Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
Phone : 02162 - 261122 , 200100
e-mail : agcenggsatara@gmail.com
Website :-www.agce.edu.in
Institute Code : Engg. DTE EN-6545
BCA 6545, MCA 6545, B.Voc 6545

DEPARTMENT OF MECHANICAL ENGINEERING (Design Engineering)

7

ABOUT THE DEPARTMENT

Mechanical Engineering is one of the core departments of Arvind Gavali College of Engineering. The department has qualified and UGC-approved faculty members along with well-equipped laboratories to support effective teaching and practical learning. The department is committed to providing quality education and developing skilled engineers who can meet the needs of industry and society. The academic activities, guidance, and learning environment are designed to help students build strong technical knowledge and practical skills. The main focus of the department is to prepare competent and responsible engineering professionals.

Design Engineering is an important area of Mechanical Engineering. It is related to the design and development of machines, products, and engineering systems used in various industries such as manufacturing, automotive, aerospace, and automation. The field encourages creativity, problem-solving, and innovation, which are essential for modern engineering applications.

The department gives equal importance to academic excellence and practical exposure. To strengthen students' industrial knowledge, various training programs, industrial visits, internships, and project-based activities are encouraged. These initiatives help students understand real industrial practices and prepare them for future professional challenges. For co-curricular and extracurricular development, the Mechanical Engineering Students Association (MESA) has been established. The association regularly organizes technical events, workshops, competitions, and cultural activities, providing students with opportunities to improve their technical, leadership, and communication skills.

“Nothing is Impossible for Mechanical Engineers with Skill-Oriented Knowledge.”

DEPARTMENT VISION

To develop professional technocrats and socially responsible engineers in the field of Mechanical engineering.

DEPARTMENT MISSION	
M1	To impart advanced knowledge and technical competencies in design engineering through innovative curriculum, modern engineering tools, simulation technologies, and interdisciplinary learning.
M2	To promote research, innovation, entrepreneurship, and industry collaboration for developing sustainable products, smart manufacturing systems, and emerging technology-driven solutions.
M3	To nurture ethical values, leadership qualities, teamwork, and lifelong learning abilities among students to address complex engineering challenges and contribute responsibly to society.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)	
PEO 1	The graduates will be able to excel in professional careers by applying advanced design engineering principles and modern technologies to solve complex engineering problems.
PEO 2	The graduates will be able to pursue research, innovation, entrepreneurship, and lifelong learning for continuous professional growth.
PEO 3	The graduates will be able to exhibit leadership, ethical values, and social responsibility in developing sustainable and industry-oriented engineering solutions.

PROGRAM OUTCOMES (PO)	
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.
PO 4	Apply modern engineering tools, digital technologies, and computational techniques for analysis, design, optimization, and innovation of engineering systems.
PO 5	Develop sustainable products and intelligent manufacturing solutions by integrating advanced technologies, resource-efficient practices, and lifecycle considerations.
PO 6	Demonstrate leadership, professional ethics, teamwork, and social responsibility while addressing multidisciplinary engineering challenges.

Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
Phone : 02162 - 261122 , 200100
e-mail : agcenggsatara@gmail.com
Website :-www.agce.edu.in
Institute Code : Engg. DTE EN-6545
BCA 6545, MCA 6545, B.Voc 6545

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
PEO 1	3	3	3	2	3	2
PEO 2	2	2	2	3	2	1
PEO 3	1	1	1	2	1	3

• Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
• Phone : 02162 - 261122 , 200100
• e-mail : agcenggsatara@gmail.com
• Website :-www.agce.edu.in
• Institute Code : Engg. DTE EN-6545
• BCA 6545, MCA 6545, B.Voc 6545

As per NEP Guidelines Proposed Scheme of Credit Distribution

	Year	**FY**		**SY**		**Actual Credit**
Sr. No.		**I**	**II**	**III**	**IV**	
1	Basic Science Course	--	--	--	--	--
2	Engineering Science Course	--	--	--	--	--
3	Program/Professional Core Courses	7	7	--	--	14
4	Program/Professional Elective Course	6	7	--	--	13
5	Multi Minor	--	--	3	--	3
6	Open Elective	3	3	2	--	8
7	Vocational and Skill Enhancement Course	1	1	--	--	2
8	Ability Enhancement Course	--	--	--	--	--
9	Entrepreneurship /Economics/ Management Courses (Mgt./Economics/Mkt./Finance)	--	--	--	--	--
10	Indian Knowledge System	2	--	--	--	2
11	Value Education Course	--	--	2	--	2
12	Research Methodology	3	--	--	--	3
13	Common Egg. Project/Field Project (PBL/Seminar/Mini Project)	--	2	--	--	2
14	Project	--	--	10	20	30
15	Internship/OJT (PBL/Seminar/Mini Project/Virtual Internship/Physical)	--	1	--	--	1
16	Co-curricular Courses	--	--	1	--	1
	Total Credits	**22**	**21**	**18**	**20**	**81**

SEMESTER – I

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PCC	26MDE1101	Experimental Stress Analysis & Digital Sensing	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
2	PCC	26MDE1102	Advanced Numerical and Simulation Techniques	3	1	0	4	4	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	PEC	26MDE1103X	Professional Elective Course - I	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
4	PEC	26MDE1104X	Professional Elective Course - II	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
5	HSSM	26MDE1105	Research Methodology & ESG Tools	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
6	OE	26MDE1106X	Open Elective - I	3	0	0	0	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
7	IKS	26MDE1107	Concepts & Applications in Engineering	2	0	0	0	2	CA1	25		20
									MSE	--		
									CA2	25		
									ESE	--		
8	VESC	26MDE1108L	Multiphysics Modelling and Simulation Laboratory	0	0	2	2	1	CA1	25		45
									CA2	25		
									POE	50	20	
			Total	**20**	**1**	**2**	**23**	**22**		**750**		
Total Contact Hours – 23 Total Credits - 22												

Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
Phone : 02162 - 261122 , 200100
e-mail : agcenggsatara@gmail.com
Website :-www.agce.edu.in
Institute Code : Engg. DTE EN-6545
BCA 6545, MCA 6545, B.Voc 6545

Professional Elective and Open Elective Courses List for F. Y. M. Tech (Design Engineering) SEM – I

Sr. No.	Course Code	Course Name
PEC-I		
1	26MDE11031	MEMS, Nanotechnology & Smart Materials
2	26MDE11032	Mechatronics, Control Systems & Robotics
3	26MDE11033	Tribology in Design
PEC-II		
1	26MDE11041	Condition Monitoring & Predictive Maintenance
2	26MDE11042	Rapid Prototyping & Generative Design
3	26MDE11043	Electric Vehicles and its Drivetrains
Open Elective-I		
1	26MDE11061	Digital Twin Essentials
2	26MDE11062	AI & Machine Learning in Design
3	26MDE11063	Sustainable Engineering Design

SEMESTER – II

Sr. No.	Category	Course Code	Course Name	Teaching Scheme L	T	P	Hrs./ Week	Cr	Evaluation Scheme Components	Max	Min for Passing	
1	PCC	26MDE1201	Mechanical Vibration	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
2	PCC	26MDE1202	Smart Manufacturing and Industry 5.0	3	1	0	4	4	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	PEC	26MDE1203X	Professional Elective Course - III	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
4	PEC	26MDE1204X	Professional Elective Course - IV	3	1	0	3	4	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
5	OE	26MDE1205X	Open Elective - II	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
6	PCC	26MDE1206	Technical Seminar	0	0	2	2	1	CA1	25		45
									CA2	25		
									OE	50	20	
7	VSEC	26MDE1207L	Smart Engineering Practice Laboratory	0	0	2	2	1	CA1	25		45
									CA2	25		
									OE	50	20	
8	PR	26MDE1208	Field or Community Engagement Project	0	0	4	4	2	CA1	25	20	20
									CA2	25		
									OE	--		
			Total	**15**	**2**	**8**	**25**	**21**		**750**		

Total Contact Hours – 22 Total Credits - 21

Professional Elective and Open Elective Courses List for F. Y. M. Tech (Design Engineering) SEM – II:

Sr. No.	Course Code	Course Name
PEC-III		
1	26MDE12031	Precision Engineering and Micro Manufacturing
2	26MDE12032	Robotics and Automation
3	26MDE12033	Vehicle Dynamics
PEC-IV		
1	26MDE12041	Drone Design and UAV Systems
2	26MDE12042	Product Life cycle Management
3	26MDE12043	Lean Manufacturing and Six Sigma
Open Elective-II		
1	26MDE12051	Engineering Data Analytics
2	26MDE12052	Design Thinking and Innovation Engineering
3	26MDE12053	Engineering Economic Analysis

• Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
• Phone : 02162 - 261122 , 200100
• e-mail : agcenggsatara@gmail.com
• Website :-www.agce.edu.in
• Institute Code : Engg. DTE EN-6545
• BCA 6545, MCA 6545, B.Voc 6545

SEMESTER – III

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./Week	Cr	Components	Max	Min for Passing	
1	PR	26MDE2101	Dissertation Phase - I	0	0	20	20	10	CA1	25		45
									CA2	25		
									OE	50	20	
2	MDM	26MDE2102 X	MDM-I	3	0	0	3	3	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
3	VEC	26MDE2103	Universal Human Values (UHV) & Professional Ethics	2	0	0	2	2	CA1	25		20
									MSE	--		
									CA2	25		
									ESE	--	--	
4	OE	26MDE2104 X	Open Elective III	2	0	0	2	2	CA1	15		45
									MSE	20		
									CA2	15		
									ESE	50	20	
5	CC	26MDE2105	Yoga	0	0	2	2	1	CA 1	25	20	20
									CA2	25		
									ESE	--	--	
			Total	**7**	**0**	**22**	**29**	**18**		**400**		
Total Contact Hours –30 Total Credits - 18												

Multi-Disciplinary Minor and Open Elective Courses List for F. Y. M. Tech (Design Engineering) SEM – III:

Sr. No.	Course Code	Course Name
Multi-Disciplinary Minor		
1	26MDE21021	Applications of IoT and Industry 4.0
2	26MDE21022	eCommerce Technologies
3	26MDE21023	Entrepreneurship & Start-ups
Open Elective-III		
1	26MDE21041	Project Management for Managers
2	26MDE21042	Industrial Safety Engineering
3	26MDE21043	Design for Manufacturing and Assembly

SEMESTER – IV

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs. /Week	Cr	Components	Max	Min for Passing	
1	PR	26MDE2201	Dissertation Phase - II	0	0	40	40	20	CA-1	25		45
									CA-2	25		
									OE	50	20	
			Total	**0**	**0**	**40**	**40**	**20**		**100**		
Total Contact Hours – 40 Total Credits - 20												

Title of the Course: Experimental Stress Analysis & Digital Sensing **Course Code:** 26MDE1101	**L**	**T**	**P**	**Credit**
	3	**--**	**-**	**3**

Course Pre-Requisite: Engineering Mechanics, Strength of Materials, Basic Engineering Physics (Optics), Mathematics for Engineering Applications

Course Description:

Experimental Stress Analysis and Digital Sensing is a specialized course that introduces students to the principles and techniques used for measuring stress, strain, displacement, and deformation in engineering components and structures. The course covers the fundamentals of elasticity, various strain measurement methods, electrical resistance strain gauges, strain analysis techniques, and optical methods such as photoelasticity. It also provides practical knowledge of modern digital sensing technologies, data acquisition systems, signal conditioning, and IoT-based structural health monitoring

Course Objectives:

1. Understand the necessity of experimental stress analysis and the fundamental concepts of stress, strain, elasticity, and stress–strain relationships.
2. Identify and compare various strain measurement techniques and select appropriate methods for different engineering applications.
3. Apply electrical resistance strain gauges, Wheatstone bridge circuits, and strain gauge instrumentation for accurate measurement and analysis of strain.
4. Analyze strain data using rosette gauges and other experimental techniques to determine stress distributions in engineering components.
5. Understand the principles of optics and photoelasticity used in experimental stress analysis.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the need for experimental stress analysis and apply the fundamentals of elasticity, stress, strain, plane stress, and plane strain concepts.
CO2	Describe various strain measurement techniques and select suitable strain gauges for engineering applications.
CO3	Apply electrical strain gauge techniques and Wheatstone bridge circuits for accurate strain measurement and analysis.
CO4	Analyze stress distribution using photo elastic and optical experimental techniques.
CO5	Apply digital sensing technologies, data acquisition systems, and smart sensor networks for real-time measurement, monitoring, and analysis of stress and strain in engineering structures.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		1		2
CO2	3	2		2	2	2
CO3	3	3	1	3	3	1
CO4	3	3	1	3	2	
CO5	3	3	2	3	3	1

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Introduction and Fundamentals of Elasticity** Need for stress analysis, Importance of experimental methods, Merits and demerits of experimental methods, Stress at a point, Stress equations of equilibrium, Two-dimensional state of stress, Strains and displacements, Stress-strain relationship for 2-D state of stress, Plane stress and plane strain concepts.	08
2.	**Strain Measurement Techniques** Introduction to strain measurement, Mechanical strain gauges, Optical strain gauges, Electrical strain gauges, Acoustical strain gauges, Semiconductor strain gauges, Grid method of strain analysis, Case studies.	07
3.	**Electrical Strain Gauges and Strain Analysis** Strain gauge construction, Strain gauge adhesives and mounting techniques, Gauge sensitivity and gauge factor, Strain gauge linearity, hysteresis, and zero shift, Temperature compensation, Environmental effects (moisture, humidity, hydrostatic pressure, high and cryogenic temperatures), Wheatstone bridge, Calibration of strain gauge circuits, Strain analysis using: Three-element rectangular rosette, Torque gauge.	08
4.	**Optical Methods and Photoelasticity**	09

	Nature and wave theory of light, Optical instruments, Plane and circular polariscopes, Stress-optic law, Effect of stressed models in plane and circular polariscopes, Principal stress directions and principal stress difference, Dark field and light field arrangements, Two-dimensional photoelasticity, Isochromatic and isoclinic fringe patterns ,Materials for 2-D photoelasticity ,Introduction to moiré fringe technique ,Coating methods, Case studies. .	
5.	**Digital Sensing and Data Acquisition** Introduction to Digital Sensing and Smart Sensors ,Sensor characteristics: Accuracy, Precision, Resolution, Sensitivity, Range, and Calibration ,Digital strain measurement systems ,Data Acquisition Systems (DAQ) ,Signal conditioning techniques ,Analog-to-Digital Conversion (ADC) ,Digital signal processing for sensor data ,Wireless sensor networks for structural health monitoring ,Applications of IoT-based sensing in stress and strain measurement.	08

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Experimental Stress Analysis	James W. Dally and William F. Riley	McGraw-Hill Education
2.	McGraw-Hill Education	R.S. Sirohi and H.C. Radhakrishna	New Age International Publishers
3.	Theory of Elasticity	S.P. Timoshenko and J.N. Goodier	McGraw-Hill Education
4.	Measurement Systems: Application and Design	Ernest O. Doebelin and D.N. Manik	McGraw-Hill Education

Reference Books			
1.	Sensors and Transducers	D. Patranabis	PHI Learning.
2.	Measurement Systems: Application and Design	E.O. Doebelin & D.N. Manik,	McGraw-Hill.
3.	Smart Sensors and MEMS	S. Nihtianov & A. Luque	Woodhead Publishing.

Add resource link like NPEL

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_me23

Title of the Course: Advanced Numerical and Simulation Techniques **Course Code:** 26MDE1102	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Pre-Requisite: Engineering Mathematics, Numerical Methods, Finite Element Method (FEM), Computer Programming (MATLAB/Python)

Course Description: This course focuses on advanced numerical methods and simulation techniques used in modern mechanical design engineering. It covers mathematical modeling, numerical solution strategies, finite element analysis, computational fluid dynamics, optimization techniques, and multi-physics simulations. The course enables students to solve complex engineering problems using commercial and open-source simulation software and interpret simulation results for design improvement and decision-making.

Course Objectives:

1. Understand advanced numerical techniques for solving engineering problems.
2. Develop mathematical models of mechanical systems and processes
3. Apply finite element and computational simulation methods to design problems.
4. Analyze and validate simulation results for engineering decision-making
5. Utilize optimization and multi-physics simulation tools in product development

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Apply advanced numerical methods to solve engineering equations and mathematical models.
CO2	Develop computational models for mechanical design and manufacturing problems.
CO3	Perform finite element simulations for structural and thermal analysis.
CO4	Analyze fluid flow and heat transfer problems using computational simulation tools.
CO5	Evaluate and optimize engineering designs using multi-physics and advanced simulation techniques.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	2	2
CO2	2	3	3	2	3	2
CO3	3	3	3	3	3	
CO4	3	3	2	3	3	2
CO5	2	2	3	3	3	1

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Advanced Numerical Methods for Engineering Applications** Review of numerical methods used in engineering. Sources of numerical errors. Accuracy, precision, stability and convergence. Bisection method. Regula-Falsi method. Newton-Raphson method. Modified Newton-Raphson method. Trapezoidal rule. Simpson's 1/3 and 3/8 rules.	8
2.	**Mathematical Modeling and Computational Techniques** Concept of modelling and simulation. Physical system representation. Governing equations Engineering System Modelling-Mechanical systems, Thermal systems, Fluid systems Discretization Techniques-Finite Difference Method (FDM) , Finite Volume Method (FVM) ,Finite Element Method (FEM). Structured mesh, Unstructured mesh, Mesh quality parameters, Grid independence study.	8
3.	**Finite Element Analysis for Mechanical Design** Fundamentals of Finite Element Method -Historical development, Engineering applications, FEM solution procedure. Element Formulation-One-dimensional elements, Two-dimensional elements, Three-dimensional elements, Shape functions, Stiffness matrix formulation. Static structural analysis, Stress and strain calculations, Beam and truss analysis, Contact analysis basics, Case studies. .	9
4	**Computational Fluid Dynamics and Heat Transfer Simulation** Fundamentals of CFD Governing equations of fluid flow, Finite volume method, Turbulence modeling, Heat transfer simulations Boundary conditions, Post-processing and result interpretation	8
5	**Optimization and Multi-Physics Simulation** Design optimization techniques, Gradient and non-gradient optimization, Response surface methodology, Multi-objective	9

	optimization, Ulti-physics simulation concepts, Coupled structural-thermal-fluid analysis, Industrial case studies.	

