



KINGSTON ENGINEERING COLLEGE

(An Autonomous Institution)

**(Approved by AICTE & COA, New Delhi, Affiliated to Anna University, Chennai)
Chittoor Main Road, Christianpet,
Katpadi, Vellore-632059**

MASTER OF ENGINEERING IN ENGINEERING DESIGN

AUTONOMOUS CURRICULUM REGULATION 2026

Academic Year 2026-27 onwards



INSTITUTE VISION

To be a pioneer in engineering and management education by providing amicable ambience and being a centre for learning thereby perpetuating versatile professionals in engineering and management suitable for industry, higher education and research.

INSTITUTE MISSION

- Developing, nurturing and building professionals with technical, research and managerial expertise, intellectual proficiency, right attitude and moral ethics.
- Building infrastructure that earmarks the institution to be the most preferred educational destination and provides the right ambience for creative and innovative teaching - learning process.
- Enabling learners to broaden their horizon and helping to meet global challenges.

QUALITY POLICY

To establish and implement a robust quality system at Kingston Engineering College, encircling teaching, learning, research, and self-reliance, focusing on core and support functions to ensure accountability to stakeholders through continuous improvement and sustenance towards promoting holistic academic excellence.

CONTENTS

S.No.	Particulars	Page Number
1	Department Vision and Mission	1
2	Program Educational Objectives (PEOs)	1
3	Program Outcomes (POs)	1
4	Program Specific Outcomes (PSOs)	2
5	Mapping of PEOs with POs	2
6	Mapping of PEOs with PSOs	2
7	Sustainability Development Goals (SDGs)	2
8	Curriculum for the Semester I to IV	3
9	List of Programme Electives	5
10	Credit Distribution	6
11	Syllabus for Semester I to IV	8

M.E – ENGINEERING DESIGN

CURRICULLUM R-2026

CHOICE BASED CREDIT SYSTEM

VISION OF THE DEPARTMENT

The department of Mechanical Engineering strives to develop skilled, competent, ethical and versatile mechanical engineers capable of designing, developing and analyzing the complex problems and implementation of emerging engineering technologies, to solve the real time problems.

MISSION OF THE DEPARTMENT

- ❖ To impart quality education in Mechanical Engineering and develop competent graduates with strong technical and practical skills.
- ❖ To enable students to identify, analyze, and solve engineering problems using modern tools and emerging technologies.
- ❖ To promote research, consultancy, and lifelong learning with professional ethics and social responsibility for industry and higher education.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission.

- PEO 1:** Apply mechanical engineering knowledge to develop engineering solutions for societal and industrial needs.
- PEO 2:** Demonstrate technical competence and practical skills using modern engineering tools and technologies.
- PEO 3:** Identify, analyze, and solve engineering problems with professional and ethical responsibility.
- PEO 4:** Exhibit leadership, teamwork, and effective communication in multidisciplinary environments.
- PEO 5:** Pursue higher education, research, innovation, and lifelong learning for successful careers.

PROGRAM OUTCOMES (POs)

At the time of their graduation students of Engineering Design Programme should be in possession of the following Programme Outcomes

- PO 1** An ability to independently carry out research /investigation and development work to solve practical problems
- PO 2** An ability to write and present a substantial technical report/document
- PO 3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The Post Graduates of M.E –Engineering Design programme will be able to:

- PSO 1:** Apply advanced principles of mechanics, materials, and computational methods to design, analyze, and optimize mechanical systems and components using modern tools and simulation techniques.
- PSO 2:** Develop innovative and sustainable engineering solutions through integrated product design, lifecycle management, and advanced manufacturing processes.

MAPPING OF PEOs WITH PSOs

PEOs	POs		
	PO 1	PO 2	PO 3
PEO 1:	3	3	3
PEO 2:	3	2	2
PEO 3:	2	3	2
PEO 4:	-	-	1
PEO 5:	1	1	2

MAPPING OF PEOs WITH PSOs

PEOs	PSOs	
	PSO 1	PSO 2
PEO 1:	3	2
PEO 2:	2	3
PEO 3:	3	2
PEO 4:	1	1
PEO 5:	2	3

SUSTAINABILITY DEVELOPMENT GOALS (SDG)



M.E ENGINEERING DESIGN

REGULATION 2026

CURRICULUM FOR SEMESTER I to IV

CHOICE BASED CREDIT SYSTEM

(For the students admitted in the Academic year 2026-2027)

I Semester

S.No	Course code	Course Title	L	T	P	C	Hours/ Week	Course Category	SDG Mapping
THEORY COURSES									
1	ED26M01	Applied Mathematical and Statistical Modelling	3	1	0	4	4	BS	4,8,9
2	ED26101	Topology Optimization and Generative Design	3	0	0	3	3	PC	7,9,12,13
3	ED26102	Advanced Mechanics of Materials	3	0	0	3	3	PC	9,11,12
4	ED26103	Research Methodology and IPR	3	0	0	3	3	PC	4,9,16
LAB INTEGRATED THEORY COURSES									
5	ED26104	Design and Analysis of Advanced Mechanisms	3	0	2	4	5	PC	8,9,12
PRACTICAL COURSES									
6	ES26111	Design Practice with CAD Tools Laboratory	0	0	4	2	4	PC	8,9,12
7	ED26112	Multi Body Dynamics Laboratory	0	0	4	2	4	PC	9,12,13
EMPLOYABILITY ENHANCEMENT COURSE									
8	ED26S01	Technical Seminar	0	0	2	1	2	EE	4,8,9
	TOTAL		15	1	12	22	28		

II Semester

S.No	Course code	Course Title	L	T	P	C	Hours/ Week	Course Category	SDG Mapping
THEORY COURSES									
1	ED26201	Vibration, Fracture, and Failure Analysis	3	0	0	3	3	PC	9,11,12 13
2		Programme Elective – I	3	0	0	3	3	PE	
3		Programme Elective – II	3	0	0	3	3	PE	

LAB INTEGRATED THEORY COURSES									
4	ED26202	Finite Element Methods	2	0	4	4	6	PC	9,11,12
5	ED26203	Computational Fluid Dynamics	2	0	2	3	4	PC	7,9,13
PRACTICAL COURSES									
6	ED26211	Research Article Replication Practice	0	0	2	1	2	PC	4,9,17
EMPLOYABILITY ENHANCEMENT COURSE									
7	ED26S02	Industry Oriented Course I	1	0	0	1	1	EE	
MANDATORY COURSE									
8	ED26S03	Self-Learning Course / Swayam NPTEL	-	-	-	1	-	SL	
TOTAL			14	1	8	19	22		
III Semester									
S.No	Course code	Course Title	L	T	P	C	Hours/ Week	Course Category	SDG Mapping
THEORY COURSES									
1		Programme Elective – III	3	0	0	3	3	PE	
2		Programme Elective - IV	3	0	0	3	3	PE	
3		Programme Elective - V	3	0	0	3	3	PE	
4		Programme Elective - VI	3	0	0	3	3	PE	
PRACTICAL COURSES									
5	ED26311	Project Work I	0	0	12	6	12	EE	9,11,12
EMPLOYABILITY ENHANCEMENT COURSES									
6	ED26S04	Industry Oriented Course II	1	0	0	1	1	EE	
TOTAL			13	0	12	19	25		
IV Semester									
S.No	Course code	Course Title	L	T	P	C	Hours/ Week	Course Category	SDG Mapping
	ED26411	Project Work II	0	0	24	12	24	EE	9,11,12
TOTAL			0	0	24	12	24		

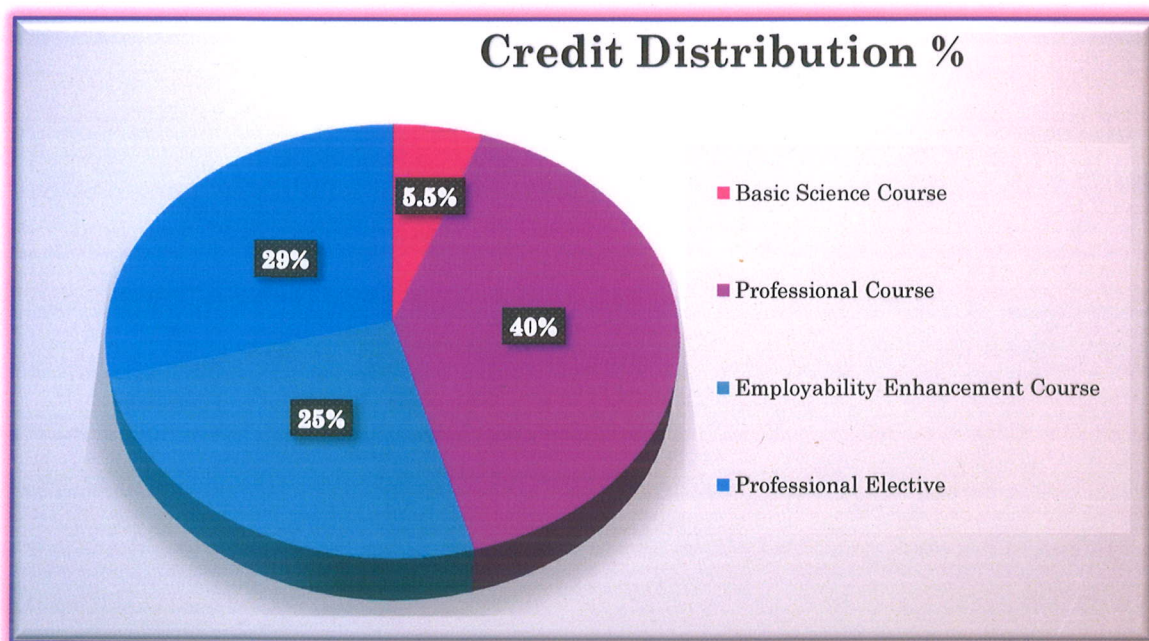
M.E ENGINEERING DESIGN
REGULATION 2026
LIST OF PROGRAMME ELECTIVES

PROGRAMME ELECTIVE COURSES									
S.No.	Course code	Course Title	L	T	P	C	Hours/Week	Course Category	SDG Mapping
1	ED26001	Design with Advanced Materials	3	0	0	3	3	PE	9,12,13
2	ED26002	Integrated Product Design and Development	3	0	0	3	3	PE	8,9,12
3	ED26003	Design for Sustainability	3	0	0	3	3	PE	11,12,13
4	ED26004	Composite Materials and Mechanics	3	0	0	3	3	PE	7,9,12
5	ED26005	Quality Concepts in Design	3	0	0	3	3	PE	8,9,12
6	ED26006	Bearing Design and Rotor Dynamics	3	0	0	3	3	PE	7,8,9
8	ED26007	Solid Freeform Manufacturing	3	0	0	3	3	PE	8,9,12
9	ED26008	Product Lifecycle Management	3	0	0	3	3	PE	9,12,13
10	ED26009	Design of Hydraulic and Pneumatic Systems	3	0	0	3	3	PE	7,8,9
11	ED26010	Mechanical Measurements and Analysis	3	0	0	3	3	PE	4,8,9
12	ED26011	Surface Engineering	3	0	0	3	3	PE	9,12,13
13	ED26012	Computer Graphics	3	0	0	3	3	PE	4,8,9
14	ED26013	Vehicle Dynamics	3	0	0	3	3	PE	7,9,11
15	ED26014	Advanced Finite Element Analysis	3	0	0	3	3	PE	4,8,9
16	ED26015	Advanced Machine Tool Design	3	0	0	3	3	PE	8,9,12
17	ED26016	Material Handling Systems and Design	3	0	0	3	3	PE	8,9,11
18	ED26017	Creativity and Innovation Management	3	0	0	3	3	PE	4,8,9
19	ED26018	Material Testing and Characterization	3	0	0	3	3	PE	4,8,9

