simulation environments.
12. Design a simple factory layout using CAD software, indicating workstations, material flow, and storage areas.

Reference Books:

1. M. P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson Education, 2015.
2. S. K. Vajpayee, "Principles of Computer Integrated Manufacturing", 1st Edition, Prentice Hall of India (PHI Learning), 2009.
3. Y. Koren, "Computer Control of Manufacturing Systems", 1st Edition, McGraw-Hill Education, 1983.
4. P. G. Ranky, "Computer Integrated Manufacturing", 1st Edition, Prentice Hall International, 1990.
5. Kusiak, A. Intelligent Manufacturing Systems, 1st Edition, Prentice Hall, 1990.
6. Chang, T. C., Wysk, R. A., and Wang, H. P. Computer-Aided Manufacturing, 3rd Edition, Pearson Education, 2006.
7. Kalpakjian, S., and Schmid, S. R. Manufacturing Engineering and Technology, 7th Edition, Pearson Education, 2014.
8. Mikell P. Groover. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th Edition, John Wiley & Sons, 2020.

E-Resources:

1. <http://vlabs.iitkgp.ac.in/cim/>

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PROGRAM ELECTIVE - II
(Select any one course from the given Program
Elective Courses)

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Program Elective – II (Tribology)							Code: MEPE602A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	40	60	-	-	-	100
Prerequisites:									
Engineering Mechanics, Fluid Mechanics, Mechanics of Solids									
Course Objectives:									
1. To understand the fundamentals of tribology, friction, wear mechanisms, and their significance in engineering applications. 2. To develop knowledge of lubrication principles, advanced lubricants, and hydrodynamic bearing systems for effective tribological performance. 3. To analyze tribological failures using surface engineering, condition monitoring, and predictive maintenance techniques. 4. To explore modern trends and industrial applications of tribology to support sustainable and advanced engineering solutions.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamentals of tribology and its engineering applications								
CO2	Analyze friction, wear mechanisms, and surface characteristics of engineering materials								
CO3	Select suitable lubrication techniques and advanced lubricants for engineering applications								
CO4	Analyze the performance of hydrodynamic bearings for engineering applications								
CO5	Evaluate tribological failures using condition monitoring and predictive maintenance techniques								
CO6	Apply tribological principles to modern engineering applications using sustainable and emerging technologies								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Tribology: Definition, history and scope of tribology, Economic importance of tribology, Tribological systems and their components, Surface topography and surface roughness, Contact between engineering surfaces, Importance of tribology in machine design and maintenance.								04
2.	Friction, Wear and Surface Characterization: Friction: Types of friction. Laws of friction, Adhesion and deformation theories, Stick-slip phenomenon, Friction measurement techniques, Factors affecting friction. Wear: Fundamentals of wear, Wear mechanisms, Adhesive wear, Abrasive wear, Corrosive wear, Surface fatigue wear, Fretting wear, Erosive wear, Archard's wear								04