Text Books

Sr.No	Title	Author	Publisher
1.	Numerical Methods for Engineers	Steven C. Chapra, Raymond P. Canale	McGraw-Hill Education
2.	Applied Numerical Methods with MATLAB for Engineers and Scientists	Steven C. Chapra	McGraw-Hill Education
3.	Introduction to Finite Elements in Engineering	Tirupathi R. Chandrupatla, Ashok D. Belegundu	Pearson Education
4.	Numerical Methods for Scientific and Engineering Computation	M. K. Jain, S. R. K. Iyengar, R. K. Jain	New Age International Publishers

Reference Books

1.	The Finite Element Method	O. C. Zienkiewicz, R. L. Taylor, J. Z. Zhu	Butterworth-Heinemann (Elsevier)
2.	Engineering Optimization: Theory and Practice	Singiresu S. Rao	Wiley India Pvt. Ltd.
3.	Multiphysics Modeling Using COMSOL	Roger W. Pryor	Jones & Bartlett Learning

Title of the Course: MEMS, Nanotechnology & Smart Materials **Course Code:** 26MDE11031	**L**	**T**	**P**	**Credit**
	3	**--**	**-**	**3**

Course Pre-Requisite: Engineering Materials and Metallurgy, Mechanics of Materials, Manufacturing Processes, Materials Characterization Techniques

Course Description:

This course introduces emerging technologies in Micro-Electro-Mechanical Systems (MEMS), Nanotechnology, and Smart Materials that are transforming modern engineering design and manufacturing. The course covers the fundamentals of micro fabrication, MEMS devices, nano scale materials and characterization techniques, as well as smart materials and their engineering applications. Students will learn about sensors, actuators, nano-engineered materials, shape memory alloys, piezoelectric materials, magnetostrictive materials, and intelligent structures. The course emphasizes design, fabrication, characterization, and application of advanced materials and micro/nano systems in automotive, aerospace, biomedical, manufacturing, and smart engineering systems.

Course Objectives:

1. Develop an understanding of MEMS technology, micro fabrication processes, and MEMS-based devices.
2. Introduce nanotechnology concepts, nanomaterial, synthesis techniques, and characterization methods.
3. Provide knowledge of smart materials and their behavior under different environmental and loading conditions.
4. Enable students to analyze and select advanced materials and MEMS devices for engineering design applications.
5. Familiarize students with emerging applications of MEMS, nanotechnology, and smart materials in intelligent engineering systems.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the principles of MEMS technology, micro fabrication processes, and MEMS-based devices used in engineering applications.
CO2	Analyze nanomaterial, synthesis techniques, and characterization methods for advanced engineering applications.
CO3	Evaluate the behavior and performance of smart materials and intelligent structures for mechanical system design.
CO4	Apply MEMS, nanotechnology, and smart material concepts to develop innovative solutions for modern engineering and manufacturing systems.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	1	3	2
CO2	3	3	2	3	3	2
CO3	3	2	3	2	2	2
CO4	2	3	3	3	3	1
CO5	2	2	1	3		

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Fundamentals of MEMS and Micro fabrication** Introduction to MEMS and Microsystems, MEMS Applications in Engineering, Scaling Laws and Miniaturization, Materials for MEMS, Micro fabrication Techniques, Photolithography, Thin Film Deposition, Oxidation, Diffusion, Etching Processes, Surface and Bulk Micromachining, MEMS Packaging and Reliability.	08
2	**MEMS Sensors, Actuators and Microsystems** MEMS Sensors and Transducers, Pressure Sensors, Accelerometers, Gyroscopes, Microfluidic Devices, MEMS Actuators, Electrostatic Actuation, Piezoelectric Actuation, Thermal Actuation, Biomedical and Automotive MEMS Applications, Case studies.	09
3	**Nanotechnology and Nanomaterials** Introduction to Nanotechnology, Size Effects and Nanoscale Phenomena, Classification of Nanomaterials, Carbon Nanotubes (CNTs), Graphene and Nano composites, Synthesis Techniques: Top-Down Approach, Bottom-Up Approach, Nanomaterial Characterization: SEM, TEM, AFM XRD, Engineering Applications of Nanomaterials.	09
4	**Smart Materials and Intelligent Structures** Introduction to Smart Materials, Characteristics and Selection Criteria, Shape Memory Alloys (SMA), Piezoelectric Materials, Magnetostrictive Materials, Electro-rheological and Magneto-rheological Materials, Electro active Polymers, Fiber Optic Sensors, Smart Structures and Adaptive Systems.	08

5	**Advanced Applications and Emerging Trends** Nano-enabled Manufacturing, MEMS in Robotics and Automation, Smart Sensors and Actuator Networks, Structural Health Monitoring Systems, Nano-Bio Engineering Applications, Energy Harvesting Using Smart Materials, Internet of Things (IoT) Enabled Smart Devices, Recent Trends in MEMS, Nanotechnology and Smart Materials, Case studies. .	08

Text Books

Sr. No	Title	Author	Publisher
1	Fundamentals of Micro fabrication and Nanotechnology (Vol. I)	Marc J. Madou	CRC Press
2	MEMS and Microsystems: Design and Manufacture	Tai-Ran Hsu	McGraw-Hill Education
3	Nanotechnology: Principles and Practices	Sulabha K. Kulkarni	Springer
4	Smart Materials and Structures	M. V. Gandhi and B. S. Thompson	Springer

Reference Books

Sr. No	Title	Author	Publisher
1	Introduction to MEMS Engineering	Nadim Maluf and Kirt Williams	Artech House
2	Nanotechnology for Engineers	Stephen D. Campbell	CRC Press
3	Smart Materials and Technologies for the Architecture and Design Professions	Michelle Addington and Daniel Schodek	Elsevier
4	Micro and Nano Manufacturing: Fundamentals and Applications	Hans N. Hansen	Springer

Title of the Course: Mechatronics, Control Systems & Robotics Course Code: 26MDE11032	L	T	P	Credit
	3	--	-	3

Course Pre-Requisite: Electrical and Electronics Engineering, Fundamentals of Sensors and Instrumentation, Mechanical System Design, Control Engineering Fundamentals

Course Description:

This course introduces the integration of mechanical systems with electronics, control engineering, and intelligent automation technologies. It covers the fundamentals of mechatronic systems, sensors, actuators, control system design, programmable automation, robotics, and industrial applications. The course emphasizes modeling, analysis, and design of automated systems used in modern manufacturing and smart industries. Students will gain knowledge of robotic manipulators, motion control, machine vision, industrial communication, and emerging trends associated with Industry 4.0 and intelligent manufacturing systems. The course equips design engineers with the necessary skills to develop efficient, reliable, and automated engineering solutions.