M.E ENGINEERING DESIGN

CREDIT DISTRIBUTION CURRICULUM R-2026

Sl. No	Course Category	Credits per semester				KEC Credits	Credits %
	Semester	I	II	III	IV		
1	Basic Science Course (BS)	4	0	0	0	4	5.5
2	Professional Course (PC)	17	12	0	0	29	40.3
3	Professional Elective (PE)	0	6	12	0	18	25
4	Employability Enhancement Courses (EE)	1	1	7	12	21	29.2
TOTAL		22	19	19	12	72	100




Chairman
 [Board of Studies/Mechanical]
Chairman
 Board of Studies
 Department of Mechanical Engineering
 Kingston Engineering College
 Vellore - 632 059


PRINCIPAL
PRINCIPAL
 Kingston Engineering College
 Chittoor Main Road, Vellore - 632 059.
 Phone : 0416-2298300

SEMESTER I

M.E ENGINEERING DESIGN
REGULATION 2026
Semester – I

ED26M01	Applied Mathematical and Statistical Modelling	L	T	P	C
SDG: 4,8,9		3	1	0	4
Course Objectives: - To equip students with advanced mathematical techniques, specifically Fourier Transforms, for formulating and solving partial differential equations that model fundamental mechanical engineering phenomena such as heat transfer, vibrations, and fluid flow. - To provide a strong foundation in statistical inference, enabling students to estimate population parameters (like material properties and process capabilities) from experimental data and assess the quality and reliability of these estimators. - To enable students to design efficient, structured experiments and apply appropriate statistical tests to make valid, data-driven decisions for comparing processes, optimizing designs, and solving complex engineering problems.					
Fourier Transform: Definitions, Properties, Transform of elementary functions, Dirac delta function, Convolution theorem, Parseval's identity, Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poisson's equations.					
Estimation Theory: Unbiasedness, Consistency, Efficiency and sufficiency, Maximum likelihood estimation, Method of moments.					
Testing of Hypothesis: Sampling distributions, small and large samples, Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions, Analysis of r x c tables, Goodness of fit, independent of attributes.					
Design of Experiments: Analysis of variance, One way and two-way classifications, completely randomized design, Randomized block design, Latin square design, 22 Factorial design.					
References: - Andrews, L. C., & Shivamoggi, B. K. (2003). Integral transforms for engineers. Prentice Hall of India. - Devore, J. L. (2014). Probability and statistics for engineering and the sciences, Cengage Learning. - Johnson, R. A., Miller, I., & Freund, J. (2015). Miller and Freund's probability and statistics for engineers, Pearson Education Asia.					
E-resources: https://www.edx.org/learn/probability-and-statistics/massachusetts-institute-of-technology-probability-the-science-of-uncertainty-and-data https://www.itl.nist.gov/div898/handbook/ https://ocw.mit.edu/courses/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Apply Fourier transform techniques to formulate and solve partial differential equations arising in mechanical engineering applications.	PO1 (2), PO3 (1)	2	1
CO2	Analyze and solve partial differential equations associated with engineering phenomena such as heat transfer, mechanical vibrations, and fluid flow using appropriate mathematical methods.	PO1 (2), PO3 (2)	2	2
CO3	Apply statistical inference techniques to estimate population parameters and evaluate the quality, accuracy, and reliability of estimators using experimental engineering data.	PO2 (2), PO3 (2)	2	2
CO4	Design and conduct structured statistical experiments and apply appropriate statistical tests for comparing processes and evaluating engineering performance.	PO2 (2), PO3 (2)	2	2
CO5	Apply data-driven statistical methods to analyze experimental results, optimize engineering designs and processes, and make valid decisions for solving complex engineering problems.	PO1 (2), PO3 (2)	2	2

Case Study Presentation on Sustainable Generative Design: In groups, students research and present a real-world case (e.g., Airbus bracket or Nike Flyprint shoe) that uses generative design for sustainability. Focus on how design choices reduce material use or carbon footprint.

References:

1. Belegundu, A. D., and Chandrupatla, T. R., Optimization Concepts and Applications in Engineering, Cambridge University Press, 2011.
2. Chong, E. K. P., and Zak, S. H., Introduction to Optimization, Wiley, 2013.
3. Boyd, S., and Vandenberghe, L., Convex Optimization, Cambridge University Press, 2004.
4. Bohnacker, H., Gross, B., Laub, J., and Lazzeroni, C., Generative Design: Visualize, Program, and Create with Processing, Princeton Architectural Press, 2012.
5. Adeli, H., Advanced Structural Optimization, Chapman & Hall/CRC, 1994.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Apply optimization techniques (linear, nonlinear, integer programming) to solve mechanical design problems, focusing on material distribution and design efficiency.	PO1 (3), PO3 (2)	3	2
CO2	Implement gradient-based optimization methods for practical problems, such as minimizing weight in mechanical systems, and analyze convergence behavior.	PO1 (3), PO2 (2)	3	2
CO3	Perform topology optimization using SIMP and level set methods for efficient material distribution in mechanical components, and evaluate the optimization results.	PO1 (3), PO3 (3)	3	3
CO4	Use generative design principles, evolutionary algorithms, and AI-driven systems for design generation, with a focus on integrating with additive manufacturing.	PO2 (3), PO3 (3)	3	3

ED26102	Advanced Mechanics of Materials	L	T	P	C
SDG: 9,11,12		3	0	0	3

Course Objective:

The objective of this course is to provide students with an in-depth understanding of the theory of elasticity and advanced stress analysis techniques essential for the design and evaluation of mechanical and structural components. The course emphasizes the formulation and solution of stress-strain relations, equilibrium equations, and compatibility conditions in various coordinate systems. It covers the analysis of flat plates, curved beams, torsional members, and rotating bodies, along with the evaluation of contact stresses and deflections. Students will develop the ability to apply analytical and energy methods to solve complex solid mechanics problems encountered in real-world engineering applications.

Elasticity: Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, theories of failure, differential equations of equilibrium, compatibility, boundary conditions-representation of three-dimensional stress of a tension generalized hook's law, St. Venant's principle, plane stress, Airy's stress function. Energy methods

Activities: Use MATLAB/ANSYS to visualize 3D stress states and Airy's stress function solutions, Apply failure theories to real-life engineering components (e.g., pressure vessel, shaft).

Stresses In Flat Plates and Curved Members: Circumference and radial stresses, deflections, curved beam with restrained ends, closed ring subjected to concentrated load and uniform load, chain links and crane hooks. Solution of rectangular plates, pure bending of plates, deflection, uniformly distributed load, various end conditions.

Activities: Analyze deflection of a rectangular plate under UDL using ANSYS, Compare analytical vs FEM solutions for curved beams, Write a technical note on applications of plate theory in aerospace or civil structures.

Shear and Torsion: Location of shear centre for various thin sections, shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section, General Torsional equation, Torsion of rectangular cross section, St.Venants theory, elastic membrane analogy, Prandtl's stress function, torsional stress in hollow thin-walled tubes and multi-walled sections

Activities: Find the shear center for an open thin-walled section experimentally (e.g., channel section), Use FEM to analyze torsional stresses in rectangular and hollow thin-walled tubes, Students design a beam subjected to unsymmetrical bending and justify choice of section.

Stresses in Rotating Members and Contact Stresses: Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications

Activities: Calculate allowable speeds for rotating discs (e.g., turbine blade roots, flywheels), Use ANSYS/ABAQUS to simulate stress in rotating discs with varying thickness, Mini project on predicting failure in machine components under contact stresses.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Boresi, A. P., & Schmidt, R. J. (2009). Advanced mechanics of materials. Wiley India Pvt. Ltd.
2. Hibbeler, R. C. (2011). Mechanics of materials. Prentice Hall.
3. Cook, R. D., & Young, W. C. (1999). Advanced mechanics of materials. Prentice Hall.
4. Chandramouli, P. N. (2017). Theory of elasticity. Yes Dee Publishing.

5. Srinath, L. S. (2010). Advanced mechanics of solids. Tata McGraw-Hill.
6. Timoshenko, S., & Goodier, J. N. (2010). Theory of elasticity. Tata McGraw-Hill.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Understand and apply fundamental concepts of elasticity, stress-strain relations, and equilibrium equations to analyze mechanical components under various loading conditions.	PO3 (3)	1	3
CO2	Analyze stresses and deflections in flat plates, curved beams, and torsional members using analytical and energy methods.	PO3 (3)	2	3
CO3	Evaluate stresses in rotating members and contact stresses in mechanical components for design and failure analysis.	PO1 (3), PO3 (2)	3	2
CO4	Develop problem-solving skills to formulate and solve complex solid mechanics problems encountered in real-world engineering applications.	PO1 (3), PO2 (2)	2	3

IPR Developments in India for the past Five Years – Development of IPR Laws in India – International Cooperation on IPR – New Developments in IPR – Administration of Patent System – International Patent protection – Case Studies in Indian and Global Contexts.

Activities: Study of recent IPR developments, comparison of Indian and international patent systems, and presentation of IPR case studies.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002, An introduction to Research Methodology, RBSA Publishers.
2. Cohen, L. Lawrence, M., & Morrison, K. (2005), Research Methods in Education (5th edition). Oxford: Oxford University Press.
3. Kothari, C.R., 1990, Research Methodology: Methods and Techniques, New Age International.
4. Dornyei, Z. (2007). Research Methods in Applied Linguistics. Oxford: Oxford University Press.
5. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009, Research Methods: A Process of Inquiry, Allyn and Bacon.
6. Fink, A., 2009, Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
7. Day, R.A., 1992, How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Wadehra, B.L. 2000, Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
9. Coley, S.M. and Scheinberg, C. A., 1990, Proposal Writing, Sage Publications.
10. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options, Zed Books, New York.
11. Leedy, P.D. and Ormrod, J.E., 2004, Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Publications.