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	law, Wear testing methods, Surface characterization techniques, Wear reduction techniques.	
3.	Lubrication Technology and Advanced Lubricants: Boundary lubrication, Mixed lubrication, Hydrodynamic lubrication, Elastohydrodynamic lubrication, Greases, Solid lubricants, Lubricant additives, Nano-lubricants, Bio-lubricants, Smart lubricants, Sustainable lubrication practices, Lubrication systems used in industries.	05
4.	Hydrodynamic Bearings: Reynolds equation, Assumptions of hydrodynamic lubrication, Petroff's equation, Sommerfeld number, Journal bearings, Hydrostatic bearings, Thrust bearings.	04
5.	Tribological Failures and Condition Monitoring: Tribological Failure Analysis: Bearing failures, Gear wear, Seal failures, Failure due to improper lubrication. Condition Monitoring: Oil analysis, Wear debris analysis, Ferrography, Predictive maintenance using tribological data.	05
6.	Emerging Trends and Industrial Applications: Advanced Applications: Tribology in manufacturing processes, Metal cutting and forming, Automotive tribology, Railway engineering, Aerospace tribology, Wind turbine tribology, Biomedical tribology, MEMS/NEMS tribology, Robotics tribology. Emerging Technologies: Green tribology, Industry 5.0 and sustainable manufacturing, Artificial Intelligence and Machine Learning in tribology.	04
TOTAL		26
Text Books:		
1. Prasanta Sahoo, "Engineering Tribology", Prentice Hall of India Publication, 2005. 2. B. C. Mujumdar, "Introduction to Tribology and Bearings", S. Chand and Company Ltd., New Delhi. 3. Gwidon Stachowiak and Andrew W. Batchelor, "Engineering Tribology", 4 th Edition, Butterworth-Heinemann, Oxfordshire, UK, 2016.		
Reference Books:		
1. Bharat Bhushan, "Principles and Applications of Tribology", 2 nd Edition, Wiley India. 2. J. Halling, "Principles of Tribology", McMillan Press Ltd. 3. B. Bhushan and B. K. Gupta, "Handbook of Tribology: Materials, Coatings and Surface Treatments", McGraw Hill Ltd. 4. S. K. Basu, S. N. Sengupta, and B. B. Ahuja, "Fundamentals of Tribology", Prentice Hall of India Publication, 2005. 5. Ian M. Hutchings, "Tribology: Friction and Wear of Engineering Materials", Butterworth-Heinemann. 6. A. R. Jones, "Tribology: Friction, Wear, and Lubrication", CRC Press. 7. O. Pinkus and B. Sternlicht, "Theory of Hydrodynamic Lubrication", McGraw-Hill Book Co. Inc., New York.		

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8. G. N. Stachowiak, A. W. Batchelor, and G. B. Stachowiak, "Experimental Methods in Tribology", Tribology Series 44, Elsevier, 2004.
9. Michael M. Khonsari, "Applied Tribology: Bearing Design and Lubrication", John Wiley & Sons, 2001.
10. M. B. Peterson and W. O. Winer, "Wear Control Handbook", ASME, 1980.

E-Resources:

1. NPTEL course on Tribology, by Dr. Harish Hirani, IIT Delhi
<https://nptel.ac.in/courses/112102015>
2. NPTEL course on Friction and Wear of materials : Principle and case studies, by Prof. B. V. Manoj Kumar , Prof. Bikramjit Basu, IIT Roorkee
<https://nptel.ac.in/courses/113108083>

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DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Program Elective – II (Electric and Hybrid Vehicles)							Code: MEPE602B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	40	60	-	-	-	100
Prerequisites:									
Knowledge of Electrical Engineering, Fundamentals and Automobile Engineering.									
Course Objectives:									
1. To understand the fundamentals and types of Electric and Hybrid Vehicles. 2. To learn the basics of vehicle dynamics and hybrid traction systems. 3. To study electric motors, drives, batteries, and propulsion systems used in EVs. 4. To understand charging systems and energy management techniques in Electric Vehicles. 5. To explore recent trends and future developments in electric mobility.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamentals, types, and performance characteristics of Electric and Hybrid Vehicles.								
CO2	Describe vehicle dynamics, hybrid traction systems, and regenerative braking concepts.								
CO3	Explain the construction, operation, and control of electric motors and drives used in EVs.								
CO4	Apply concepts of batteries, energy storage systems, and propulsion systems in EV applications.								
CO5	Explain charging systems and energy management strategies used in Electric and Hybrid Vehicles.								
CO6	Discuss recent trends and future applications of Electric Mobility systems.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Electric and Hybrid Vehicles : History and evolution of Electric and Hybrid Vehicles, Environmental and energy-related importance of EVs, Comparison of conventional, hybrid, and electric vehicles, Types of EVs: BEV, HEV, PHEV, FCEV.								4
2.	Vehicle Dynamics and Hybrid Traction Systems: Vehicle resistances (rolling, aerodynamic, and gradient), tractive effort and power requirement, basics of hybrid traction systems, hybrid drive-train topologies (series, parallel, and series-parallel), power flow control and fuel efficiency, fundamentals of regenerative braking.								5
3.	Electric Motors and Drives for EVs: Electric propulsion system: Introduction and requirements of electric motors in EVs, Construction, working principle, characteristics, and applications of: DC Motor, Induction Motor (IM), Permanent Magnet Synchronous Motor (PMSM),								5