Course Objectives:

1. Develop an understanding of mechatronic system architecture and integration of mechanical, electronic, and control components.
2. Introduce advanced sensors, actuators, signal conditioning, and industrial automation technologies used in modern engineering systems.
3. Enable students to model, analyze, and design control systems for automated mechanical applications.
4. Provide knowledge of robotic systems, kinematics, motion control, and industrial robotic applications.
5. Familiarize students with intelligent manufacturing, Industry 4.0 technologies, and emerging trends in automation and robotics.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Analyze and integrate sensors, actuators, electronics, and mechanical components for the development of mechatronic systems.
CO2	Model, analyze, and design control systems for automated mechanical and electromechanical applications.
CO3	Develop automation solutions using PLCs, industrial communication systems, and intelligent control strategies.
CO4	Evaluate and apply robotic systems, motion control techniques, and Industry 4.0 technologies for advanced manufacturing and design applications.
CO5	Explain Industry 4.0 concepts and evaluate the applications of CPS, IoT, Digital Twins, AI, autonomous robots, and smart manufacturing systems in modern mechatronics and robotics.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	3	2
CO2	3	3	3	2	2	2

CO3	2	3	3	2	3	1
CO4	2	2	3	3	3	-
CO5	2	2			3	

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Fundamentals of Mechatronic Systems** Introduction to Mechatronics and System Integration, Elements of Mechatronic Systems, Mechatronic Design Methodology, Sensors and Transducers, Signal Conditioning Systems, Actuators: Electrical, Hydraulic and Pneumatic, Microcontrollers and Embedded Systems Overview, Case Studies of Mechatronic Products.	08
2	**Control Systems for Mechatronic Applications** Mathematical Modelling of Mechanical and Electromechanical Systems, Transfer Functions and Block Diagrams, Time Domain Analysis, Stability Analysis and Routh Criterion, Frequency Response Techniques, PID Controllers and Controller Tuning, Digital Control Fundamentals, Control System Design for Mechatronic Systems, Case studies.	09
3	**Industrial Automation and Programmable Systems** Industrial Automation Concepts, Programmable Logic Controllers (PLC), PLC Programming and Ladder Logic, Human Machine Interface (HMI), Supervisory Control and Data Acquisition (SCADA), Industrial Sensors and Smart Instrumentation, Industrial Communication Protocols, Automation Case Studies in Manufacturing.	08

4	**Robotics and Intelligent Motion Control** Introduction to Robotics, Robot Classification and Configuration, Robot Kinematics and Workspace Analysis, Forward and Inverse Kinematics, End Effectors and Grippers, Trajectory Planning and Motion Control, Robot Sensors and Machine Vision, Industrial Robotics Applications in Manufacturing and Design.	09
5	**Industry 4.0, Smart Manufacturing and Emerging Technologies** Industry 4.0 Concepts, Cyber-Physical Systems, Internet of Things (IoT) in Manufacturing, Digital Twin Technology, Artificial Intelligence in Automation, Autonomous Robotic Systems, Smart Factories and Flexible Manufacturing Systems, Recent Trends and Future Scope of Mechatronics and Robotics.	08

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W. Bolton	Pearson Education
2.	Modern Control Engineering	Katsuhiko Ogata	Pearson Education
3.	Robotics: Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani and Giuseppe Oriolo	Springer Publications

Reference Books			
1.	Mechatronics System Design	Devdas Shetty and Richard A. Kolk	Cengage Learning
2.	Automation, Production Systems and Computer-Integrated Manufacturing	Mikell P. Groover	Pearson Education
3.	Introduction to Robotics: Mechanics and Control	John J. Craig	Pearson Education

Title of the Course: Tribology in Design Course Code: 26MDE11033	L	T	P	Credit
	3	--	-	3

Course Pre-Requisite: Engineering Mechanics, Strength of Materials, Theory of Machines, Engineering Materials and Manufacturing Processes

Course Description: Tribology in Design is an advanced course that focuses on the science and engineering of interacting surfaces in relative motion. The course introduces the fundamentals of surface topography, friction, wear, lubrication mechanisms, and surface engineering techniques. It covers various lubrication regimes, hydrodynamic and hydrostatic lubrication theories, and the design and performance analysis of fluid film and rolling element bearings. The course also emphasizes modern tribological measurement techniques, instrumentation, and international standards used for evaluating friction, wear, lubrication, and bearing performance. The knowledge gained through this course enables students to design reliable, efficient, and durable mechanical systems with improved performance and reduced maintenance requirements.

Course Objectives:

1. Develop an understanding of surface characteristics, friction phenomena, wear mechanisms, and surface engineering techniques used in mechanical systems.
2. Introduce the principles of lubrication and various lubrication regimes employed in tribological applications.
3. Enable students to analyze and design fluid film bearings and evaluate their performance under different operating conditions.
4. Provide knowledge of rolling element bearing design, selection, life estimation, and failure analysis for engineering applications.
5. Familiarize students with tribological measurement techniques, instrumentation, and international standards for assessing friction, wear, and bearing performance.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the concepts of surface engineering, friction, wear mechanisms and lubrication principles for engineering applications.
CO2	Analyze various lubrication regimes and evaluate the performance of lubricated tribological systems.
CO3	Design and assess the performance of fluid film bearings and rolling element bearings under different operating conditions.
CO4	Apply tribological measurement techniques, instrumentation and international standards for evaluating friction, wear and bearing performance.
CO5	Apply advanced tribological measurement and characterization techniques to evaluate and interpret the tribological behavior and condition of engineering systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	2
CO2	3	3	2	1	1	

CO3	3	3	3	2	2	2
CO4	2	2	-	3	3	1
CO5	2	3	2	3	3	1

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Surface Engineering, Friction and Wear** Topography of surfaces and surface features, Surface interactions, Theory of friction, Sliding and rolling friction ,Friction properties of metallic and non-metallic materials ,Friction under extreme conditions, Wear: types, mechanisms and factors affecting wear ,Wear-resistant materials ,Surface treatments, surface modifications and surface coatings.	09
2	**Lubrication Theory and Lubrication Regimes** Lubricants and their physical properties, Lubricant standards and specifications, Lubrication regimes, Hydrodynamic lubrication theory, Reynolds equation ,Thermal, inertia and turbulent effects in lubrication, Electro-hydrodynamic (EHD) lubrication, Magneto-hydrodynamic lubrication, Hydrostatic lubrication, Gas lubrication, Solid lubrication.	09
3	**Design of Fluid Film Bearings** Design and performance analysis of journal and thrust bearings, Full partial, fixed and pivoted journal bearings, Lubricant flow and delivery systems, Power loss in bearings, Heat generation and temperature	09

	analysis, Steady and dynamically loaded journal bearings, Special bearings, Hydrostatic bearing design.	
4	**Rolling Element Bearings** Geometry and kinematics of rolling element bearings, Bearing materials and manufacturing processes, Contact stresses and Hertzian stress equation, Load distribution and load sharing, Stress and deflection analysis, Axial loads and rotational effects, Bearing life, dynamic load capacity and variable loading, ISO standards for rolling bearings, Oil film effects, Failure modes and failure analysis of rolling bearings.	08
5	**Tribological Measurements and Instrumentation** Surface topography measurement techniques, Electron microscopy for tribological analysis, Friction and wear measurement methods, Laser-based measurement techniques, Tribology instrumentation, International standards in tribological testing, Bearing performance measurements, Bearing vibration measurements.	07

Text Books

Sr.No	Title	Author	Publisher
1	Basic Lubrication Theory	Cameron A.	Ellis Horwood Ltd., UK, 1981
2	Principles of Tribology	Halling J.	Macmillian, 1984
3	Engineering Tribology	Williams J.A.	Oxford Univ. Press, 1994.

Reference Books

Sr.No	Title	Author	Publisher
1	Tribology Hand Book	Neale, M.J.,	Butterworth Heinemann, 1995.
2	Tribology in Machine Design	StolarskiT.a.	Industrial Press Inc., 1990.

NPTEL link: https://nptel.ac.in/courses/112102015?

Title of the Course: Condition Monitoring & Predictive Maintenance Course Code: 26MDE11041	L	T	P	Credit
	3	--	-	3

Course Pre-Requisite: Fundamentals of Mechanical Engineering, Fundamentals of Vibration and Instrumentation

Course Description: This course provides comprehensive knowledge of condition monitoring techniques and predictive maintenance strategies used in modern industries. It covers fault diagnosis methods, vibration analysis, lubrication monitoring, thermography, ultrasonic testing, data-driven predictive maintenance, and Industry 4.0-based maintenance practices. The course enables students to assess machinery health, predict failures, and optimize maintenance decisions to improve reliability and reduce downtime.