Weblinks:

- www.ipindia.nic.in - Intellectual Property Office, India
 - www.patentoffice.nic.in - Patent office, India
 - <http://copyright.gov.in/> - Copyright Office, India
 - ipr.icegate.gov.in - Automated Recordation & Targeting for IPR Protection
 - <http://www.icegate.gov.in> - E- Commerce portal of Central Board of Excise and Customs
 - www.ipab.tn.nic.in - Intellectual Property Appellate Board, India
 - www.mit.gov.in - Department of Information Technology, India
 - <http://www.mit.gov.in/content/office-semiconductorintegrated-circuits-layout-designregistry>
1. Semiconductor Integrated Circuits Layout-Design Registry (SICLDR)

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain the fundamental concepts, principles, and methodologies of research and identify suitable research topics and problems.	PO1(3)	3	2
CO2	Formulate research problems, define appropriate parameters, and select suitable research methods, measurement, and scaling techniques.	PO1(3) PO2(3) PO3(3)	2	1
CO3	Apply appropriate data analysis techniques and hypothesis testing procedures for interpreting research findings.	PO1(3) PO2(3) PO3(3)	2	3
CO4	Prepare a structured research proposal and develop a research report/thesis using appropriate scientific and technical writing practices.	PO1(3) PO2(3) PO3(3)	3	2
CO5	Explain and apply the fundamentals of Intellectual Property Rights (IPR), including patents, trademarks, and copyrights, in protecting and commercializing research outcomes.	PO3(3)	2	3

References:

1. Ghosh, A., & Mallik, A. K. (1999). Theory of mechanism and machines. EWLP.
2. Waldron, K. J., & Kinzel, G. L. (2016). Kinematics, dynamics and design of machinery. John Wiley & Sons.
3. Norton, R. L. (2012). Design of machinery. Tata McGraw-Hill.
4. Sandor, G. N., & Erdman, A. G. (1984). Advanced mechanism design: Analysis and synthesis. Prentice Hall.
5. Uicker, J. J., Pennock, G. R., & Shigley, J. E. (2017). Theory of machines and mechanisms. Oxford University Press.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Apply kinematic analysis methods to design and simulate the motion of basic mechanisms (e.g., four-bar, slider-crank).	PO1 (3), PO2 (2)	3	2
CO2	Synthesize and design complex mechanisms, such as four-bar and six-bar linkages, to meet specific motion generation or path generation objectives.	PO1 (3), PO3 (3)	3	3
CO3	Analyze and synthesize compliant mechanisms and path curvature theory to optimize motion and performance of mechanical systems.	PO1 (3), PO3 (2)	3	2
CO4	Design and simulate CAM mechanisms, including optimizing cam profiles and testing different motion types using simulation software.	PO1 (3), PO2 (3)	3	3

ED26111	Design Practice with CAD Tools Laboratory	L	T	P	C
SDG: 8,9,12		0	0	4	2
Course Objective: The objective of this course is to equip students with the fundamental and practical knowledge of engineering drawing standards and CAD tools, enabling them to interpret and create accurate 2D and 3D representations of mechanical components and assemblies. The course aims to develop skills in applying BIS conventions, tolerancing, and geometric dimensioning, constructing orthographic projections, producing part and assembly drawings, and simulating basic kinematic mechanisms using CAD software for real-world mechanical applications.					
Study exercise 1 Code of practice for Engineering Drawing, BIS/ASME specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. 2 Limits, Fits – Tolerancing of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning & Tolerancing. 3 Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.					
Sketching for solid modeling 4 Orthographic projection of mechanical parts: Hexagonal Nut, Sectioned Hollow stepped shaft, L – Bracket, Slotted Blocks, other similar parts.					
Part Drawing, Assembly and Geometrical Properties 5 Bearings – Bush Bearing, Taper bearing 6 Valves – Safety and Non-return Valves. 7 Couplings – Flange, Oldham's, Muff, Gear couplings. 9 Joints – Universal, Knuckle, Gib & Cotter, Strap, Sleeve & Cotter joints. 10 Engine parts – Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, Multi-plate clutch. 11 Machine Components – Screw Jack, Machine Vice, Lathe Tail Stock, Lathe Chuck, Plummer Block, Vane and Gear pumps.					
Kinematics 12 Simulation of slider crank mechanism 13 Simulation of crank and rocker mechanism					
Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Apply engineering drawing standards, BIS/ASME specifications, and tolerancing principles for mechanical components.	PO1 (3), PO3 (2)	2	2
CO2	Create accurate 2D orthographic projections and detailed part drawings of mechanical components using CAD tools.	PO1 (3), PO3 (3)	3	2
CO3	Develop assembly drawings and interpret geometric properties of machine components and joints.	PO1 (2), PO3 (3)	3	2
CO4	Simulate basic kinematic mechanisms (slider crank, crank and rocker) using CAD software for mechanical applications.	PO1 (3), PO3 (3)	3	2

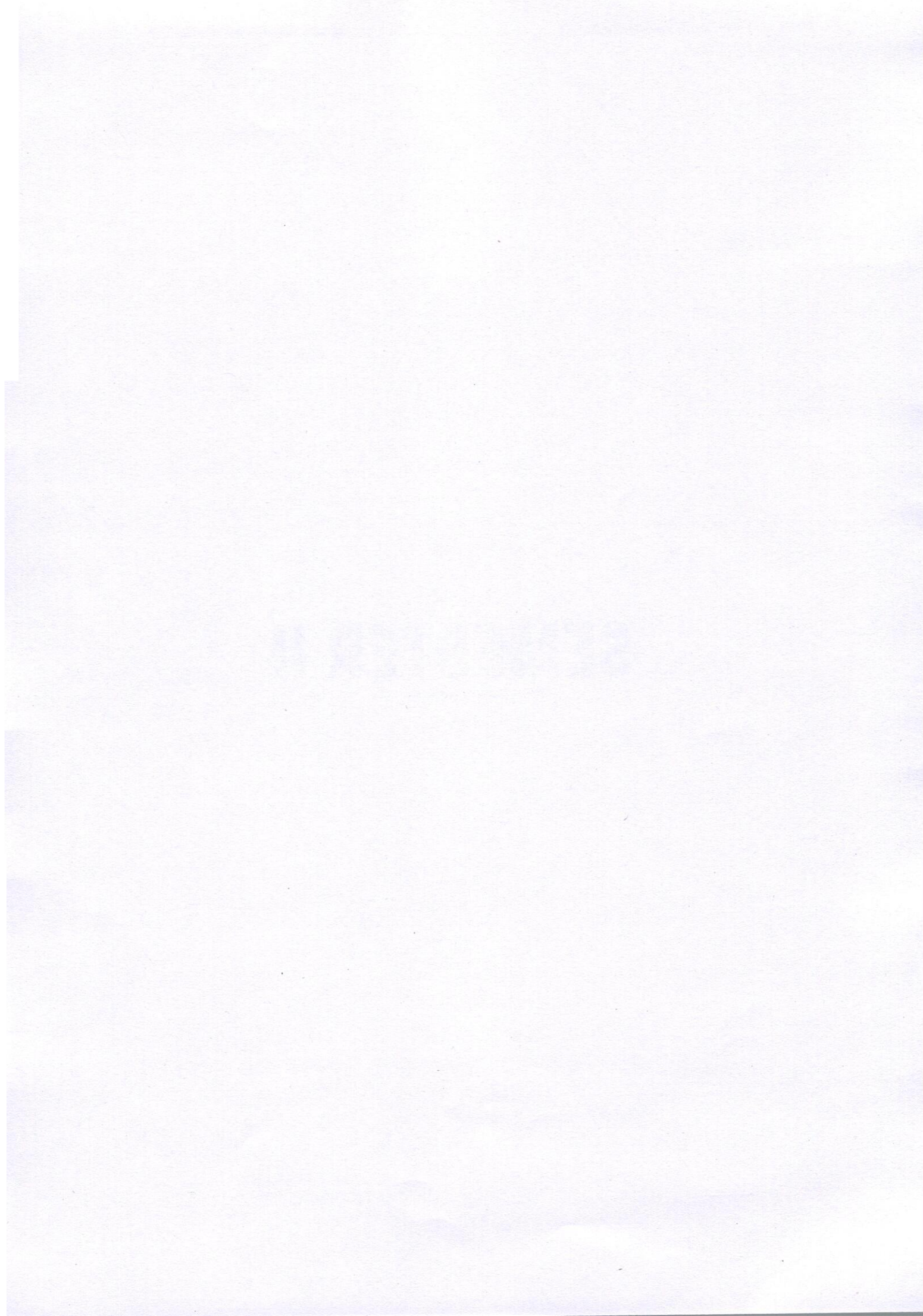
ED26112	Multi Body Dynamics Laboratory	L	T	P	C
SDG: 9,12,13		0	0	4	2

List of Experiments:

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Analyze and simulate free fall, projectile motion, and pendulum dynamics to understand basic motion and forces in mechanical systems.	PO1 (3), PO3 (2)	3	2
CO2	Perform kinematic and dynamic analysis of four-bar and slider-crank mechanisms, including their inversions, to understand mechanical system behavior.	PO1 (3), PO2 (2)	3	2
CO3	Design and simulate CAM profiles for various follower output motions to understand motion generation in mechanical systems.	PO1 (3), PO3 (2)	3	3
CO4	Conduct vibration analysis (SDOF and MDOF) and evaluate the dynamic behavior of mechanical systems under different excitation conditions.	PO1 (3), PO2 (3)	3	2
CO5	Design a virtual product using commercial software, integrating multi-body dynamics principles in product design and analysis.	PO2 (3), PO3 (3)	3	3

SEMESTER II



M.E ENGINEERING DESIGN

REGULATION 2026

SEMESTER – II

ED26201	Vibration, Fracture, and Failure Analysis	L	T	P	C
SDG: 9,11,12,13		3	0	0	3
Course Objective: To equip students with fundamental and advanced knowledge of mechanical vibrations, fracture mechanics, and failure analysis, enabling them to analyze the dynamic behavior of mechanical systems, predict failure modes, and apply diagnostic techniques for identifying and preventing structural failures in engineering components.					
Fundamentals of Vibration Basics of mechanical vibration – Classification: free and forced vibration, damped and undamped systems – Single degree-of-freedom systems – Natural frequency – Damping models – Forced vibration response – Resonance – Vibration isolation – Introduction to multi-degree-of-freedom systems – Modal analysis.					
Fracture Mechanics Introduction to fracture mechanics – Linear elastic fracture mechanics (LEFM) – Stress intensity factor – Griffith's energy balance – Modes of crack opening – Fracture toughness – Crack tip plasticity – Fatigue crack growth – Paris' Law – Experimental determination of fracture parameters – Concept of R-curves.					
Failure Theories and Analysis Theories of failure: maximum principal stress, maximum shear stress, distortion energy theory – Ductile vs brittle failure – Creep and fatigue failures – High-cycle and low-cycle fatigue – S-N curve – Miner's rule – Failure analysis methodology – Case studies of failed mechanical components.					
Condition Monitoring and Vibration-based Fault Diagnosis Principles of condition monitoring – Vibration signature analysis – Frequency spectrum analysis – Time-domain and frequency-domain features – Fault detection techniques – Crack detection in shafts and rotors – Vibration sensors and instrumentation – Case studies on vibration-based failure analysis.					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. Rao, S. S., Mechanical Vibrations, 6th Edition, Pearson Education, 2017. 2. Timoshenko, S. P., and Young, D. H., Vibration Problems in Engineering, 5th Edition, John Wiley & Sons, 1990. 3. Anderson, T. L., Fracture Mechanics: Fundamentals and Applications, 4th Edition, CRC Press, 2017. 4. Bannantine, J. A., Comer, J. J., and Handrock, J. L., Fundamentals of Metal Fatigue Analysis, Prentice Hall, 1990. 5. Juvinall, R. C., and Marshek, K. M., Fundamentals of Machine Component Design, 6th Edition, Wiley, 2017. 6. ASM International, Metals Handbook, Volume 11: Failure Analysis and Prevention, 10th Edition, ASM International, 2002.					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamentals of vibration, fracture mechanics, failure theories, and condition monitoring	PO1 (1), PO2 (1)	1	1
CO2	Apply vibration, fracture mechanics, and failure analysis techniques to solve engineering problems	PO2 (2), PO3 (2)	2	2
CO3	Estimate critical parameters such as natural frequency, stress intensity factor, fatigue life, and system responses	PO3 (2), PO4 (2)	2	2
CO4	Analyze vibration signals, failure modes, and condition monitoring data for fault diagnosis	PO4 (2), PO5 (2)	2	2