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	Switched Reluctance Motor (SRM), Motor drive efficiency (basic numerical problems), Comparison of electric motors used in EVs.	
4.	Batteries, Energy Storage and Electric Propulsion System: Energy storage requirements in EVs and HEVs, Types of batteries: Lead Acid, Nickel-Metal Hydride (NiMH), and Lithium-ion, Battery parameters: capacity, State of Charge (SOC), Depth of Discharge (DOD), and energy density, Battery Management System (BMS), Introduction to supercapacitors and fuel cells, Basic architecture of electric propulsion systems, Numerical on battery capacity calculation and charging time estimation.	4
5.	Charging Systems and Energy Management: Basics of propulsion motor selection, Introduction to power electronics and supporting subsystems, Energy management strategies in Hybrid Electric Vehicles (HEVs), AC and DC charging systems, Plug-in Hybrid Electric Vehicles (PHEVs), Charging standards and infrastructure, Fundamentals of Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V), Smart charging concepts.	4
6.	Future Trends and Applications of EVs: Thermal management of batteries and electric motors (Introduction), Smart and connected electric vehicles, Autonomous and solar electric vehicles, Wireless charging systems, EV ecosystem and charging infrastructure in India, Government policies and incentives for EV adoption, Environmental impact and sustainability, Recent trends in electric mobility.	4
TOTAL		26
Text Books:		
1. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 3rd Edition, CRC Press, 2018. 2. James Larminie and John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, Wiley Publication, 2012. 3. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press.		
Reference Books:		
1. Chris Mi, M. Abul Masrur, and David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley Publication, 2011. 2. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", 1st Edition, CRC Press. 3. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes Publication, 2002.		
E-Resources:		
1. Prof. S. Majhi, Dr. Praveen Kumar, Introduction to Hybrid and Electric Vehicles, IIT Guwahati– https://nptel.ac.in/courses/108103009?utm 2. Prof. Amit Jain Prof. Avanish Tripathi, EV - Vehicle Dynamics and Electric Motor Drives, IIT Delhi - https://youtu.be/G3mRjSGKL6I?si=zZgDRoYqkdbK5XkE		

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DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM ELECTIVE - III

**(Select any one course from the given Program
Elective Courses)**

DEPARTMENT OF MECHANICAL ENGINEERING

Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Program Elective – III (Industrial Hydraulics and Pneumatics)							Code: MEPE603A		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	40	60	-	-	-	100
Prerequisites:									
Fundamentals of Mathematics, Mechanics ,Fluid Mechanics, Thermodynamics & Gas Laws									
Course Objectives:									
1. To familiarize the students with fundamental principles, design and operation of hydraulic and pneumatic machines. 2. To provide students with an understanding of the fluids and components utilized in modern industrial fluid power systems. 3. To develop a measurable degree of competence in the design, construction and operation of fluid power circuits. 4. To analyze and implement different control mechanisms—including manual, mechanical, electrical. 5. To impart practical skills for diagnosing faults, performing routine maintenance, and ensuring safety standards in industrial fluid power.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Identify various components of hydraulic and pneumatic systems from their symbols								
CO2	Select pump, compressor and actuator for a given fluid operated system.								
CO3	Select appropriate control valves for a given fluid operated system.								
CO4	Select appropriate special components for advanced fluid operating system.								
CO5	Develop hydraulic and pneumatic circuits for given applications.								
CO6	Install, Select, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Hydraulic and Pneumatic Systems: Oil hydraulic & pneumatic system: Basic components and general layout, advantages and disadvantages, comparison between electric, hydraulic and pneumatic systems. Hydraulic Fluid: Functions, types, properties, Construction and working of Filter, Regulator and Lubricator (FRL) unit used in pneumatics.								5
2.	Pumps and Compressors and Actuators: Hydraulic pumps: Classification, construction and working. Compressors: Types, construction, working principle of reciprocating and Hydraulic and pneumatic actuators: Classification, function and applications, Construction and working of linear Actuators.								5
3.	Control Valves:								4