Course Objectives:

1. To understand the concepts of maintenance engineering and condition monitoring techniques.
2. To develop competency in vibration-based fault diagnosis and machinery health assessment.
3. To apply advanced condition monitoring techniques such as oil analysis, thermography, and ultrasonic.
4. To utilize predictive maintenance methodologies and data analytics for failure prediction.
5. To analyze Industry 4.0 technologies and emerging trends in intelligent maintenance systems.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain maintenance philosophies and condition monitoring principles used in industrial systems.
CO2	Analyze vibration signals to diagnose faults in rotating machinery.
CO3	Apply lubrication analysis, thermography, and ultrasonic techniques for machinery condition assessment.
CO4	Develop predictive maintenance strategies using reliability concepts and data-driven approaches.
CO5	Evaluate Industry 4.0-enabled maintenance systems and emerging technologies for intelligent asset management.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	2	–
CO2	3	3	2	3	3	–
CO3	2	3	2	3	3	–
CO4	2	3	3	3	3	1
CO5	1	2	2	2	3	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Introduction to Maintenance and Condition Monitoring** Maintenance philosophies (Breakdown, Preventive, Predictive and Proactive Maintenance); Reliability, Availability and Maintainability (RAM); Maintenance Planning; Condition Monitoring Concepts; Machinery Health Monitoring; Sensors and Instrumentation for Maintenance.	08
2	**Vibration-Based Condition Monitoring** Fundamentals of Mechanical Vibrations; Vibration Measurement Instruments; Time and Frequency Domain Analysis; FFT Analysis; Fault Diagnosis of Bearings, Gears and Rotating Machinery; Vibration Standards (ISO 10816/20816); Case Studies.	09
3	**Advanced Condition Monitoring Techniques** Lubrication and Oil Debris Analysis; Ferrography; Wear Particle Analysis; Infrared Thermography; Ultrasonic Testing; Acoustic Emission Monitoring; Motor Current Signature Analysis (MCSA); Applications and Limitations.	09
4	**Predictive Maintenance and Reliability Analysis** Failure Modes and Effects Analysis (FMEA); Root Cause Analysis (RCA); Reliability Models; Weibull Analysis; Remaining Useful Life (RUL) Estimation; Data Analytics for Maintenance; Machine Learning Applications in Predictive Maintenance, Case studies.	08

5	**Industry 4.0 and Smart Maintenance** Internet of Things (IoT) for Condition Monitoring; Digital Twins; Cloud-Based Maintenance Systems; Cyber-Physical Systems; Intelligent Asset Management; Maintenance Decision Support Systems; Emerging Trends and Industrial Case Studies.	08

Text Books

Sr.No	Title	Author	Publisher
1	Practical Machinery Vibration Analysis and Predictive Maintenance	Cornelius Scheffer and Paresh Girdhar	Elsevier
2	Machinery Condition Monitoring: Principles and Practices	Amitava K. S. Jardine, Daming Lin and Dragan Banjevic	CRC Press
3	Maintenance Engineering Handbook	Keith Mobley	McGraw-Hill

Reference Books

Sr.No	Title	Author	Publisher
1	An Introduction to Predictive Maintenance	R. Keith Mobley	Butterworth-Heinemann
2	Mechanical Fault Diagnosis and Condition Monitoring	R. Collacott	Chapman & Hall
3	Reliability-Centered Maintenance	John Moubray	Industrial Press

NPTEL link: https://nptel.ac.in/courses/112105124

https://nptel.ac.in/courses/112106270

Title of the Course: Rapid Prototyping & Generative Design Course Code: 26MDE11042	L	T	P	Credit
	3	--	-	3

Course Pre-Requisite: Fundamentals of Engineering Design, Manufacturing Processes, Basics of Optimization Techniques and Finite Element Analysis

Course Description: This course provides in-depth knowledge of rapid prototyping, additive manufacturing, and generative design methodologies employed in advanced engineering product development. It focuses on the integration of design optimization, topology optimization, biomimetic approaches, and AI-assisted generative techniques with additive manufacturing processes to develop innovative, lightweight, and high-performance products. The course equips students with competencies required for Industry 4.0-driven digital product realization.

Course Objectives:

1. Understand the principles, technologies, and applications of rapid prototyping and additive manufacturing.
2. Apply digital workflow techniques for preparing engineering designs suitable for additive manufacturing.
3. Analyze additive manufacturing processes, material selection, and post-processing requirements for engineering applications.
4. Employ topology optimization and generative design methodologies to create innovative and efficient engineering solutions.
5. Evaluate industrial applications, sustainability aspects, and emerging trends in rapid prototyping and generative design.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the principles, evolution, and applications of rapid prototyping and additive manufacturing technologies.
CO2	Develop digital models and process planning strategies for additive manufacturing applications.
CO3	Select suitable additive manufacturing processes and materials based on design and functional requirements.
CO4	Apply topology optimization and generative design approaches for developing optimized engineering products.
CO5	Assess industrial implementation, sustainability considerations, and future developments in rapid prototyping and generative design.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	2	2
CO2	2	3	2	2	3	–
CO3	3	3	2	3	3	2

CO4	2	3	3	3	3	–
CO5	1	2	2	2	2	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Introduction to Rapid Prototyping and Additive Manufacturing** Product development cycle; Need for rapid prototyping; Evolution of additive manufacturing; Classification of RP technologies; Advantages and limitations; Applications in aerospace, biomedical, automotive, tooling, and consumer products.	08
2	**Digital Workflow and Design Data Preparation** CAD modelling for additive manufacturing; STL and AMF file formats; Tessellation errors; Model repair; Build orientation; Slicing techniques; Support structure generation; Process planning; Design guidelines for additive manufacturing (DfAM), Case studies.	09
3	**Additive Manufacturing Processes and Materials** Stereolithography (SLA); Fused Deposition Modelling (FDM); Selective Laser Sintering (SLS); Selective Laser Melting (SLM); Electron Beam Melting (EBM); Binder Jetting; Material Jetting; Directed Energy Deposition (DED); Materials for AM (polymers, metals, ceramics, composites); Post-processing techniques.	09
4	**Generative Design and Optimization**	08

	Fundamentals of generative design; Design objectives and constraints; Topology optimization; Lattice and cellular structures; Biomimetic design concepts; Multi-objective optimization; AI-assisted generative design; Integration of CAD–CAE–AM; Industrial case studies using commercial software.	
5	**Advanced Applications and Emerging Trends** Rapid tooling and rapid manufacturing; Reverse engineering; Mass customization; Digital manufacturing; Sustainability in additive manufacturing; Economic considerations; Industry 4.0 integration; Digital twins; Future trends and industrial applications of generative design.	08

Text Books

Sr.No	Title	Author	Publisher
1	Rapid Prototyping: Principles and Applications	Chua C.K., Leong K.F. and Lim C.S.	World Scientific Publishing
2	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David Rosen and Brent Stucker	Springer
3	Design for Additive Manufacturing	Martin Leary	Elsevier

Reference Books

Sr.No	Title	Author	Publisher
1	Topology Optimization: Theory, Methods and Applications	Martin P. Bendsøe and Ole Sigmund	Springer
2	Additive Manufacturing Technologies in Product Development	N. Hopkinson, R.J.M. Hague and P.M. Dickens	Wiley
3	Generative Design: Visualize, Program, and Create with Processing	Hartmut Bohnacker, Benedikt Groß, Julia Laub and Claudius Lazzeroni	Princeton Architectural Press

NPTEL link: https://nptel.ac.in/courses/112104304

https://nptel.ac.in/courses/112102106

Title of the Course: Electric Vehicles and its Drivetrains Course Code: 26MDE11043	L	T	P	Credit
	3	--	-	3

Course pre-requisite: Basic knowledge of Engineering Mechanics, Strength of Materials, Theory of Machines, Machine Design, and Fundamentals of Electrical Engineering. Familiarity with vehicle systems and engineering calculations will be beneficial.

Course Description: This course provides an overview of electric vehicle technologies, drivetrain systems, energy storage, vehicle dynamics, and design considerations. It focuses on the analysis and design of EV components, performance evaluation, and the application of engineering principles for sustainable transportation systems.

Course Objectives:

1. Understand the fundamentals of electric vehicles and drivetrains.
2. Analyze vehicle dynamics and performance characteristics.
3. Study electric motors, transmissions, and battery systems.
4. Learn battery management and charging technologies.
5. Apply design and simulation tools for EV system development.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the fundamentals, architecture, and types of electric vehicles.
CO2	Analyze electric vehicle drivetrain performance and vehicle dynamics.
CO3	Evaluate the characteristics and selection of electric motors and transmission systems for EVs.
CO4	Design and assess battery energy storage systems and battery management strategies.
CO5	Apply modeling, simulation, and design techniques for electric vehicle components and systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				2
CO2	2	3	2	2	1	
CO3	2	2	3	2	2	2
CO4	2	2	3	2	2	2
CO5	1	2	3	3	3	1