6. Tirupathi R.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain FEM fundamentals, 1D/2D problems, isoparametric formulation, and nonlinear analysis	PO1 (3), PO3 (2)	3	2
CO2	Apply FEM techniques to model and solve structural and thermal problems	PO1 (3), PO2 (3)	3	3
CO3	Estimate errors, meshing needs, and eigenvalues in FEM solutions	PO1 (3), PO3 (3)	3	3
CO4	Analyze FEM results for accuracy, optimization, and problem-solving	PO3 (3)	3	3

ED26203	Computational Fluid Dynamics	L	T	P	C
SDG: 7,9,13		2	0	2	3
Course Objective: To equip students with a solid foundation in the principles and numerical techniques of computational fluid dynamics, enabling them to model, analyze, and solve complex fluid flow and heat transfer problems relevant to engineering design using modern CFD tools and turbulence models.					
Fundamentals of CFD and Governing Equations Introduction to CFD – Applications in Engineering Design – Types of fluid flow Fundamental conservation equations: mass, momentum, energy – Classification of PDEs: hyperbolic, parabolic, elliptic – Initial and boundary conditions – Simplification of Navier-Stokes equations for various flow regimes – Non-dimensionalization – Reynolds number and its significance.					
Discretization and Solution Techniques Introduction to numerical methods – Finite Difference Method (FDM) – Finite Volume Method (FVM) – Finite Element Method (FEM) – Grid generation and mesh quality – Structured vs unstructured meshes – Discretization of governing equations – Upwind, central and hybrid schemes – Stability, consistency and convergence – SIMPLE and PISO algorithms – Time-marching methods: explicit and implicit schemes.					
Turbulence Modelling and Applications Introduction to turbulence – Reynolds Averaged Navier-Stokes (RANS) equations – Eddy viscosity concept – Turbulence models: k- ϵ , k- ω , SST – Wall functions – Near-wall modelling – Heat transfer and multi-physics in CFD – Case studies using commercial CFD solvers – CFD for component design and optimization – Validation and verification of CFD results.					
Lab Exercises: 1. Mesh Generation and Grid Independence Study 2. Simulation of Laminar Flow in a Circular Pipe 3. Turbulent Boundary Layer Flow over a Flat Plate 4. Conjugate Heat Transfer in a Heated Channel 5. Transient Flow Over a Cylinder and Vortex Shedding Analysis 6. Mixing Flow Analysis in a Tee Junction					
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%					
References: 1. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics, Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014. 2. Subas and V. Patankar "Numerical heat transfer fluid flow", CRC Press, 2018. 3. Jiyuan Tu, Gaun-Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics: A practical approach, Elsevier, 2018. 4. Chung T.J, Computational Fluid Dynamics, Cambridge University Press, 2014. 5. Randall J. LeVeque, Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2004. 6. Vladimir D. Liseikin, Grid Generation Methods, Springer, 2017. 7. Moukalled F, Mangani L, Darwish M, The Finite Volume Method in Computational Fluid Dynamics, Springer, 2016. 8. Hirsch Ch, Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics, Elsevier, 2007. 9. Oleg Zikanov, Essential Computational Fluid Dynamics, Wiley, 2019.					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain CFD fundamentals, governing equations, and flow classification	PO1, PO3	2	1
CO2	Apply numerical methods (FDM, FVM, FEM) and CFD tools for fluid flow and heat transfer problems	PO1, PO3	2	2
CO3	Estimate and model turbulence effects using RANS and other turbulence models	PO3, PO2	2	2
CO4	Analyze and validate CFD simulations, and optimize engineering components	PO3, PO2	2	2

ED26211	Research Article Replication Practice	L	T	P	C
SDG: 4,9,17		0	0	2	1
Course Objective: The objective of this course is to develop students' ability to critically analyze, interpret, and replicate published research articles in their field of study. It aims to enhance understanding of research methodologies, experimental design, data analysis, and result validation by engaging students in hands-on replication of existing scholarly work. Through this process, students will gain insights into research rigor, reproducibility, and ethical practices in scholarly communication.					
List of exercises: 1. Selection of a Research Article for Replication 2. Objective and Methodology Extraction from Published Research 3. Literature Benchmarking and Related Work Mapping 4. Reconstructing the Experimental or Simulation Setup 5. Dataset Creation or Acquisition for Replication 6. Algorithm or Model Reconstruction and Implementation 7. Simulation Execution and Output Validation 8. Graphical and Tabular Result Reproduction 9. Error and Deviation Analysis in Replication 10. Replicating Statistical and Hypothesis Tests 11. Preparation of Replication Research Report 12. Oral Presentation and Peer Review of Replication Work					
Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain research methodologies, article structure, and replication principles	PO1 (3), PO3 (2)	3	2
CO2	Apply experimental, simulation, and data analysis techniques to replicate research	PO1 (3), PO2 (3)	3	3
CO3	Analyze replication results, estimate errors, and validate outcomes	PO3 (3)	3	3

SEMESTER III

ED26311	Project Work I	L	T	P	C
SDG: 9,11,12		0	0	12	6

Course Objectives:

- The main learning objective of this course is to prepare the students for identifying a specific problem for the current need of the society and or industry, through detailed review of relevant literature, developing an efficient methodology to solve the identified specific problem.

Note: A project topic must be selected by the students in consultation with their guides. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

SEMESTER IV

ED26411	Project Work II	L	T	P	C
SDG: 9,11,12		0	0	24	12

Course Objectives:

- The main learning objective of this course is to prepare the students for solving the specific problem for the current need of the society and or industry, through the formulated efficient methodology, and to develop necessary skills to critically analyse and discuss in detail regarding the project results and making relevant conclusions.

Note: A project topic must be selected by the students in consultation with their guides. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

PROGRAMME ELECTIVE COURSES

ED26001	Design with Advanced Materials	L	T	P	C
SDG: 9,12,13		3	0	0	3

Course Objective:

This course is designed to equip students with a comprehensive understanding of metallic materials and their applications. It aims to develop the ability to analyse various strengthening and failure mechanisms in metals and to apply metallurgical parameters effectively in the design of advanced materials. Students will gain insight into the relationship between material selection and processing methods, enabling informed decisions in engineering design. The course also fosters innovation by encouraging the development of novel materials through a deep understanding of the properties and behaviour of existing metallic systems. Additionally, students will critically analyse the use of different materials across a range of engineering applications.

Basic Concepts of Material Behavior

Engineering Design process and the role of materials; materials classification and their properties, strengthening mechanisms-grain size reduction, solid solution strengthening, strain hardening, grain boundary strengthening, precipitation, particle, fibre and dispersion strengthening, Effect of temperature, strain and strain rate on plastic behavior – Super plasticity – Failure of metals

Activities Based Learning:

1. Case study discussion on material behavior in real-world engineering failures
2. Virtual presentation on microstructural changes during strengthening
3. Group presentation on strengthening mechanisms with example materials

Behavior Under Cyclic Loads and Failure Design

Stress intensity factor and fracture toughness – Fatigue-low and high cycle fatigue test, fracture mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue – Safe life, Stress life, strain-life and fail - safe design approaches- Fracture of non-metallic Materials – Failure analysis, sources of failure, procedure of failure analysis.

Activities Based Learning:

1. Simulation on fatigue crack propagation and S-N curves
2. Numerical analysis on fracture toughness and fatigue design
3. Failure analysis report based on a real-world case
4. Mind map creation on design approaches under fatigue loading

Materials Selection and Design Integration

Material selection based on function, objectives, constraints, and service requirements- Free variables in selection- Relationship between material selection and processing- Case studies in advanced materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

Activities Based Learning:

1. Project on material selection for a specific engineering product
2. Interactive seminar on Ashby's material selection charts
3. Group debate on trade-offs in materials selection
4. Industry-based mini-case analysis of material choice and processing

Advanced Steels and Intermetallics

Steels-Advanced high strength steel, Dual phase (DP) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel and Q&P steels- Nitrogen steels, austenitic steels- intermetallic compounds: Ni and Ti aluminides- Overview of alloy families: Al, Mg, Cu- Introduction to superalloys: iron, cobalt, and nickel base.

Activities Based Learning:

1. Comparative chart activity on different advanced steels
2. Individual assignment on intermetallic properties and applications
3. Video-based discussion on heat treatment of steels
4. Discussion on superalloy classifications and usage

Metal Matrix Composites (MMC) and Emerging Metallic Systems

Definition, characteristics, and applications of MMCs- Fabrication techniques and challenges-Performance evaluation of MMCs- Examples of MMCs used in aerospace, automotive, and military applications.

Activities Based Learning:

1. Case study: MMCs in aerospace structural components
2. Design task: Choose MMCs for a lightweight structure
3. Presentation: Comparison between conventional metals and MMCs
4. Poster creation on fabrication methods of MMCs

Non-Metallic and Composite Materials

Polymers: structure formation, properties, applications, environmental impact- Advanced ceramics: WC, TiC, TaC, Al₂O₃, SiC, Si₃N₄, CBN, diamond- Fracture and deformation of ceramics- Glasses, clay products, and refractory ceramics- Composite materials: GFRP and CFRP laminated composites

Activities Based Learning:

1. Industrial visit to observe polymer and ceramic manufacturing
2. Case analysis of failure in ceramic-based components
3. Team presentation on CFRP and GFRP in automotive or aviation
4. Comparative table on mechanical properties of metals vs non-metals

(Note: Split the activities among the students (Maximum of three/ group) such that all the activities are covered)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988.
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd Edition), McGraw Hill, 2000.
3. Willam D. CallisterJr. and David G. Rethwisch, Callister's Materials Science and Engineering,(2nd Edition) Wiley Editorial, 2018.
4. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials,(34d edition), Butterworth-Heiremann, 1997.
5. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
6. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
7. Ashby M.F., Materials Selection in Mechanical Design, 2nd Edition, Butter worth.
8. www.astm.org/labs/pages/131350.htm.

