DEPARTMENT OF MECHANICAL ENGINEERING

Y23 M.TECH MACHINE DESIGN HANDBOOK

i. COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (CTEO)

COURSE CODE	23MT5102	MODE		LTPS	2-2-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2, PO3
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO4, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO4, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO4, PO5

Syllabus

Module 1	Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.
Module 2	Unconstrained Optimization Techniques: Newton's method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.
Module 3	Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.
Module 4	Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Engineering Optimization: Methods and Applications"	Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V.	Wiley	2006
2	"Introduction to Optimization"	Chong, E. K. P., & Zak, S. H.	Wiley	2013
3	"Optimization Concepts and Applications in Engineering"	Belegundu, A. D., & Chandrupatla, T. R.	Pearson	2011
4	"Optimization in Practice with MATLAB®: For Engineering Students and Professionals"	Achanta, S., & Darby-Dowman, K.	Cambridge University Press	2015

5	"Applied Optimization: Formulation and Algorithms for Engineering Systems"	Ross, I. J.	Cambridge University Press	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Optimization Engineer (COE)	INFORMS	Y	Online	INFORMS	COE Certification
2	Professional Engineering Optimization Certification	Optimization Firm	Y	Online	Optimization Firm	PE Optimization Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	Software	Commercial
2	Python with NumPy/SciPy	Software	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	24
	Tutorial	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	8	
In-Sem Summative	In-Sem Exam-I	18	36
	In-Sem Exam-II	18	
End-Sem Summative	End Semester Exam	40	40

ii. Design of experiments (DOE)

COURSE CODE	23MD5101	MODE		LTPS	0 0 4 0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the basics of Design of Experiments (DoE) and understand the principles, advantages, and applications in engineering.	3	PO1, PO2, PO4
CO2	Plan and design experiments using various techniques such as factorial designs, response surface methodology, and analysis.	5	PO1, PO3, PO5

Syllabus

Module 1	Introduction to Design of Experiments (DoE): Basics of DoE, principles, advantages, and applications in engineering.

Module 2	Planning and Designing Experiments: Experimental design techniques, factorial designs, response surface methodology, and statistical analysis of data.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives"	Chris Mi, M. Abul Masrur	Wiley	2018
2	"Design of Alternative Energy Systems: Second Edition"	Mohammad Rasul	McGraw-Hill Education	2016
3	"Fundamentals of Electric Vehicle Drives"	Saeed Book Bank	CRC Press	2017
4	"Hybrid and Electric Vehicles: Principles and Applications"	Chris Mi	CRC Press	2013
5	"Advanced Electric Drive Vehicles"	Ali Emadi	CRC Press	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Hybrid Vehicle Design Engineer (CHVDE)	Society of Automotive Engineers (SAE)	Yes	Online Exam	SAE	https://www.sae.org/standards/content/j2882/
2	Electric Vehicle Certified Technician (EVT)	Automotive Service Excellence (ASE)	Yes	Computer-Based Test (CBT)	ASE	https://www.ase.com/Tests/ASE-Certification-Tests

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Minitab	Statistical	Commercial
2	Design-Expert Software	Engineering	Commercial

Evaluation Components:

Evaluation	Component		Weightage	Total
In-Sem Formative	Lab Weekly exercise / Continuous evaluation		12.5	25
	Project Continuous evaluation		12.5	
In-Sem Summative	In Semester Exam-I		17.5	35
	In Semester Exam-II		17.5	
End-Sem Summative	Lab End Sem Exam	Viva	7	40
		Exercise	20	
		Report	5	
	External Review		8	

iii. MODELLING AND ANALYSIS OF MECHANICAL ELEMENTS (MAME)

COURSE CODE	22ME5102	MODE	R	LTPS	2-0-2-4	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	To understand various evaluation criteria's for CAD/CAM system and need of graphics standard.	3	PO4
CO2	To represent different curves and surfaces of geometric models mathematically.	3	PO1,PO2
CO3	To represent solid models using different solid represent schemes	3	PO1,PO2
CO4	To recognize and apply various data exchange formats in geometric modelingand also will be able to apply finite element modeling and mechanical assembly concepts in design applications	3	PO1,PO3
CO5	Build the 3D models		