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Introduction to Electric Vehicles and Vehicle Architecture** Evolution of electric mobility and sustainable transportation, Classification of Electric Vehicles (BEV, HEV, PHEV, FCEV), Comparison of conventional and electric vehicles, Electric vehicle architecture and subsystem integration, Vehicle specifications and performance requirements, Design considerations for EV platforms **Numerical Problems** Vehicle energy consumption, Driving range estimation, Power-to-weight ratio calculation	09
2.	**Electric Vehicle Drivetrains and Vehicle Dynamics** Electric drivetrain configurations, Traction requirements and tractive effort calculations, Rolling resistance, aerodynamic drag, and grade resistance, Vehicle acceleration and maximum speed analysis, Regenerative braking systems, Mechanical design considerations in driveline components **Numerical Problems** Tractive force calculation, Road load analysis, Power requirement for vehicle motion, Gradeability calculations	08
3.	**Electric Motors and Transmission Systems** Selection of traction motors for EV applications, BLDC, PMSM, and Induction Motors, Torque-speed characteristics, Single-speed and multi-speed transmissions, Gearbox and differential design considerations, Motor mounting and drivetrain integration **Numerical Problems** Motor torque calculations, Gear ratio determination, Wheel torque estimation, Transmission efficiency calculations	09
4	**Energy Storage Systems and Battery Pack Design**	08

	Battery technologies for EV applications, Lithium-ion battery characteristics, Battery pack configuration and sizing, Battery thermal management systems, Battery Management System (BMS), Safety and reliability considerations **Numerical Problems** Battery energy calculations, Battery sizing for required range, Charging time estimation, Energy density calculations	
5	**Structural Design, Modelling and Future Trends** Lightweight materials for EV structures, Chassis and frame design considerations, Design for manufacturability and sustainability, Finite Element Analysis (FEA) of EV components, Electric vehicle modelling and simulation, Emerging technologies in electric mobility **Numerical Problems** Stress and strain calculations, Factor of safety determination, Weight reduction analysis, Structural efficiency calculations	08

Text Books

Sr. No	Title	Author	Publisher
1.	Electric Vehicle Technology Explained	James Larminie and John Lowry	John Wiley & Sons
2.	Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi	CRC Press
3.	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	CRC Press

Reference Books

1.	Fundamentals of Vehicle Dynamics	Thomas D. Gillespie	SAE International
2.	Electric Vehicle Engineering	Sandeep Dhameja	Cengage Learning
3.	Advanced Electric Drive Vehicles	Ali Emadi	CRC Press

Add resource link like NPEL

1. https://onlinecourses.nptel.ac.in/noc23_ee01/preview?utm_source=chatgpt.com
2. https://onlinecourses.nptel.ac.in/noc26_ee27/preview?utm_source=chatgpt.com
3. https://www.nptel.ac.in/courses/108106170?utm_source=chatgpt.com

Title of the Course: Research Methodology & ESG Tools Course Code: 26MDE1105	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite: Basic knowledge of engineering concepts, Fundamental understanding of statistics

Course Description: This course introduces postgraduate students to the principles and practices of research methodology, enabling them to identify research problems, conduct literature reviews, formulate research proposals, and communicate research findings effectively. The course also develops competencies in interpretation of results and technical report writing. In addition, it familiarizes students with Environmental, Social, and Governance (ESG) concepts, frameworks, and tools that support sustainable engineering practices and responsible decision-making. The course prepares students to undertake independent research and integrate sustainability considerations into engineering solutions.

Course Objectives:

1. To understand the fundamental concepts, objectives, motivations, and various types of research used in engineering and scientific investigations.
2. To develop the ability to formulate research problems, conduct literature reviews, and critically analyze information generated through different research processes.
3. To enable students to identify suitable research problems and prepare hypothetical proposals for future research and testing.
4. To equip students with skills for interpreting research findings and preparing professional technical reports following accepted academic standards.
5. To introduce ESG concepts, reporting frameworks, and sustainability assessment tools for integrating responsible practices into engineering decision-making.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain research concepts, objectives, motivations, and distinguish among different types of research methodologies.
CO2	Formulate research problems, perform literature surveys, and critically evaluate research findings using systematic approaches.
CO3	Formulate and analyze mathematical models of engineering systems using differential equations, difference equations, graph-based methods, and simulation techniques to solve practical engineering problems.
CO4	Interpret research outcomes and prepare technical reports conforming to professional and academic standards.
CO5	Apply ESG frameworks and sustainability assessment tools to evaluate and support engineering decisions and practices.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	1	–	2
CO2	3	3	2	3	2	–
CO3	2	3	3	3	2	1

CO4	1	2	1	2	1	1
CO5	2	2	3	2	2	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Fundamentals of Research and Types of Research** Research Concepts – Concepts, meaning, objectives, and motivation of research. Types of research – Descriptive research, conceptual research, theoretical research, applied research, and experimental research.	08
2.	**Research Methodology and Literature Review** Research Process – Criteria for good research, Problems encountered by Indian researchers, Formulation of research task, Literature Review – Importance, methods, and sources, Quantification of cause–effect relationships, Discussions, field study, and critical analysis of facts generated. Hypothetical proposals for future development and testing, Selection of research task, Case studies.	09
3.	**Mathematical Modelling and Simulation** Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.	06

4.	**Interpretation of Results and Research Report Writing** Interpretation and Report Writing – Techniques of interpretation, cautions in interpretation, Significance of report writing, Different steps in report writing, Layout of research report, Mechanics of writing research reports – Layout and format, style of writing, typing, references, tables, figures, conclusions, and appendices.	08
5.	**ESG Tools and Sustainability Assessment** Introduction to ESG (Environmental, Social, and Governance) concepts and their significance in sustainable development, ESG frameworks and reporting standards – GRI, SASB, TCFD, and Integrated Reporting. ESG assessment and measurement tools – ESG scorecards, materiality assessment, sustainability indicators, and benchmarking techniques, Life Cycle Assessment (LCA) and carbon footprint analysis tools. Software and digital tools for ESG reporting and performance monitoring, Application of ESG tools in engineering decision-making, risk assessment, and sustainable product and process development, Case studies.	09

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Research Methodology: Methods and Techniques	Kothari, C.R. and Garg, G.	4th Edition, New Age International Publishers
2.	Research Methodology: A Step-by-Step Guide for Beginners	Kumar, R.	5th Edition, Sage Publications
3.	Research Design: Qualitative, Quantitative and Mixed Methods Approaches	Creswell, J.W. and Creswell, J.D.	6th Edition, Sage Publications

Reference Books			
1.	Business Research Methods	Cooper, D.R. and Schindler, P.S.	14th Edition, McGraw-Hill Education
2.	Design and Analysis of Experiments	Montgomery, D.C	10th Edition, Wiley
3.	The Sustainable Value of ESG Performance	Eccles, R.G., Lee, L.E., and Stroehle, J.C.	Wiley

Add resource link like NPEL

https://nptel.ac.in/courses/121106007

Title of the Course: Digital Twin Essentials Course Code: 26MDE11061	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite: Engineering design principles, Fundamentals of CAD, Basic programming concepts

Course Description: Digital Twin technology is transforming the way products, processes, and systems are designed, monitored, and optimized throughout their lifecycle. This course introduces the concepts, architecture, enabling technologies, and applications of Digital Twins in manufacturing, smart products, healthcare, energy systems, and Industry 4.0 environments. Students will gain insights into data acquisition, simulation integration, real-time synchronization, predictive analytics, and lifecycle management using Digital Twin frameworks. The course emphasizes the role of Digital Twins in design engineering and intelligent decision-making.

Course Objectives:

1. Understand the concepts, evolution, architecture, and enabling technologies of Digital Twins.
2. Explain data acquisition, communication frameworks, and integration mechanisms for Digital Twin development.
3. Analyze modelling and simulation approaches employed in creating Digital Twin systems.
4. Evaluate analytics, machine learning, and predictive maintenance strategies in Digital Twin applications.
5. Assess industrial applications, implementation challenges, and future trends of Digital Twin technologies.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain research concepts, objectives, motivations, and distinguish among different types of research methodologies.
CO2	Develop understanding of data acquisition, IoT connectivity, and system integration for Digital Twins.
CO3	Apply modelling and simulation techniques for creating Digital Twin representations of engineering systems.
CO4	Analyze operational data using analytics and machine learning for monitoring and predictive maintenance.
CO5	Evaluate Digital Twin applications, implementation challenges, ethical considerations, and emerging trends in Industry 4.0.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	2	2
CO2	2	2	2	2	3	2
CO3	2	3	3	2	3	–
CO4	2	3	2	3	3	1
CO5	1	2	1	2	2	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Introduction to Digital Twins** Evolution from CAD to Cyber-Physical Systems and Digital Twins, Definition, characteristics, and taxonomy of Digital Twins, Digital Thread and Product Lifecycle Management (PLM), Digital Twin architecture and functional components, Enabling technologies: IoT, Cloud Computing, Big Data, AI, Edge Computing, Role of Digital Twins in Design Engineering	08
2.	**Data Acquisition and System Integration** Sensors, smart instrumentation, and data acquisition systems, Industrial communication protocols (MQTT, OPC-UA, Modbus), IoT platforms and connectivity frameworks, Data management and synchronization, Interoperability standards, Cyber-Physical System integration for Digital Twins, Case studies.	09
3.	**Modelling and Simulation for Digital Twins** Physics-based and data-driven models, Multi-domain modelling approaches, CAD/CAE integration with Digital Twins, Finite Element Analysis and system simulation, Co-simulation techniques, Real-time model updating and calibration	08
4.	**Analytics and Predictive Intelligence** Data preprocessing and feature extraction, Introduction to achine learning for Digital Twins, Predictive maintenance methodologies, Condition monitoring and anomaly detection, Visualization and dashboard development, Decision support systems and optimization, case studies.	08