E-Resources:

www.astm.org/labs/pages/131350.html

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamental material behavior, strengthening mechanisms, and failure modes	PO1 (2), PO3 (1)	2	1
CO2	Apply fatigue, fracture, and failure analysis techniques to engineering components	PO1 (2), PO3 (2)	2	2

CO3	Estimate material performance and select suitable materials for design applications	PO2 (2), PO3 (2)	2	2
CO4	Analyze advanced steels, intermetallics, MMCs, and composites for engineering applications	PO2 (2), PO3 (2)	2	2

ED26002	Integrated Product Design and Development	L	T	P	C
SDG: 8,9,12		3	0	0	3
Course Objective: This course aims to provide a comprehensive understanding of the generic product development process, including product planning and customer need analysis. It enhances students' abilities to set product specifications and effectively generate, select, and test design concepts. Emphasis is placed on product architecture, industrial design, and Design for Manufacturing (DFM) principles. The course also introduces prototyping techniques, robust design through Design of Experiments (DoE), and the importance of patenting innovations. Additionally, it integrates economic principles and project management practices essential for successful new product development.					
Introduction to Product Development: Overview of Product Development, Characteristics of Successful Products, Product Development Teams and Organizations- Challenges, Duration and Cost of Product Development, Product Development Process (Generic and Front-End), Process Flows and Opportunity Identification.					
Activities: <i>Brainstorming Session: Identifying latent vs stated needs for a new product</i>					
Product Planning and Customer Needs: Product Planning Process, Identifying and Understanding Customer Needs, Importance of Latent Needs, Establishing Target and Final Specifications					
Activities: <i>Design Review Meeting: Present and defend a selected product concept</i>					
Concept Generation, Selection and Testing: Concept Generation Activities- Concept Selection: Screening and Scoring- Concept Testing Techniques and Caveats					
Activities: Use mind maps to visually expand product features and functions					
Product Architecture and Industrial Design: Product Architecture, Definition, Planning, and System, Level Design; Delayed Differentiation and Platform Planning; Industrial Design, Need, Process, Management, Quality Assessment.					
Activities: <i>Product Platform Case Study: Explore delayed differentiation in brands (e.g., Dell, Toyota)</i>					
Design for Manufacturing (DFM) Principles: DFM Process Overview- Integration of Design and Manufacturing Early in the Development Cycle- Cost and Complexity Considerations; Cross-functional Collaboration for Manufacturability.					
Activities: <i>Presentation: Pros and cons of different DFM strategies in a selected industry</i>					
Prototyping, Economics & Project Management: Prototyping: Principles, Planning, and Technologies, Product Development Economics, Cost Estimation and Analysis, Project Management: Task Representation, Planning, Execution, Postmortem Evaluation of Projects.					
Activities: <i>Prototype Demo: Create and explain a low-fidelity prototype (paper or digital)</i>					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. Ulrich, K. T., Eppinger, S. D., & Goyal, A. (2012). Product design and development, McGraw-Hill Education (India) Pvt. Ltd. 2. Crow, K. (n.d.). Concurrent engineering/integrated product development [Workshop book]. DRM Associates. 3. Otto, K. N., & Wood, K. L. (2016). Product design: Techniques in reverse engineering and new product development. Pearson Education, Inc. 4. Rosenthal, S. (1992). Effective product design and development. Business One Irwin 5. Pugh, S. (1991). Total design: Integrated methods for successful product engineering. Addison Wesley Publishing.					

ED26003	Design for Sustainability	L	T	P	C
SDG: 11,12,13		3	0	0	3
Course Objective: The main learning objective of this course is to prepare the students for understanding the design for sustainable behaviour and design practices.					
Foundations of Sustainable Design: Understanding sustainability through design- Challenges and evolution toward sustainable solutions- Product lifecycle design and eco-efficient product-service systems (PSS)- Eco-design principles, strategies, and green design methodologies					
Activities: Lifecycle Mapping and Eco-Design Redesign					
Design for Sustainable Behaviour (DSB): Behavioral change through design- Comprehensive Action Determination Model (CADM), Methods and tools to support sustainable behaviour- Individual cognitive vs context-driven approaches- Frameworks and future research in DSB					
Activities: Designing for Sustainable User Behavior Using CADM					
Design for Environment (DE): Global, regional, and local environmental objectives- Lifecycle assessment (LCA) methods and tools, Environmentally responsible product assessment (e.g., AT&T method), Design techniques: minimizing material use, disassembly, recyclability, energy efficiency.					
Activities: Lifecycle Assessment of Competing Product Designs					
Product-Service Systems and Systemic Sustainability Design: Transition from product to integrated product-service design- Categories and practices of PSS for sustainability- Systemic design at regional/territorial levels- Regulatory frameworks, innovation levels, and evolution of sustainable design.					
Activities: Conceptualizing a Sustainable Product-Service System (PSS) Systemic Design Case Study: Regional Sustainability in Practice					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. Ceschin, F.. & Gaziulusoy, I. (2020). Design for sustainability: A multi-level framework from products to socio-technical system. Routledge. 2. Boothroyd, G. (1980). Design for assembly automation and product design. Marcel Dekker. 3. Bralla, J. G. (1999). Design for manufacture handbook. McGraw-Hill. 4. Boothroyd, G., Heartz, W., & Nike, P. (1994). Product design for manufacture. Marcel Dekker. 5. Dickson, J. R., & Corroda, P. (1995). Engineering design and design for manufacture: A structural approach. Field Stone Publishers. 6. Fixel, J. (1996). Design for the environment. McGraw-Hill. 7. Graedel, T. E., & Allenby, B. R. (1996). Design for the environment. Pearson. 8. Otto, K., & Wood, K. (2009). Product design (4th impression). Pearson.					
E-resources: 1. Massachusetts Institute of Technology, Department of Civil & Environmental Engineering. (2006). <i>Design for Sustainability</i> (Course No. 1.964, Fall 2006). MIT Open Course Ware. Retrieved from https://ocw.mit.edu/courses/1-964-design-for-sustainability-fall-2006/ 2. University of Melbourne, Department of Mechanical Engineering. (2023). <i>Sustainable and Life Cycle Engineering</i> (Subject Code: MCEN90060). University of Melbourne Handbook. Retrieved from https://handbook.unimelb.edu.au/2023/subjects/mcen90060 3. Jolliet, O. (2023). <i>Life Cycle Assessment</i> . University of Michigan. Coursera Online Course. Retrieved from https://www.coursera.org/learn/life-cycle-assessment					
Other Resources:					

Science and Technology of Materials": <https://ocw.mit.edu/courses/3-016-science-and-technology-of-materials-fall-2009/>

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Understand the foundations of sustainable design, including eco-design principles, lifecycle thinking, and sustainable product-service systems.	PO1 (3), PO3 (3)	1	1
CO2	Analyze and apply design strategies to influence sustainable behavior using models like the Comprehensive Action Determination Model (CADM).	PO1 (3), PO3 (3)	2	3
CO3	Conduct lifecycle assessment (LCA) and environmentally responsible product evaluations to minimize environmental impact in design.	PO1 (3), PO3 (3)	3	2
CO4	Develop sustainable product-service systems and systemic design approaches addressing regional and global sustainability challenges.	PO1 (3), PO2 (2), PO3 (3)	2	3

ED26004	Composite Materials and Mechanics	L	T	P	C
SDG: 7,9,12		3	0		3

Course Objectives:

- The main learning objective of this course is to prepare the students for understanding the design for sustainable behaviour and design practices.

Introduction to Composite Materials
 Definition of composite materials, matrix materials – polymers, metals, ceramics; reinforcements – particles, whiskers, inorganic fibers, metal filaments, advanced fibers – carbon and graphite fibers, ceramic fibers, fiber fabrication, natural composites – wood, jute. Advantages and drawbacks of composites over monolithic materials, mechanical properties and applications of composites. Particulate-reinforced composites, dispersion-strengthened composites, fiber-reinforced composites, rule of mixtures, characteristics of fiber-reinforced composites, manufacturing of fibers and composites.

Manufacturing of Composites
 Manufacturing process of epoxy resins and fibers, polymer matrix composites (PMCs) – hand lay-up, spray technique, filament winding, pultrusion, resin transfer moulding (RTM), bag moulding, injection moulding, sandwich mould composites (SMC). Manufacturing of metal matrix composites (MMCs) – solid state, liquid state, vapor state processing. Ceramic matrix composites (CMCs) – hot pressing, reaction bonding process, infiltration technique, direct oxidation. Interfaces in composites.

Lamina Constitutive Equations
 Lamina assumptions – macroscopic viewpoint, generalized Hooke's Law, reduction to homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix (Q_{ij}), stress and moment resultants, strain-displacement relations. Basic assumptions of laminated anisotropic plates, laminate constitutive equations – coupling interactions, balanced laminates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli. Evaluation of lamina properties from laminate tests, quasi-isotropic laminates, determination of lamina stresses within laminates, laminate analysis using computer tools.

Lamina Strength Analysis and Laminated Plate Analysis
 Maximum stress and strain criteria, Von-Mises yield criterion for isotropic materials, Hill's criterion for anisotropic materials, Tsai-Hill and Tsai-Wu failure criteria, tensor polynomial criterion. Prediction of laminate failure, equilibrium equations of motion, energy formulations, governing equations for plates – static bending analysis, buckling analysis, free vibration analysis, natural frequency prediction.

Thermo-Structural Analysis of Laminates
 Fabrication and residual stresses in FRP laminated composites, coefficient of thermal expansion (CTE), modification of Hooke's Law and laminate constitutive equations, orthotropic lamina CTEs. Stress and moment resultants due to cooling during fabrication, calculations for thermo-mechanical stresses in FRP laminates, thermally quasi-isotropic laminates, case studies on classical laminate theory (CLT) for evaluating residual stresses in multi-layered isotropic structures such as electronic packages.

Applications and Advanced Topics in Composite Design
 Real-world case studies and applications of composite material design, implementation of classical laminate theory (CLT), impact and fatigue behavior, durability analysis, hybrid composites, smart composites with embedded sensors, environmental considerations and recycling of composites.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

- Agarwal BD and Broutman LJ, "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.

2. Gibson R F, Principles of Composite Material Mechanics, McGraw-Hill, 1994, CRC press, 4th Edition, 2015.
3. Hyer MW and Scott R White, "Stress Analysis of Fiber – Reinforced Composite Materials", McGrawHill, 1998
4. Issac M Daniel and OriIshai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007 Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
5. Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rd Edition, 2007.

E-Resources:

<https://nptel.ac.in/courses/112/104/112104251>

NPTEL Course: Composite Materials by IIT Kanpur – Covers mechanics, manufacturing, and applications of composite materials.

<https://www.coursera.org/learn/composite-materials>

Coursera: Introduction to Composite Materials – Offers practical understanding and analysis tools for composite structures.

<https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-20-structural-mechanics-spring-2003/>

MIT Open Course Ware: Structural Mechanics – Includes advanced topics on composite and anisotropic materials.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamentals, lamina theory, laminated plates, thermo-structural effects, and applications	PO1 (2), PO3 (1)	2	1
CO2	Apply lamina/laminate analysis, failure criteria, and thermo-mechanical calculations	PO2 (2), PO3 (2)	2	2
CO3	Estimate stresses, strength, residual stresses, and natural frequencies	PO1 (2), PO3 (2)	2	2
CO4	Analyze performance, failure, and durability of composite structures	PO3 (1), PO4 (2)	1	2

ED26005	Quality Concepts in Design	L	T	P	C
SDG: 8,9,12		3	0	0	3

Course Objective:

The main learning objective of this course is to prepare the students for imparting knowledge on various concepts in engineering design and principles of implementing quality in a product or service.