Syllabus

Module 1	CADTOOLS:Definition of CAD Tools, Types of System, CAD/CAM system evaluation criteria, brieftreatment of input an output devices. Graphics standards, functional areas of CAD, ModelingandViewing, Softwaredocumentation efficient useofCADSoftware.GEOMETRICMODELING:Types of Mathematical representation of curves, wire frame models, wire frame entities,parametric representation of synthetic curves hermit cubic splines, Bezier curves, B-Splinesrationalcurves.
Module 2	SURFACEMODELING:Mathematical representation surfaces, surface model, surface entities, surfacerepresentation,parametricrepresentationofsurfaces,planesurface,rulesurface,surfaceofrevolution,tabularcylinder.PARAMETRICREPRESENTATIONOFSYNTHETICSURFACES:Hermit Bi-Cubic surface, Bezier curve surface, B-Spline surface, COONs, Blending Surface,Sculptured surface, Surface Manipulation- Displaying, segmentation, trimming, intersection,Transformations(2D and3D).
Module 3	GEOMETRICMODELING3D:Solidmodeling, solid representation, Boundary Representation (B-Rep), Constructive SolidGeometry.CAD/CAMDATAEXCHANGE:Evaluationofdata–Exchangeformat,IGESDatarepresentationsandstructure,STEPArchitecture,Implementation, ACIS and DXF.
Module 4	DESIGNAPPLICATIONS:FiniteElementModelingandAnalysisandMechanicalAssembly.COLLABORATIVEENGINEERING:CollaborativeDesign,Principles,Approaches,tools,designssystem.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	CAD/CAM Theory and Practice	Ibrahim Zeid	McGrawHill	1991
2	CAD/CAM	PN Rao	TMH	2002
3	CAD/CAM Principles, Practice and Manufacturing Management	Chris Mc.Mohan, Jimmie Browne	Pearson	

4	Concurrent Engineering Fundamentals: Integrated Product Development	E. Paul DeGarmo, J. Temple Black, Ronald A. Kohser	CRC Press	1991
5	Successful implementation of concurrent Product and Process	Sammy G Sinha	Wiley John and Sons Inc.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Autodesk Certified Professional: AutoCAD	Autodesk	Yes	Online	Autodesk	AutoCAD Certification
2	ertified SolidWorks Professional (CSWP)	Dassault Systèmes	Yes	Online	Dassault Systèmes	CSWP Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	CNC Train Simulation Software	MTAB	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

iv. Robotics: Manipulator Design and Analysis (RMDA)

COURSE CODE	23MD5102	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs

CO1	Apply homogeneous transformations and DH parameters	Understand	PO1, PO3, PO4
CO2	Apply forward and inverse kinematics to Robots	Apply	PO1, PO2, PO3, PO4
CO3	Apply rigid body dynamics and dynamic modelling to Robots	Apply	PO1, PO2, PO3, PO4
CO4	Design mechanical systems for robot manipulators	Analyse	PO1, PO2, PO3, PO4
CO5	Apply configuration space and motion planning	Apply	PO1, PO2, PO3, PO4

Syllabus

Module 1	1. Introduction to Robotics • Definition of Robotics, Classification of Robots, Robot Components and Architecture 2. Robot Kinematics • Homogeneous Transformations, Denavit-Hartenberg (DH) Parameters
Module 2	1. Forward Kinematics, Inverse Kinematics 2. Robot Dynamics • Rigid Body Dynamics, Lagrange's Equation, Newton-Euler Equations,
Module 3	1. Dynamic Modeling of Manipulators 2. Robot Motion Planning • Configuration Space, Path Planning 3. Motion Planning Algorithms Robot Control • Proportional-Integral-Derivative (PID) Control, Computed-Torque Control
Module 4	1. Robot Manipulator Design • Mechanical Design Considerations 2. Actuators and Drive Systems Robot Sensors and Perception (3 hours) • Sensor Types and Selection, Sensing Techniques for Robotics

Note: During Practical sessions, Robot Programming and Simulation tools will be studied.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Robotics: Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo	Springer	-
2	Introduction to Robotics: Mechanics and Control	John J. Craig	Pearson	-
3	Robot Dynamics and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	Wiley	-
4	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	Wiley	-
5	Introduction to Autonomous Robots: Kinematics, Perception, Localization, and Planning	Nikolaus Correll	CRC Press	-

6	Robotics: Control, Sensing, Vision, and Intelligence	K.S. Fu, R.C. Gonzalez, C.S.G. Lee	McGraw-Hill	-

Global Certifications:

Mapped Global Certifications:						
Sl. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Any MBD tool – MSC Adams	MSC Hexagon	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

v. Mechanical Behaviour of Materials><(MBM)>

COURSE CODE	23MD5103	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the significance of compatibility and equilibrium equations. Evaluation of factor of safety against yielding in multi- axial stress state.	4	PO1
CO2	Solve 2-D elasticity problems in Cartesian and Polar coordinate systems	4	PO2
CO3	Analyze the bending of cantilever beams having rectangular and circular cross-sections; Axisymmetric stress and deformation in a solid of revolution ; and simple 3-D stress analysis problems	4	PO1
CO4	Understand the plastic deformation and plastic yielding. Solving problems using the characteristic methods and engineering methods.	4	PO1