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	Introduction, Classification of Control Valves, Actuation Methods, advantages, disadvantages, applications of valves.	
4.	Advanced Components and Accessories: Construction and working of Telescopic, tandem and rod less cylinder. Dual pressure valve (AND logic valve), Shuttle valve (OR Logic valve), time delay valve and quick exhaust valve. Accessories: Types, construction and functions of pipes, hoses, fittings, seals and gaskets, accumulators, muffler, Introduction to electro pneumatics, advantages.	4
5.	Hydraulic and Pneumatic Circuits: Fundamentals of Circuit Design ,Basic Hydraulic Circuits, Speed Control Methods (Metering),Pneumatic Circuits and Logic Controls, Electro-Pneumatic and Electro-Hydraulic Circuits	4
6.	Troubleshooting and Applications: Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Design of Pneumatic circuits for Pick and Place applications.	4
TOTAL		26
Text Books:		
1. S. R. Majumdar, "Pneumatic Systems: Principles and Maintenance", Tata McGraw-Hill Education. 2. S. Ilango and V. Soundararajan, "Introduction to Hydraulics and Pneumatics", PHI Learning Pvt. Ltd. 3. Harry Stewart, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", Elsevier (Butterworth-Heinemann).		
Reference Books:		
1. Andrew Parr, "Hydraulics & Pneumatics: A Technician's and Engineer's Guide", Elsevier (Butterworth-Heinemann). 2. Anthony Esposito, "Fluid Power with Applications", Pearson. 3. D. Stewart, "Hydraulic and Pneumatic Power for Production", Industrial Press. 4. Vickers Systems International, "Industrial Hydraulics Manual", Vickers Systems International.		
E-Resources:		
1. https://www.youtube.com/watch?v=zHto_QiORz0 2. https://www.youtube.com/watch?v=Px1wnARs12Q 3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me51 4. https://en.wikipedia.org/wiki/		

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Program: B. Tech. (Mechanical Engineering)							Semester: VI		
Course: Program Elective – III (Design of Transmission Systems)							Code: MEPE603B		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
02	-	-	02	40	60	-	-	-	100
Prerequisites:									
Engineering Mechanics, Mechanics of Solids, Theory of Machines, Machine Design – I.									
Course Objectives:									
1. To understand the fundamentals, classification, design methodology, and thermal management principles of mechanical transmission systems. 2. To study the construction, working principles, and design aspects of automotive, electric, hybrid, and material handling transmission systems. 3. To apply engineering principles and modern design tools for the analysis, design, and optimization of transmission systems. 4. To develop the ability to select appropriate transmission systems based on efficiency, reliability, durability, and industrial application requirements.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamentals, classification and design methodology of transmission systems.								
CO2	Analyze the construction and working of automotive transmission systems used in modern vehicles.								
CO3	Select suitable transmission systems for electric vehicles, hybrid vehicles and material handling applications.								
CO4	Evaluate thermal management, lubrication and cooling requirements for transmission systems.								
CO5	Design and optimize transmission systems considering efficiency, weight, NVH, durability and reliability.								
CO6	Apply CAD/CAE tools and engineering standards for transmission system design and performance evaluation.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Transmission Systems: Introduction to transmission systems, Functions and performance requirements, Classification of transmission systems: Mechanical, Hydraulic, Hydrostatic, Electric, Hybrid transmissions, Design methodology for transmission systems, Customer requirements and design specifications, Design standards and industrial practices								04
2.	Automotive Transmission Systems: Requirements of automotive transmissions, Manual Transmission (MT) , Automated Manual Transmission (AMT), Gear shift mechanisms and synchronizers, Dual-Clutch Transmission (DCT): construction, working and								05