Design Fundamentals, Methods and Material Selection

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

Design for Quality

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders- Measures and Matrices-Design of Experiments –design process- Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors Running the experiments – Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating

Failure Mode Effects Analysis, Design for Six Sigma and Design for Safety

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modelling, mechanical embodiment principles-FMEA method linking fault states to systems modelling - Basis of SIX SIGMA – Serviceability – Preventive Maintenance – Breakdown Maintenance – Testability – Role of reliability in maintenance and repair.

Design of Experiments

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios.

Statistical Tools for Quality and Process Analysis

Frequency Distributions and Histograms- Run Charts- Stem-and-Leaf Plots- Pareto Diagrams- Cause and Effect Diagrams (Ishikawa)- Box Plots- Probability Distributions- Statistical Process Control (SPC)- Scatter Diagrams- Multivariable Chart- Matrix Plots and 3D Plots.

Reliability Engineering and Failure Analysis

Reliability Concepts- Survival and Failure Analysis- Series and Parallel System Reliability- Mean Time Between Failures (MTBF)- Weibull Distribution.

Activities Based Learning:

1. Morphology Mapping & Benchmarking Challenge
2. TRIZ-Based Ideation for Innovative Product
3. House of Quality Construction for a New Product
4. Mini Design of Experiments (DOE) on a Simple System
5. FMEA Case Study on a Consumer Product
6. Six Sigma Roleplay: DMAIC in a Manufacturing Scenario
7. Statistical Visualization Lab Using Real Data
8. Reliability Analysis of a Series/Parallel System

(Note: Split the activities among the students (Maximum of three/ group) such that all the activities are covered)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
2. George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., 2013
3. Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, ,TataMcgraw-Hill Education, 2015
4. Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001
5. Montgomery, D.C., "Design and Analysis of experiments", John Wiley and Sons, 2019.
6. Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain engineering design principles, quality concepts, and reliability fundamentals	PO1 (3), PO3 (2)	3	2
CO2	Apply design methods, TRIZ, DOE, FMEA, and Six Sigma tools in practical scenarios	PO1 (3), PO2 (3)	3	3
CO3	Estimate product reliability, process performance, and statistical measures for quality analysis	PO1 (3), PO3 (3)	3	3
CO4	Analyze design outcomes, experimental results, and quality metrics for improvement and decision-making	PO3 (3)	3	3

ED26006	Bearing Design and Rotor Dynamics	L	T	P	C
SDG: 7,8,9		3	0	0	3

Course Objective:

The main learning objective of this course is to prepare the students for knowing about different types of bearings available for machine design and their operating principles and acquiring research knowledge in the developing area of the rotor dynamics such as identification of rotor bearing system parameters and its use in futuristic model-based condition monitoring and fault diagnostic.

Classification and Selection of Bearings

Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings- Electro Magnetic Bearings-Dry Bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non-metallic bearings

Design and Performance of Rolling and Journal Bearings

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Design and performance analysis of Rolling bearings- Contact Stresses and Centrifugal stresses-Elasto hydrodynamic lubrication- Fatigue life calculations- dynamics of hydro dynamic bearings -Squeeze film effects in journal bearings and thrust bearings -Rotating loads, alternating and impulse loads in journal bearings

Vibration and Instability in Rotating Systems

Flexural and torsional vibrations, critical speeds of shafts using Rayleigh's method, matrix iteration methods, Prohal and Myklested method, equivalent discrete systems, geared and branched systems. - Instability of rotors mounted on fluid film bearings, rigid rotor instability, instability of a flexible rotor, instability threshold by transfer matrix methods, internal hysteresis of shafts, instability in torsional vibrations

Balancing of Rotors

Balancing of rotors, Concepts and principles of Single-plane balancing, Two-plane balancing, balancing criteria for flexible rotors, bearing dynamic parameters estimation, measurement & digital processing techniques

Conditioning Monitoring

Introduction to rotary machinery maintenance, fundamentals of data acquisition, principles of condition monitoring, transducers for condition monitoring, fault diagnosis in rotating machines, NDT methods in condition monitoring, wear and debris analysis, case studies in condition monitoring.

Advanced Applications and Integration

Integration of bearing design, balancing, and condition monitoring- Smart bearing technologies- Predictive maintenance using AI/ML- Industry 4.0 in rotary machine health monitoring.

Activities Based Learning:

1. Use an online tool or simulation software to visualize load behavior in different bearing types.
2. Calculate dimensions and load-carrying capacity of a pivoted journal bearing.
3. Plot fatigue life vs. load for different rolling bearing types.
4. Apply Rayleigh's method for shaft critical speed using software.
5. Process vibration data from rotor test rigs using FFT.
6. Choose appropriate sensors for balancing flexible rotors in a machine.
7. Analyze real or simulated vibration data to detect fault patterns.
8. Brainstorm potential machine learning models for fault prediction in bearings.
9. Simulate or review an industry's rotary equipment and suggest integration of condition monitoring systems.
10. Design a predictive maintenance plan using vibration sensors and IoT.

(Note: Split the activities among the students (Maximum of three/ group) such that all the activities are covered)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. J. S. Rao, "Rotor Dynamics", New Age International Publishers, New Delhi.
2. T. Yamamoto and Y. Ishida, "Linear and Nonlinear Rotor Dynamics: A Modern Treatment with Applications", John Wiley.
3. J. S. Rao, "Vibratory Condition Monitoring of Machines", Narosa Publishing House.
4. Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 2001.
5. Cameron, A. "Basic Lubrication Theory", Ellis Horward Ltd., UK, 1981.
6. Halling, J. (Editor) – "Principles of Tribology", Macmillian – 1984. 4. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994.
7. S.K.Basu, S.N.Segupta & B.B.Ahuja, "Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2005.
8. G.W.Stachowiak & A.W. Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain types, selection, and operating principles of bearings and rotor systems	PO1 (3), PO3 (2)	2	1
CO2	Apply bearing design, rotor balancing, and vibration analysis methods	PO2 (3), PO3 (3)	2	2
CO3	Estimate bearing performance, fatigue life, and critical speeds of rotors	PO1 (3), PO3 (3)	2	2
CO4	Analyze rotor vibrations, instability, and condition monitoring data for fault diagnosis	PO3 (3), PO4 (2)	1	2

ED26007	Solid Freeform Manufacturing	L	T	P	C
SDG: 8.9.12		3	0	0	3

Course Objective:

Introduction

Design for Additive Manufacturing (DfAM)

Vat Polymerization, Material Extrusion & Sheet Lamination Technologies

Powder Bed Fusion, Binder Jetting, Material Jetting

Direct Energy Deposition Technologies

Materials and Applications Of SFM

Activities Based Learning:

1. Use an online tool or simulation software to visualize load behavior in different bearing types.
2. Calculate dimensions and load-carrying capacity of a pivoted journal bearing.
3. Plot fatigue life vs. load for different rolling bearing types.
4. Apply Rayleigh's method for shaft critical speed using MATLAB.
5. Process vibration data from rotor test rigs using FFT.
6. Choose appropriate sensors for balancing flexible rotors in a machine.
7. Analyze real or simulated vibration data to detect fault patterns.
8. Brainstorm potential machine learning models for fault prediction in bearings.
9. Simulate or review an industry's rotary equipment and suggest integration of condition monitoring systems.
10. Design a predictive maintenance plan using vibration sensors and IoT.

(Note: Split the activities among the students (Maximum of three/ group) such that all the activities are covered)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 3rd Edition, 2021. ISBN 978- 3-030-56126-0.
2. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2016. ISBN: 978-1-56990-582-1.
3. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1st Edition, 2019 FL, USA. ISBN- 9780429029721
5. Ben Redwood, Brian Garret, Filemon Schoffer, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017. ISBN-13: 978- 9082748505.
6. Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain SFM evolution, DfAM concepts, AM technologies, materials, and applications	PO1 (3), PO3 (2)	3	2
CO2	Apply DfAM guidelines, CAD modeling, process planning, and SFM techniques to design and simulate parts	PO1 (3), PO2 (3)	3	3
CO3	Estimate process parameters, part quality, material behavior, and load/fatigue in AM components	PO1 (3), PO3 (3)	3	3
CO4	Analyze SFM processes, hybrid techniques, material applications, and simulation/monitoring data for optimization	PO3 (3)	3	3

ED26008	Product Lifecycle Management	L	T	P	C
SDG: 9,12,13		3	0	0	3
Course Objective: To understand and apply the principles and concepts in Product Life-Cycle Management for Product Design and Development.					
Introduction to PLM Definition of PLM; PLM Initiative; PLM Paradigm – P, L and M of PLM – Scope of PLM – PLM Paradigm – Benefits of PLM – Spread of PLM – Overcoming Problems & Enabling Opportunities – PLM Environment – Issues in the Traditional Environment – Product Data Issues – A Complex, Changing Environment – Example from “Before PLM” – Product Pains: Aerospace Products; Power Plants; Automotive Products – Product Opportunities.					
PLM Environment: Business Process and Product Data Business Processes in the PLM Environment – Relevance of Business Processes in PLM – Definitions & Introductions for Business Process – Business Process Reality in a Typical Company – Business Process Activities in the PLM Initiative – Learning from Experience with Business Process- Product Data in the PLM Environment – Relevance of Product Data in PLM – Product Data Reality in a Typical Company – Product Data Activities in the PLM Initiative – Learning from Experience with Product Data.					
PLM Environment: Information Systems Information Systems in the PLM Environment – Relevance of Information Systems Applications in PLM – PLM Applications in the Product Lifecycle – Generic and Specific PLM Applications – PDM System: A Special Application – Importance of the PDM System in PLM – Reality in a Typical Company – Application Activities in the PLM Initiative – Best Practice PDM System Selection – Learning from Experience with Information Systems.					
PLM Environment: Project Management Project/Program Management in the PLM Environment – Skills and Relevance – Definitions and Introduction with Project Management – Project Management Reality in a Typical Company – Project Management Activities in the PLM Initiative – Learning from Experience with Project Management.					
Activities Based Learning: 1. Getting Started with PLM software’s Engineering BOM 2. Working with CAD Parts 3. Creating and Attaching Specifications 4. Creating Engineering Bill of Materials 5. Releasing Parts Using the ECM Process 6. Use Matrix Query Language (MQL) to fetch the info from Database (DB) and test queries on PLM. (Note: Split the activities among the students (Maximum of three/ group) such that all the activities are covered)					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition). 2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.					

3. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management, Springer Publisher, 3rd Ed., 2008.
4. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.
5. Ivica Crnkovic, Ulf Askund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain PLM concepts, paradigms, benefits, business processes, and PLM environment	PO1 (3), PO3 (2)	3	2
CO2	Apply PLM software tools for CAD parts, specifications, and engineering BOM creation	PO1 (3), PO2 (3)	3	3
CO3	Estimate product data requirements, project timelines, and process efficiency in PLM initiatives	PO1 (3), PO3 (3)	3	3
CO4	Analyze PLM processes, project management activities, and database queries for optimization and decision-making	PO3 (3)	3	3

S. S. S. S.

ED26009	Design of Hydraulic and Pneumatic Systems	L	T	P	C
SDG: 7,8,9		3	0	0	3

Course Objective:

The main learning objective of this course is to prepare the students for imparting knowledge on fluid power principles and inculcating the skills to design and develop hydraulic and Pneumatic circuits.