5.	**Applications, Challenges, and Future Directions** Digital Twins in smart manufacturing and Industry 4.0, Applications in aerospace, automotive, healthcare, smart cities, and energy systems, Implementation challenges and limitations, Cybersecurity, privacy, ethics, and governance issues, Sustainability considerations, Emerging trends: Generative AI, Autonomous Twins, Metaverse integration, case studies.	09

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Digital Twin Driven Smart Manufacturing	Tao, F., Zhang, H., Liu, A., and Nee, A. Y. C..	Academic Press, Elsevier
2.	Characterizing the Digital Twin: A Systematic Literature Review	Jones, D., Snider, C., Nassehi, A., Yon, J., and Hicks, B.	CIRP Journal of Manufacturing Science and Technology, Elsevier,
3.	Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems	Grieves, M. and Vickers, J.	Springer

Reference Books			
1.	Digital Twin: Enabling Technologies, Challenges and Open Research	Fuller, A., Fan, Z., Day, C., and Barlow, C.	IEEE Access
2.	Product Lifecycle Management	Stark, J.	Springer
3.	Industrial Artificial Intelligence: Applications with Sustainable Performance	Lee, J., Bagheri, B., and Kao, H. A.	Springer

Add resource link like NPEL

Title of the Course: AI & Machine Learning in Design	**L**	**T**	**P**	**Credit**
Course Code: 26MDE11062	**3**	**--**	**--**	**3**

Course Pre-Requisite: Fundamentals of Engineering Design, Basic Programming Knowledge, Fundamentals of CAD/CAE

Course Description: This course introduces Artificial Intelligence (AI) and Machine Learning (ML) techniques for solving engineering design problems. It focuses on the application of intelligent algorithms in product design, optimization, predictive analysis, generative design, and digital engineering. Students will gain knowledge of modern AI tools and their integration into the design process to enhance innovation, efficiency, and decision-making in engineering applications.

Course Objectives:

1. To understand the fundamentals of Artificial Intelligence and its role in engineering design.
2. To apply machine learning algorithms for modeling and solving design-related problems.
3. To develop intelligent systems using neural networks and deep learning techniques for design applications.
4. To employ AI-based optimization and generative design approaches in engineering product development.
5. To analyze industrial applications, ethical considerations, and emerging trends of AI in design engineering.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the concepts of AI and their applications in engineering design.
CO2	Apply supervised and unsupervised machine learning techniques to solve design engineering problems.
CO3	Develop and evaluate neural network and deep learning models for intelligent design applications.
CO4	Analyze operational data using analytics and machine learning for monitoring and predictive maintenance.
CO5	Assess industrial applications, ethical issues, and future directions of AI-enabled design systems.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	–	–	1	2
CO2	2	3	2	2	3	–
CO3	2	2	3	3	3	2
CO4	2	3	3	3	3	–
CO5	1	1	–	2	2	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination

(MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Introduction to Artificial Intelligence in Design** Fundamentals of AI; Evolution of AI; Intelligent Design Systems; Knowledge Representation; State Space Search; Heuristic Search Techniques; Expert Systems in Design; Applications of AI in Product Design and Manufacturing.	08
2.	**Machine Learning for Design Engineering** Introduction to Machine Learning; Data Collection and Pre-processing; Feature Engineering; Supervised Learning (Regression, Decision Trees, SVM, k-NN); Unsupervised Learning (Clustering, Dimensionality Reduction); Model Evaluation; Design Prediction Applications, case studies.	09
3.	**Neural Networks and Deep Learning** Artificial Neural Networks; Backpropagation Algorithm; Deep Neural Networks; Convolutional Neural Networks; Autoencoders; Design Image Recognition; Defect Detection; AI-assisted CAD/CAE Applications.	08
4.	**AI-Based Design Optimization** Multi-objective Optimization; Genetic Algorithms; Particle Swarm Optimization; Evolutionary Computation; Surrogate Modeling; Generative Design; Topology Optimization; Design Space Exploration; Case Studies.	08
5.	**Industrial Applications and Emerging Trends** AI in Smart Manufacturing; Predictive Maintenance; Digital Twins; Explainable AI; Ethics and Responsible AI; Sustainability in Design; Industry 4.0 Applications; Future Trends in Intelligent Product Development.	09

Text Books			
Sr.No	Title	Author	Publisher
1.	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Pearson
2.	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer
3.	Deep Learning	Ian Goodfellow, Yoshua Bengio and Aaron Courville	MIT Press

Reference Books			
1.	Machine Learning	Tom M. Mitchell	McGraw-Hill
2.	The Hundred-Page Machine Learning Book	Andriy Burkov	Andriy Burkov
3.	Engineering Design via Surrogate Modelling	Alexander I.J. Forrester, Andras Sobester and Andy Keane	Wiley

Add resource link like NPEL

https://nptel.ac.in/courses/106106140

https://nptel.ac.in/courses/106105152

Title of the Course: Sustainable Engineering Design **Course Code:** 26MDE11063	**L**	**T**	**P**	**Credit**
	3	**--**	**--**	**3**

Course Pre-Requisite: Fundamentals of Engineering Design, Engineering Materials, Manufacturing Processes

Course Description: This course focuses on the principles and practices of sustainable engineering design for developing environmentally responsible, economically viable, and socially beneficial products and systems. It introduces concepts such as life cycle assessment, eco-design, circular economy, sustainable materials, energy-efficient design, and green manufacturing. The course equips students with the knowledge and tools required to integrate sustainability considerations into engineering design and decision-making processes.

Course Objectives:

1. To understand the fundamentals of sustainability and its relevance to engineering design.
2. To apply life cycle thinking and environmental assessment techniques in product design.
3. To evaluate sustainable materials and manufacturing processes for engineering applications.
4. To incorporate eco-design principles and circular economy concepts into product development.
5. To analyze emerging trends, standards, and industrial practices in sustainable engineering design.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain sustainability principles and their application in engineering design and development.
CO2	Apply life cycle assessment tools and environmental impact evaluation methods for product analysis.
CO3	Select sustainable materials and manufacturing processes based on environmental and economic considerations.
CO4	Develop eco-friendly engineering solutions using sustainable design and circular economy principles.
CO5	Evaluate industrial sustainability practices, standards, and emerging technologies for sustainable product development.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	–	–	1	2
CO2	2	3	2	2	3	–
CO3	2	2	3	3	3	2
CO4	2	3	3	3	3	2
CO5	1	1	–	2	2	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 30%, 20% and 50% weightage respectively.

Assessment Component	Marks
CA1	15
MSE	20
CA2	15
ESE	50

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Fundamentals of Sustainable Engineering Design** Concept of sustainability; Triple Bottom Line (People, Planet, Profit); Sustainable Development Goals (SDGs); Principles of Sustainable Engineering; Environmental Challenges; Sustainability Metrics; Design for Sustainability; Role of Engineers in Sustainable Development.	08
2.	**Life Cycle Assessment and Environmental Impact Analysis** Life Cycle Thinking; Product Life Cycle Stages; Life Cycle Assessment (LCA) Methodology; Goal and Scope Definition; Inventory Analysis; Impact Assessment; Interpretation of Results; Carbon Footprint Analysis; Environmental Product Declarations, case studies.	09
3.	**Sustainable Materials and Manufacturing** Green Materials; Renewable and Recyclable Materials; Bio-based Materials; Material Selection for Sustainability; Green Manufacturing Principles; Lean Manufacturing; Energy-efficient Manufacturing Processes; Waste Minimization; Sustainable Supply Chain Concepts.	08
4.	**Eco-Design and Circular Economy** Design for Environment (DfE); Design for Disassembly; Design for Recycling; Design for Remanufacturing; Circular Economy Principles; Product-Service Systems; Sustainable Product Development; Resource Efficiency; Industrial Ecology; Case Studies.	08
5.	**Emerging Trends and Industrial Applications** Sustainable Product Innovation; Smart Sustainable Manufacturing; Industry 4.0 and Sustainability; Green Buildings and Infrastructure; Sustainable Energy Systems; Environmental Standards (ISO 14001); ESG Frameworks; Future Trends in Sustainable Engineering Design.	09
Text Books		