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	design principles , Continuously Variable Transmission (CVT): belt-driven and toroidal CVTs, Hydrodynamic drives: Fluid coupling, Torque converter.	
3.	Electric Vehicle and Hybrid Transmission Systems: EV powertrain architecture, Single-speed reduction gearbox, Multi-speed EV transmission, Integrated Drive Unit (IDU), E-Axle systems, Regenerative braking transmission, Differential selection for EVs, Hybrid Electric Vehicle (HEV) transmission systems.	05
4.	Transmission Systems Used in Material Handling: Transmission systems used in Belt conveyor, Chain conveyor Roller conveyor drives, Screw conveyor, Bucket elevator, Hoists and crane transmission systems, Automated Guided Vehicle (AGV) drive systems.	04
5.	Thermal Management of Transmission Systems: Sources of heat generation, Heat dissipation mechanisms, Lubrication methods, Cooling methods, Oil circulation systems, Temperature effects on transmission performance, Thermal design considerations.	04
6.	Design and Optimization of Transmission Systems Transmission element selection, Power flow and efficiency analysis, Weight optimization techniques, NVH (Noise, Vibration and Harshness) considerations, Reliability and durability considerations, CAD/CAE applications in transmission design.	04
TOTAL		26
Text Books:		
1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International. 2. Harald Naunheimer, Bernd Bertsche, Joachim Ryborz, and Wolfgang Novak, "Automotive Transmissions: Fundamentals, Selection, Design and Application", Springer. 3. S. S. Rattan, "Theory of Machines", McGraw Hill Education. 4. V. B. Bhandari, "Design of Machine Elements", McGraw Hill Education. 5. Robert L. Norton, "Machine Design: An Integrated Approach", Pearson Education.		
Reference Books:		
1. Robert Bosch GmbH, "Automotive Handbook", Wiley. 2. Wei Liu, "Vehicle Powertrain Systems", Wiley. 3. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press. 4. Richard G. Budynas and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill. 5. Joseph E. Shigley, "Mechanical Engineering Design", McGraw Hill. 6. Gwidon W. Stachowiak and Andrew W. Batchelor, "Engineering Tribology", Butterworth-Heinemann.		
E-Resources:		
1. NPTEL course on Electric Vehicles - Part 1, by Prof. Amit Jain, IIT Delhi - https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_eel8		

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2. NPTEL course on Fundamentals of Automotive Systems, by Prof. C. S. Shankar Ram, IIT Madras - <https://nptel.ac.in/courses/107106088>
3. NPTEL course on Vehicle Dynamics, by Dr. R. Krishnakumar, IIT Madras
<https://nptel.ac.in/courses/107106080>

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Mechatronics							Code: MEMD604		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
03	-	-	03	40	60	-	-	-	100
Prerequisites:									
Basic knowledge of Mechanical Engineering, Electrical and Electronics Engineering, Sensors, and Control Systems.									
Course Objectives:									
1. To understand the fundamentals of mechatronics and the integration of mechanical, electrical, electronic, and control systems. 2. To develop knowledge of sensors, actuators, controllers, PLCs, and embedded systems used in industrial automation. 3. To analyze mechatronic systems for automation, monitoring, and control in manufacturing and process industries. 4. To familiarize students with modern industrial technologies such as robotics, IIoT, Industry 4.0, and smart manufacturing.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Explain the fundamentals of mechatronics, system integration, and industrial applications.								
CO2	Select appropriate sensors and actuators for mechatronic systems.								
CO3	Analyze electrical, electronic, and control systems used in mechatronics.								
CO4	Develop PLC ladder logic programs for industrial automation.								
CO5	Design embedded system applications using Arduino for automation.								
CO6	Evaluate robotic systems and Industry 4.0 technologies for smart manufacturing.								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Introduction to Mechatronics: Introduction to Mechatronics, interdisciplinary engineering approach, elements of mechatronic systems, measurement systems, open and closed-loop control systems, system integration, product design methodology, and industrial applications in manufacturing, automotive, and consumer products.								6
2.	Sensors and Actuators: Classification and selection of sensors, displacement, position, proximity, temperature, pressure, flow and force sensors, signal conditioning, hydraulic, pneumatic and electrical actuators, DC, stepper and servo motors, industrial applications of sensors and actuators								7