Fluid Power Principles and Hydraulic Pumps

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque- Problems, Sources of Hydraulic power : Pumping Theory-- Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems.

Hydraulic Actuators and Control Components

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators – Hydraulic motors - Control components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Accumulators, Pressure Intensifiers, Heat Exchangers, Pressure Gages - Pressure Switches- Filters –types and selection Applications – Fluid Power ANSI Symbols – Problems.

Hydraulic Circuits and Systems

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits – Servo and Proportional valves – Applications- Mechanical, hydraulic servosystems – Maintenance of Hydraulic Systems.

Pneumatic Systems

Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – classification single cylinder and multi cylinder circuits – Cascade method.

Electro Pneumatic Systems

Electro Pneumatic System – Elements – Relay ladder diagram – timer circuits –Problems, PLC – Logic ladder diagram – Controlling Fluid power actuators.

Trouble Shooting and Applications

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low-cost Automation – Hydraulic and Pneumatic power packs.

Activities Based Learning:

1. Hands-on experiment or simulation to demonstrate pressure transmission and mechanical advantage using Pascal's principle.
2. Disassemble or simulate various hydraulic actuators to understand internal construction and function.
3. Teams troubleshoot faulty hydraulic circuits presented via simulation or physical trainer kits.
4. Create pneumatic circuits for a given task using single/multi-cylinder setups.
5. Students sketch and explain a low-cost pneumatic/hydraulic system for a given industrial task.
6. Students build or simulate a small working model integrating hydraulic and pneumatic components.
7. Final presentation and demonstration of integrated system with documented learning outcomes.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Prentice Hall, 1997.
3. Shanmuga Sundaram. K., "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
4. Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
5. Joshi.P., "Pneumatic Control", Wiley India, 2008.
6. Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
7. Majumdar, S.R., "Oil Hydraulics Systems -- Principles and Maintenance", Tata McGraw Hill, 2001.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamental principles of fluid power, hydraulic and pneumatic systems	PO1 (1), PO2 (1)	1	1
CO2	Apply hydraulic and pneumatic components, circuits, and electro-pneumatic systems	PO2 (2), PO3 (2)	2	2
CO3	Estimate system performance, sizing, and selection of pumps, actuators, and valves	PO3 (2), PO4 (2)	2	2
CO4	Analyze hydraulic/pneumatic circuits, troubleshoot faults, and optimize designs	PO4 (2), PO5 (1)	2	1

ED26010	Mechanical Measurements and Analysis	L	T	P	C
SDG: 4,8,9		3	0	0	3

Course Objective:

This course equips students with fundamental knowledge of force and strain measurement techniques. It enables understanding of vibration measurement and its practical applications. Students will learn the basics of acoustics and wind flow measurements. The course also covers methods of distress measurement in materials and structures. Finally, it introduces principles and applications of non-destructive testing for evaluating component integrity.

Forces and Strain Measurement

Strain gauge, Rosette, principle, types, performance and uses. Photo elasticity – Principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.

Vibration Measurements

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

Acoustics, Wind Flow and Distress Measurements

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venture meter and flow meters – wind tunnel and its use in structural analysis – structural modeling – direct and indirect model analysis- Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.

Non-Destructive Testing Methods

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating.

Activities Based Learning:

1. Strain Gauge Calibration and Load Testing
2. Photoelasticity Demonstration with a Model Under Load
3. Vibration Measurement Using LVDT and Accelerometers
4. Signal Visualization with CRO and Data Acquisition System
5. Performance Testing of Vibration Meters and Seismographs

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Bray Don E and Stanley, R. K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2. Garas, F.K., Clarke, J.L and Armer GST, "Structural assessment", Butterworths, London, 1987
3. James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill, 3rd Edition, 1991
4. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009.
5. Srinath LS, Raghavan Mr, Lingaiah K, Gargasha G, Pant B and Ramachandra, K, "Experimental Stress Analysis", Tata McGraw Hill Company, New Delhi, 1984
6. Sirohi, R.S.and Radha krishna, H.C, "Mechanical Measurements", New Age International (P) Ltd, 3rd Edition 1997

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain principles of force, strain, vibration, acoustics, flow, and NDT measurement techniques	PO1 (3), PO3 (2)	3	2
CO2	Apply measurement instruments and experimental techniques for force, vibration, and NDT evaluation	PO1 (3), PO2 (3)	3	3
CO3	Estimate stresses, vibration parameters, flow characteristics, and structural distress levels	PO1 (3), PO3 (3)	3	3
CO4	Analyze measured data to assess structural integrity, damage, and component performance	PO3 (3)	3	3

S. J. Dewi

Chairman

Board of Studies

Department of Mechanical Engineering

Kingston Engineering College

Vellore - 632 059

ED26011	Surface Engineering	L	T	P	C
SDG: 9,12,13		3	0	0	3
Course Objective: The main learning objective of this course is to prepare the students for imparting knowledge on surface engineering and surface modification methods to solve the industrial problems.					
Friction, Wear and Lubrication Topography of Surfaces – Surface features – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non-metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact – Introduction to wear – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear – Laws of wear – Wear of metals and non-metals – Lubrication – Introduction, types of lubricants and their industrial uses, lubricant additives.					
Corrosion Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.					
Surface Treatments and Engineering Materials Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, laser re-melting, and laser cladding – Friction Stir Processing (FSP)- Introduction of engineering materials – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology – Nano Tribology.					
Surface Measuring Instruments Need for surface properties and measurement – International standards in friction and wear measurement –Construction and working principle of tribometer – Scratch tester – Construction and working principle of Optical Microscope (OM), Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) instruments – Sample preparation techniques for OM, SEM and TEM analysis – Construction and working principle of Atomic Force Microscope (AFM) and Scanning Tunneling Microscope (STM) instruments – Sample preparation techniques for AFM and STM analysis.					
Activities Based Learning: 1. Experiment to Measure Friction Coefficients for Different Material Pairs 2. Study on Corrosion Prevention by Coatings and Inhibitors 3. Case Study Analysis on Application of Titanium and Nickel-based Alloys 4. AFM/STM Observation of Nano-Scale Surface Features 5. Tribometer Use for Friction and Wear Characterization					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. G.W.Stachowiak & A.W. Batchelor, "Engineering Tribology", Butterworth-Heinemann, UK,2005 2. Rabinowicz.E, "Friction and Wear of materials", John Willey & Sons, UK,1995 3. Halling, J. (Editor), "Principles of Tribology ", Macmillian – 1984. 4. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994. 5. S.K.Basu, S.N.Sengupta&B.B.Ahuja , " Fundamentals of Tribology", Prentice –Hall of India Pvt. Ltd, New Delhi, 2005. 6. Fontana G., "Corrosion Engineering", McGraw Hill, 1985.					

ED26012	Computer Graphics	L	T	P	C
SDG:4,8,9		3	0	0	3

Course Objective:

The primary objective of this course is to equip students with a comprehensive understanding of computer graphics principles, algorithms, and modeling techniques essential for engineering applications. The course aims to build foundational knowledge in 2D and 3D graphics, scan-conversion algorithms, and geometric transformations. It develops the ability to model curves, surfaces, and solids using analytical and synthetic methods, including advanced tools such as NURBS. Students will gain proficiency in visibility determination and rendering techniques to simulate realistic graphics. Additionally, the course introduces concepts of assembly modeling, tolerance analysis, and product lifecycle management to integrate design, simulation, and visualization skills relevant to modern computer-aided design environments.

Fundamentals of Computer Graphics and Scan Conversion

Introduction to Computer Graphics, Scan-conversion of Lines: Digital Differential Analyzer (DDA) Algorithm, Bresenham's Line Drawing Algorithm, Scan-conversion of Circles and Ellipses: Bresenham's Circle Drawing Method, Midpoint Circle Algorithm, Drawing Ellipses and Other Conics

2D and 3D Transformations and Clipping

Introduction to 2D and 3D Transformations, Transformation Matrix, 2D Transformations: Identity, Scaling, Rotation, Translation, Reflection, Shear, Rotation about Arbitrary Point, Combined Transformations. Clipping Techniques: 2D Clipping: Point, Line, Polygon Clipping, 3D Viewing and Clipping, Text Clipping

Curve and Surface Modeling

Introduction to Curves: Analytical Curves: Line, Circle, Conics, Synthetic Curves: Hermite Cubic Spline, Bezier Curve, B-Spline Curve, Curve Manipulations, Introduction to Surfaces: Analytical Surfaces: Plane, Ruled, Revolution, Tabulated Cylinder, Synthetic Surfaces: Hermite Bicubic, Bezier, B-Spline, Surface Manipulations

NURBS and Solid Modeling Techniques

NURBS Basics: Curves, Lines, Arcs, Circle, Bilinear Surface, Solid Modeling Techniques: Regularized Boolean Set Operations, Primitive Instancing, Sweep Representations, Boundary Representations, Constructive Solid Geometry (CSG) Comparison of Solid Representations, User Interface for Solid Modeling

Visibility, Rendering, and Shading Techniques

Visible and Hidden Surface Removal: Coherence, Bounding Volumes, Back Face Culling, Painter's Algorithm, Z-Buffer, Floating Horizon, Roberts Algorithm, Object Rendering: Lighting and Illumination Models, Shading Techniques: Flat, Gouraud, Phong, Polygon Mesh Shading, Advanced Effects: Transparency, Shadows, Texture Ray Tracing, Ray Casting, Radiosity, Color Models

Assembly Modeling and Product Lifecycle

Assembly of Parts: Design for Manufacture (DFM), Design for Assembly (DFA), Computer-Aided DFMA, Position & Orientation Inferences, Tolerance Analysis, Center of Gravity & Mass Property Calculation, Mechanism Simulation, Product Lifecycle Management (PLM): Product Development and Management, Models for New Product Development, Graphics & Computing Standards, Data Exchange Standards

Activities Based Learning exercises:

1. Manual Implementation of Bresenham's Line and Circle Algorithms

Plot pixels on graph paper and replicate the same using code; observe the difference in pixel placement and accuracy.

2. Hands-on 2D Transformations Using Paper Cutouts

Physically perform translation, rotation, scaling, reflection, and clipping on shape cutouts to understand transformation matrices.

3. Sketching and Interpreting Bezier Curves

Manually construct Bezier curves using control points and then compare results with simulation software.

4. Solid Modeling Using CAD Tools

Design simple components by applying Boolean operations and sweep features to reinforce constructive solid geometry concepts.