Sr.No	Title	Author	Publisher
1.	Sustainable Engineering: Concepts, Design and Case Studies	David T. Allen and David R. Shonnard	Prentice Hall
2.	Engineering for Sustainable Development	Roland Clift and Angela Druckman	Springer
3.	Sustainable Design: Ecology, Architecture and Planning	Daniel E. Williams	Wiley

Reference Books			
1.	Materials and Sustainable Development	Michael F. Ashby	Butterworth-Heinemann
2.	Cradle to Cradle: Remaking the Way We Make Things	William McDonough and Michael Braungart	North Point Press
3.	Life Cycle Assessment: Theory and Practice	Michael Z. Hauschild, Ralph K. Rosenbaum and Stig I. Olsen	Springer

Add resource link like NPEL

https://nptel.ac.in/courses/112104311

https://nptel.ac.in/courses/120105010

Title of the Course: Concepts & Applications in Engineering **Course Code:** 26MDE1107	**L**	**T**	**P**	**Credit**
	2	**--**	**-**	**2**

Course Pre-Requisite: Basic understanding of engineering design principles and product development

Course Description: This course introduces M.Tech. Design Engineering students to the concepts and applications of Indian Knowledge Systems in engineering design. It explores indigenous technologies, traditional design practices, architecture, materials, and sustainable approaches that have evolved in India over centuries. The course emphasizes the relevance of IKS principles in modern product development, innovation, and responsible engineering practice, enabling students to integrate traditional wisdom with contemporary design methodologies.

Course Objectives:

1. Understand the philosophical foundations, evolution, and significance of Indian Knowledge Systems in engineering design.
2. Examine traditional engineering practices and indigenous technologies to appreciate their scientific and technological contributions.
3. Explore Indian architectural and traditional design principles for their application in engineering product and system design.
4. Integrate IKS concepts with modern engineering design methodologies to promote innovation and sustainable solutions.

Course Outcomes:

CO	**After the completion of the course the student should be able to**
CO1	Explain the role of Indian Knowledge Systems in the evolution and practice of engineering design.
CO2	Analyze indigenous technologies and traditional engineering practices for sustainable design applications.
CO3	Apply principles derived from Indian architecture and traditional design practices to engineering product development.
CO4	Integrate IKS concepts with modern design methodologies to address contemporary engineering challenges through innovative and sustainable solutions.

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	2	1	2
CO2	1	1	1	2	1	1
CO3	2			1	2	
CO4	1	1	1	2		2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), having 50% and 50% weightage respectively.

Assessment Component	Marks
CA1	25
MSE	--
CA2	25
ESE	--

CA1 and **CA2** are based on Assignment/ Declared test/ Quiz/Seminar/Group discussions presentation, etc.

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Foundations of Engineering Design in Indian Knowledge Systems** Introduction to Indian Knowledge Systems (IKS) and Engineering Evolution of Engineering Design in Ancient India, Philosophy of Design in Indian Tradition, Concepts of functionality, sustainability, and aesthetics in design, Knowledge frameworks relevant to engineering practice, Design thinking from an Indian perspective Contributions of ancient Indian scholars to engineering sciences Relevance of IKS in modern engineering design.	07
2.	**Traditional Engineering Practices and Indigenous Technologies** Materials and manufacturing practices in ancient India, Wootz steel and metallurgical advancements, Casting, forging, and metal joining techniques Indigenous tools, mechanisms, and devices Water management and irrigation systems Traditional construction technologies Shipbuilding and transportation technologies Sustainability aspects of indigenous technologies.	07
3.	**Engineering Design Principles in Indian Architecture and Product Development** Principles of Vāstu-śāstra in engineering design, Temple architecture as an example of structural optimization, Geometry and proportion in traditional Indian design, Ergonomics and human-centric design concepts, Design of artifacts and traditional products, Reverse engineering of indigenous products, Biomimicry and nature-inspired design in Indian traditions, Applications of traditional design principles in modern product development	07
4	**Contemporary Applications of IKS in Design Engineering** Integrating IKS with modern engineering design methodologies, Sustainable product and system design using IKS principles, Computational approaches for preserving indigenous knowledge, Innovation through traditional knowledge systems, Case studies on IKS-based engineering solutions, Ethical, social, and environmental considerations in design, Emerging opportunities for research in IKS and Design Engineering Mini case study/discussion on contemporary engineering applications.	07

Text Books			
Sr.No	**Title**	**Author**	**Publisher**
1.	Introduction to Indian Knowledge System: Concepts and Applications	Mahadevan, B., Bhat, V. R., and Nagendra Pavana R. N	PHI Learning Pvt. Ltd., New Delhi
2.	Indian Knowledge Systems: An Introduction	Balram Gupta	DK Printworld, New Delhi
3.	The Roots of Ancient Indian Science	B. V. Subbarayappa	Chaukhamba Sanskrit Series Office, Varanasi, Reprint Edition

Reference Books			
1.	Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts	Dharampal	India Press
2.	Indian Knowledge Systems: Vol. I & II	Kapil Kapoor and Avadesh Kumar Singh	D.K. Printworld
3.	History of Science, Philosophy and Culture in Indian Civilization	D. P. Chattopadhyaya	Centre for Studies in Civilizations

Add resource link like NPEL

https://nptel.ac.in/courses/109106188

Title of the Course: Multiphysics Modelling and Simulation Laboratory Course Code: 26MDE1108L	L	T	P	Credit
	--	--	2	1

Course Pre-Requisite: Engineering Mathematics, Strength of Materials, Fluid Mechanics, Heat Transfer, Basic Finite Element Analysis (FEA), Fundamentals of Experimental Stress Analysis

Course Description:

The Multiphysics Modelling and Simulation Laboratory provides practical exposure to the modelling, simulation, and analysis of engineering systems involving coupled physical phenomena such as structural mechanics, heat transfer, fluid flow, and sensor-based measurements. The laboratory integrates concepts from Experimental Stress Analysis, Digital Sensing, Data Acquisition Systems, and Computational Engineering Tools to study stress, strain, deformation, temperature distribution, and structural health monitoring. Students will develop simulation models, validate results using experimental methods, and analyze engineering systems using modern Multiphysics software platforms.

Course Objectives:

1. To understand the fundamentals of Multiphysics modelling and simulation techniques.
2. To develop computational models for structural, thermal, and fluid flow problems.
3. To apply strain measurement and digital sensing concepts for engineering analysis.
4. To perform coupled-field simulations and interpret engineering results.
5. To validate simulation outcomes using experimental stress analysis techniques.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Develop simulation models for structural, thermal, and fluid engineering problems.
CO2	Apply digital sensing and strain measurement techniques for engineering analysis.
CO3	Perform coupled-field and multi physics simulations using CAE software.
CO4	Analyse and interpret simulation and experimental results for engineering applications.
CO5	Validate engineering designs through integrated simulation and experimental approaches.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	3	2
CO2	3	2	2	2	3	2
CO3	3	3	2	3	3	1
CO4	2	3	3	3	2	2
CO5	3	3	3	3	2	1

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2) and End Semester Examination (POE) having 25% , 25% and 50% weightage respectively.

Assessment Component	Marks
CA1	25
MSE	-
CA2	25
POE	50

CA1 and **CA2** are based on Experimental performance, Viva, Manual performance, etc.
POE is based on 100% of experiments.

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	Introduction to Multiphysics Simulation Environment and Pre-processing Techniques using ANSYS/COMSOL.	02
2.	Simulation of Plane Stress and Plane Strain Problems and Comparison of Results.	02
3.	Structural Analysis of Cantilever Beam and Validation using Strain Gauge Measurements.	02
4.	Modelling and Analysis of a Three-Element Strain Rosette for Principal Stress Determination.	02
5.	Steady-State Thermal Analysis of Composite Structures and Heat Flux Evaluation.	02
6.	Thermo-Structural Coupled Analysis for Determination of Thermal Stresses.	02
7.	CFD Analysis of Fluid Flow Through a Pipe and Pressure Drop Measurement.	02
8.	Digital Data Acquisition and Signal Conditioning for Strain Measurement using DAQ Systems.	02
9.	Wireless Sensor-Based Structural Health Monitoring of a Beam Structure using IoT Concepts.	02
10.	Coupled Multiphysics Mini Project involving Structural, Thermal, and Sensor-Based Analysis.	02

Textbooks

Sr.No	Title	Author	Publisher

1.	Experimental Stress Analysis	Dr. Sadhu Singh	Khanna Publishers
2.	Experimental Stress Analysis	James W. Dally & William F. Riley	McGraw-Hill Education
3.	Measurement Systems: Application and Design	Ernest O. Doebelin & D. N. Manik	McGraw-Hill Education