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3.	Electrical, Electronic and Control Systems: Basic electrical components, relays, contactors, switches, electronic devices, operational amplifiers, signal conditioning, ADC, DAC, fundamentals of control systems, PID controller, motion control and industrial control applications.	6
4.	Programmable Logic Controllers: PLC architecture, input/output modules, memory organization, ladder programming, timers, counters, internal relays, PLC-based automation systems, conveyor automation, traffic control, bottle filling and packaging applications, introduction to SCADA.	7
5.	Embedded Systems and Industrial Automation: Introduction to embedded systems, Arduino architecture, interfacing of sensors and actuators, PWM, interrupts, industrial communication, embedded automation systems and real-time monitoring applications.	6
6.	Robotics and Industry 4.0: Industrial robots, robot configurations, end effectors, machine vision, Industrial Internet of Things (IIoT), cyber-physical systems, digital twin, predictive maintenance, collaborative robots, smart manufacturing and Industry 4.0 applications.	7
TOTAL		39
Text Books:		
1. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 8th Edition, Pearson Education. 2. Devdas Shetty and Richard A. Kolk, "Mechatronics System Design", 2nd Edition, Cengage Learning. 3. Michael B. Hstand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", 6th Edition, McGraw-Hill Education. 4. N. Shanmugam, "Mechatronics", Anuradha Agencies. 5. R. K. Rajput, "A Textbook of Mechatronics", S. Chand & Company Ltd.		
Reference Books:		
1. Clarence W. de Silva, "Mechatronics: An Integrated Approach", CRC Press. 2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw-Hill Education. 3. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 6th Edition, Pearson. 4. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, "The AVR Microcontroller and Embedded Systems Using Arduino", Pearson Education. 5. Stuart R. Ball, "Analog Interfacing to Embedded Microprocessor Systems", Newnes. 6. S. Brian Morriss, "Automated Manufacturing Systems: Actuators, Controls, Sensors and Robotics", McGraw-Hill. 7. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 5th Edition, Pearson. 8. Richard L. Shell and Ernest L. Hall, "Handbook of Industrial Automation", CRC Press.		

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E-Resources:

1. <https://www.nptel.ac.in/courses/112107298>
2. <https://nptel.ac.in/courses/112101304>
3. <https://www.nptel.ac.in/courses/112103293>
4. <https://www.youtube.com/@Siemens>
5. <https://www.youtube.com/@RealPars>
6. <https://www.youtube.com/@RealPars>
7. <https://matlabacademy.mathworks.com>
8. <https://docs.arduino.cc>
9. <https://factoryio.com>
10. <https://www.sce.siemens.com>
11. <https://www.fluidsim.com>

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Mechatronics Lab							Code: MEMD604P		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	-	25	-	25
Prerequisites:									
Basic knowledge of Mechanical Engineering, Electrical and Electronics Engineering, Sensors, and Control Systems.									
Course Objectives:									
1. To develop practical skills in PLC programming, microcontroller programming, sensors, actuators, and industrial automation systems. 2. To develop the ability to analyze, simulate, and troubleshoot control, pneumatic, motor, SCADA, and vision-based systems. 3. To enable students to design and integrate mechatronic systems for industrial automation and real-world applications.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Select suitable PLC, sensors, actuators, and control methods for automation applications.								
CO2	Evaluate system performance and troubleshoot faults in industrial mechatronic systems.								
CO3	Design appropriate automation solutions based on application requirements and constraints.								
List of Experiments:									
Any Eight Experiments need to be performed									
1. Water Tank Level Control System 2. Workshop Lighting Control System 3. Machine Temperature Monitoring System 4. Conveyor Belt Automation using PLC 5. Automatic Bottle Filling System 6. PLC-Based Traffic Signal System 7. Automatic Industrial Door System 8. Smart Parking Management System 9. Machine Health Monitoring System 10. Pneumatic Material Handling System 11. Rotary Indexing System using Stepper Motor 12. Variable Speed DC Motor Drive 13. Automatic Product Counting System 14. Machine Safety Interlock System 15. Automatic Machine Lubrication System 16. Servo Motor Motion Control 17. Electro-Pneumatic Control System 18. Industrial Process Monitoring using SCADA									