5. Shadow and Visibility Demonstration Using 3D Block Models

Use a torchlight on physical models to simulate surface visibility, shading, and hidden surface removal principles.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

References:

1. Boothroyd, G, "Assembly Automation and Product Design", Marcel Dekker, New York, 1991.
2. Chitale A.K and Gupta R.C., "Product Design and Manufacturing", PHI Learning Private Limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams, "Mathematical Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill, 2002.
4. Donald D Hearn and M. Pauline Baker, "Computer Graphics C Version", Prentice Hall, Inc., 2nd Edition, 1996.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006.
6. William M Newman and Robert F.Spruill "Principles of Interactive Computer Graphics", Mc Graw Hill Book Co., 1st Edition, 2001.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamentals of computer graphics, scan-conversion, 2D/3D transformations, and visibility techniques	PO1 (3), PO3 (2)	1	1
CO2	Apply graphics algorithms, curve/surface modeling, solid modeling, and assembly modeling using CAD tools	PO2 (3), PO3 (3)	2	2
CO3	Estimate errors in scan conversion, curve approximations, and tolerance calculations in assembly models	PO3 (3), PO4 (2)	1	2
CO4	Analyze complex graphics systems, rendering techniques, and PLM integration for realistic simulations	PO4 (3), PO5 (2)	2	2

ED26013	Vehicle Dynamics	L	T	P	C
SDG: 7,9,11		3	0	0	3
Course Objective: The main learning objective of this course is to prepare the students for applying the principles of tire mechanics, steering, vertical, longitudinal and lateral dynamics in vehicle design.					
Tyre Mechanics Tyre Classification, Tyre specification, Tyre forces and moments, Tyre structure, Rolling resistance and effect of various parameters on rolling resistance, Longitudinal forces, Lateral forces, Mechanism of force generation, Tractive and cornering property of tyre, Camber Thrust, Aligning Moment, Conicity and Plysteer, Performance of tyre on wet surface, Magic formulae tyre model, Tyre vibration					
Steering and Vertical Dynamics Steering Linkages, Steering Geometry Error, Front Wheel Geometry, Steering system forces and moments, Steering system models, Effect of steering ratio, understeer and braking stability on steering system, Influence of front wheel drive, Four wheel steer, Steering of Vehicle with trailer- Human response to vibration, Sources of Vibration. Passive, Semi-active and Active suspension. Suspension Models-Quarter car, half car and full car model. Suspension isolation, Influence of suspension stiffness, suspension damping, and tyre stiffness. Active control, Control law for LQR, HInfinite, Skyhook damping.					
Longitudinal Dynamics and Control Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Brake force distribution, braking efficiency and braking distance. Prediction of Vehicle performance, ABS, stability control, Traction control.					
Lateral Dynamics Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Rollaxis, Vehicle under side forces. Stability of vehicle on banked road and during turn. Effect of suspension on cornering.					
Activities Based Learning: 1. Simulation of Tractive and Cornering Forces using Magic Formula Model 2. Wet Surface Performance Comparison of Tyres 3. Modeling a Quarter-Car Suspension System in MATLAB/Simulink 4. ABS and Traction Control Simulation 5. Influence of Suspension Geometry on Cornering using CAD and Motion Study					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. Singiresu S. Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010. 2. J. Y. Wong, "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001. 3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005. 4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992. 5. G. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", 1st Edition, Springer, 2008.					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamentals of tyre mechanics, steering, suspension, and vehicle dynamics	PO1 (1), PO3 (1)	1	1
CO2	Apply vehicle dynamics principles and modeling techniques for tyre forces, suspension, and control systems	PO2 (2), PO3 (2)	2	2
CO3	Estimate performance parameters like rolling resistance, cornering forces, braking distance, and stability margins	PO3 (1), PO4 (2)	1	2
CO4	Analyze lateral, longitudinal, and vertical vehicle dynamics under different operating and control conditions	PO4 (2), PO5 (2)	2	2

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain fundamentals of bending of plates/shells, non-linear problems, and dynamic & fluid-thermal analysis	PO1 (3), PO3 (2)	1	1
CO2	Apply FEA/CFD techniques for plates, shells, metal forming, vibrations, and flow problems	PO2 (3), PO3 (3)	2	2
CO3	Estimate errors, convergence rates, and refine solutions using adaptive techniques	PO3 (3), PO4 (2)	1	2
CO4	Analyze dynamic, thermal, and fluid-structure interaction problems using simulation tools	PO4 (3), PO5 (2)	2	2

ED26015	Advanced Machine Tool Design	L	T	P	C
SDG: 8,9,12		3	0	0	3
Course Objective: To impart knowledge on the fundamental principles of machine tool design including drive mechanisms, structural elements, guideways, and spindles; to enable students to design machine tool components for strength, rigidity, precision, and dynamic stability; and to prepare them to address practical challenges in the development and optimization of modern machine tools.					
Machine Tool Fundamentals and Drive Systems Introduction to machine tool design – Machine tool drives and mechanisms – Constructional and operational features – Auxiliary motions in machine tools – Kinematics of machine tools – Motion transmission systems – Mechanical, hydraulic, and electric drives – Speed and feed regulation – Objectives of regulation – Layout of speed change gears – Stepped speed regulation – Multiple speed motors – Ray diagrams – Design considerations – Speed gearbox design – Feed drive mechanisms – Feed box design.					
Design of Structural Elements and Guideways Functions and requirements of machine tool structures – Design for strength and rigidity – Materials used – Static and dynamic stiffness – Constructional features: beds, housings, columns, tables, saddles, and carriages – Types and functions of guideways – Design of slideways – Clearance adjustment – Aerostatic slideways – Anti-friction and combination guideways – Power screw design – Recirculating ball screws.					
Spindle Design and Dynamic Analysis Functions and requirements of spindles – Effect of machine compliance on machining accuracy – Design of spindles and anti-friction bearings – Dynamics of machine tools – Elastic system of machine tools – Static and dynamic stiffness – Machine vibrations and their effects – Stability analysis.					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010. 2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009. 3. D. K Pal, S. K. Basu, “Design of Machine Tools”, 5th Edition. Oxford IBH, 2008. 4. N. S. Acherkhan, “Machine Tool Design”, Vol. I, II, III and IV, MIR publications, 1968. 5. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964. 6. F. Koenigsberger, Machine Tool Structures, Pergamon Press, 1970.					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain machine tool design fundamentals and components	PO1 (3), PO3 (2)	3	2
CO2	Apply design methods for drives, structures, guideways, and spindles	PO1 (3), PO2 (3)	3	3
CO3	Estimate strength, stiffness, speed, and feed parameters	PO1 (3), PO3 (3)	3	3
CO4	Analyze vibration, stability, and dynamic performance of machine tools	PO3 (3)	3	3

ED26017	Creativity and Innovation Management	L	T	P	C
SDG: 4,8,9		3	0	0	3
Course Objective: To equip students with a comprehensive understanding of creativity and innovation principles, methods, and tools, and to develop their ability to apply creative thinking and innovative problem-solving strategies in engineering and organizational contexts. The course also aims to cultivate skills for managing innovation, fostering a creative mindset, and transforming ideas into practical and valuable outcomes.					
Creativity Theory and Heuristics Directed creativity – Five mental actions in creativity – Factors driving creativity and innovation – Challenges in innovation – Quality management and creativity – Definition of creativity and innovation with practical examples – Mechanics of mind: perception, memory, and judgment – Amabile’s seven heuristics – Perkin’s ten heuristics – Plsek’s eight heuristics – Model of directed creativity process.					
Creativity Tools and Applications Creative thinking tools: trans-disciplinary analogy, stepping stones, dreamscape, manipulative verbs – Principles: attention, escape, movement – Tools for preparation, imagination, and action phases – Harvesting ideas – Idea enhancement checklist – Documenting ideas – Eight steps to organizational transformation – ICEDIP model – Norman’s emotional design: visceral, behavioral, reflective – Applications in process design, customer needs analysis, and product/service design – Symptoms of stuck thinking – Creative problem-solving techniques.					
Innovation Principles and Inventive Problem Solving Routine and inventive problems – Difficulty and psychological inertia – Creativity activation methods: checklists, morphological box, questionnaires – Decision aids and problem-solving tools – Requirements for inventive problem solving – Qualities of solvers of non-routine problems – Altshuller’s engineering parameters, inventive principles, and contradiction matrix algorithm – Seven tools in creative problem solving and incremental improvement.					
Innovation Management and Strategy Disruptive innovation model – Case study: minimills vs integrated steel companies – New-market and low-end disruptions – Three litmus tests – Approaches to creating new-growth businesses – Product architectures and integration – Commoditization and de-commoditization – Strategy formulation processes – Role of senior executives in leading innovation and new business growth.					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					
References: 1. Paul E. Plsek, “Creativity, Innovation and Quality”, ASQ Quality Press, Milwaukee, Wisconsin, 2000. 2. Donald A. Norman, “Emotional Design”, Perseus Books Group, New York, 2004. 3. Geoffrey Petty, “How to be better at Creativity”, The Industrial Society, 1999. 4. Semyon D. Savransky, “Engineering of Creativity – TRIZ”, CRC Press, New York, USA, 2000. 5. Clayton M. Christensen and Michael E. Raynor, “The Innovator’s Solution”, Harvard Business School Press, Boston, USA, 2003.					

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain creativity theories, heuristics, and innovation principles	PO1 (1)	1	1
CO2	Apply creative thinking tools and inventive problem-solving methods	PO1 (2), PO2 (2)	2	2
CO3	Analyze engineering and organizational problems using innovation frameworks	PO2 (2), PO3 (2)	2	2
CO4	Evaluate innovation strategies and manage creative initiatives for value creation	PO3 (2), PO4 (1)	2	1



ED26018	Materials Testing and Characterization	L	T	P	C
SDG: 4,8,9		3	0	0	3
Course Objective: This course aims to impart knowledge on various techniques of material characterization.					
MICRO AND CRYSTAL STRUCTURE ANALYSIS 09 Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg’s law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction. <i>Activities: Metallographic specimen preparation, grain size measurement using ASTM standards, identification of crystal structures using XRD patterns, and solving of Bragg’s law and diffraction problems.</i>					
ELECTRON MICROSCOPY 09 Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications. <i>Activities: Demonstration of SEM/TEM images, identification of material microstructural features, comparison of BF and DF imaging, and interpretation of SEM/TEM/AFM images.</i>					
CHEMICAL AND THERMAL ANALYSIS 09 Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA) <i>Activities: Interpretation of X-ray spectra and FTIR spectra, identification of material composition, and analysis of DSC and TGA curves.</i>					
MECHANICAL TESTING – STATIC TESTS 09 Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials. <i>Activities: Demonstration of hardness and tensile tests, preparation of stress–strain curves, and interpretation of Charpy, Izod and fracture toughness test results.</i>					
MECHANICAL TESTING – DYNAMIC TESTS 09 Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests. <i>Activities: Construction and interpretation of S–N curves, analysis of fatigue and creep test data, and interpretation of crack growth and acoustic emission test results.</i>					
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%					

References:

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R. & Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
6. Goldsten, I.J., Dale, E., Echin, N.P. & Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
7. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
8. Morita, S., Wiesendanger, R., and Meyer, E., “Non-contact Atomic Force Microscopy” Springer, 2002,
9. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.
10. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.

	COURSE OUTCOME (CO)	PO	PSO1	PSO2
CO1	Explain the fundamentals of crystal structures and microstructures and their significance in material characterization.	PO1 (1)	1	1
CO2	Apply microstructure evaluation, crystal structure analysis, and electron microscopy techniques for characterizing engineering materials.	PO1 (2), PO2 (2)	2	2
CO3	Analyze the chemical and thermal behaviour of engineering materials using appropriate chemical and thermal analysis techniques.	PO2 (2), PO3 (2)	2	2
CO4	Select and apply suitable static and dynamic mechanical testing methods to evaluate the mechanical properties and performance of engineering materials.	PO2 (2), PO3 (1)	2	1