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19. Vision-Based Inspection System
20. Design and Development of a Mechatronic System

Software Tools

- Arduino IDE
- Siemens TIA Portal / CODESYS (or equivalent PLC software)
- FluidSIM (Pneumatic/Hydraulic Simulation)
- Factory I/O (Virtual Industrial Automation)
- MATLAB/Simulink (Basic Control System Simulation)

Reference Books:

1. Clarence W. de Silva, "Mechatronics: An Integrated Approach", CRC Press.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw-Hill Education.
3. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 6th Edition, Pearson.
4. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, "The AVR Microcontroller and Embedded Systems Using Arduino", Pearson Education.
5. Stuart R. Ball, "Analog Interfacing to Embedded Microprocessor Systems", Newnes.
6. S. Brian Morriss, "Automated Manufacturing Systems: Actuators, Controls, Sensors and Robotics", McGraw-Hill.
7. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 5th Edition, Pearson.
8. Richard L. Shell and Ernest L. Hall, "Handbook of Industrial Automation", CRC Press.

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Quality Management System – III							Code: MEVS607		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	02	-	01	-	-	25	-	-	25
Prerequisites:									
Quality Management System – I, Quality Management System – II.									
Course Objectives:									
1. To understand basic principles and terms related to statistical process control. 2. To understand Kaizen philosophy of continuous, incremental improvement & Six Sigma, data-driven methodology aimed at reducing defects and process variation. 3. To understand processes in Business process management and know significance of concept customer driven quality.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Apply control charts for process controls to perform statistical analysis.								
CO2	Apply kaizen and six sigma for industrial processes								
CO3	Gain knowledge in customer relationship management								
Course Contents:									
Unit	Description								Duration (Hrs.)
1.	Statistical process Control: Specification and control limits, types of control charts, control charts for variables and attributes, Pareto diagram, process flow diagram, cause and effect diagram, check sheets and histogram, Experimental design.								08
2.	Six Sigma and Kaizen- Continuous Improvement: Key six sigma concepts, quality level, three sigma's', defects per million opportunities, implementation, DMAIC, DMADV Concept of Kaizen, lean, 5S, kaizen vs innovation, CWQC, Kaizen practice, QFD, QCC, Poka yoke, quality of work life Taguchi quality engineering, loss function, orthogonal arrays, signal to noise ratio Parameter and tolerance design								09
3.	Customer driven quality and business process management: Customers perception of quality, customer relationship management and its components, customer retention programs CRM modules, CRM in B2B and B2C context, e- CRM. BMP: introduction and BMP implementation framework.								09
TOTAL								26	
Text Books:									
1. Kanishka Bedi, "Quality Management", Oxford University Press. 2. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education.									

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Reference Books:
1. Dale H. Besterfield, "Total Quality Management", Pearson Education. 2. Poornima M. Charantimath, "Total Quality Management", Pearson, 2nd Edition. 3. V. K. Khanna, "TQM: Planning, Design and Implementation", New Age International Publishers.
E-Resources:
1. Dr. N. Venkateshwarlu, "Quality Engineering & Management", NPTEL Course, https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_me09

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Program: B. Tech. (Mechanical Engineering)							Semester: V		
Course: Internship – V							Code: MEIN605		
Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	Practical	Tutorial	Credit	CIE	ETE	TW	OR	PR	Total
-	-	-	02	-	-	25	-	-	25
Preamble:									
Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.									
Course Objectives:									
1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry. 2. Learn to implement the technical knowledge in real industrial situations.									
Course Outcomes: After completion of this course, students will be able to -									
CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.								
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.								
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.								
Internship Requirements									
1. Internship Duration: It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW). 2. Internship Opportunities: Students can explore various opportunities for internships at: f. Industries g. Research labs or organizations h. Collegiate clubs i. In-house research projects j. Online internships 3. Support and Assistance: Students can seek assistance for securing internships from: e. The Training and Placement cell, along with departmental coordinators f. Department or institute faculty members g. Personal contacts h. Directly connecting with industries or organizations 4. Request Letter: Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This letter, in the									

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standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

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