Syllabus

Module 1	ELASTICITY: Two dimensional stress analysis - Plane stress - Plane strain – Equations of compatibility - Stress function - Boundary conditions. PROBLEMS IN RECTANGULAR COORDINATES - Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems.
Module 2	PROBLEMS IN POLAR COORDINATES - General equations in polar coordinates – Stress distribution symmetrical about axis – Strain components in polar coordinates - Simple and symmetric problems.
Module 3	ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain. General theorems: Differential equations of equilibrium and compatibility - Displacement -Uniqueness of solution - Reciprocal theorem.
Module 4	BENDING OF PRISMATIC BARS: Stress function - Bending of cantilever beam - Beam of rectangular cross- section - Beams of circular cross-section. PLASTICITY: Plastic deformation of metals - Structure of metals -Deformation – Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity. METHODS OF SOLVING PRACTICAL PROBLEMS: The characteristic method – Engineering method - Compression of metal under press -Theoretical and experimental data drawing.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Theory of Elasticity	Timoshenko S.P. and Goodier J.N.	McGraw-Hill Education	1970
2	An Engineering Theory of Plasticity	E.P. Unksov	Butterworths	1961
3	Applied Elasticity	C.T. Wang	McGraw-Hill	1953
4	Theory of Plasticity for Engineers	Hoffman and Sacks	McGraw-Hill	1953
5	Theory of Elasticity and Plasticity	Sadhu Singh	Khanna Publishers	1988
6	Theory of Elasticity and Plasticity	Harold Malcolm Westergaard	Dover Publications	1964

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Understanding Solid Mechanics: Stress analysis approach	NAFEMS	Y	MCQS	NAFEMS - Professional Simulati	https://www.nafems.org/professional-development/certification/

	Stress Analysis Approaches				on Engineer	
2	Nonlinear FEA	NAFEMS	Y	MCQS	NAFEMS - Professional Simulation Engineer	https://www.nafems.org/professional-development/certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NOT APPLICABLE		
2	NOT APPLICABLE		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	100
	Tutorial	8	100
	Home Assignment and Text Book	8	40
	Skill Continuous Evaluation	NA	NA
In-Sem Summative	Semester in Exam-I	18	50
	Semester in Exam-II	18	50
	Skill in-sem	NA	NA
End-Sem Summative	End Semester Exam	40	100
	Skill end sem exam	NA	NA

vi. ESSENTIALS OF RESEARCH DESIGN> <(ERD)>

COURSE CODE	23IE5201	MODE		LTPS	1-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO4,PSO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO4,PSO1

CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO1,PSO1
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO1,PSO1

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multi-dimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methodology Methods and Techniques	C.R. Kothari	New Age International	2019
2	Business Research Methods,	Donald R.Cooper, Pamela S. Schhindler	TMH	2018
3	Research Methods for Engineers	David V Thiel	Cambridge University Press	2015
4	Engineering Research Methodology	Krishnan Nallaperumal	Manonmaniam Sundaranar University.	2013
5	Business Research Methods	William G Zikmund	South West Cengage Learning	2013

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	Research Design and Methodology Certification	Global Association of Research Methodology Education and Training (GARMET)	Proctored	Online Multiple Choice Questions	GARMET	https://www.garment.org/certifications/research-design-methodology
2	Certified Research Methodologist (CRM)	International Institute for Applied Knowledge Sciences (IIAKS)	Proctored	Online Exam	IIAKS	https://www.iiaks.org/certifications/certified-research-methodologist

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	24
	HOME ASSIGNMENT AND TEXT BOOK	8	
	TUTORIALS	8	
In-Sem Summative	IN SEM EXAMINATION-I	18	36
	IN SEM EXAMINATION-II	18	
End-Sem Summative	END SEMESTER EXAM	40	40

vii. Advanced Strength of Materials (ASM)

COURSE CODE	23MD5204	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Analyse the stresses and deflections in the beams under unsymmetrical bending and determination of shear centre.	4	PO2
CO2	Analyse the stresses induced in curved beams subjected to loading.	4	PO1, PO2
CO3	Analyse the torsional stresses in beams and determine the contact stresses.	4	PO1, PO2
CO4	Apply principles of elasticity to determine stresses in two-dimensional and three dimensional problems.	4	PO2
CO5	Simulate the structural members using ANSYS software and validate the results with analytical methods	4	PO1, PO2

Syllabus

Module 1	UNSYMMETRICAL BENDING: Bending stress in beams subjected to non-symmetrical bending, deflection of straight beams due to non symmetrical bending. SHEARCENTER:

	Bending axis and shear center-shear center of axisymmetric and unsymmetrical sections.
Module 2	CURVED BEAM THEORY: Winkler Bach formula for circumferential stress- limitation – correct factors- radial stress in curved beams– closed ring subjected to concentrated and uniform loads-stress in chain links. Torsion: Linear elastic solution, Pradtl elastic membrane (Soap-Film) Analogue, Narrow rectangular cross-section, Hollow thin wall torsion members, multiply connected cross-section.
Module 3	CONTACT STRESS: Introduction, problem of determining contact stresses, assumptions on which a solution for contact stresses is based, expression for principle stresses, method of computing contact stresses, deflections of bodies in point contact, stresses for two bodies in contact over narrow rectangular area (Line of contact). Loads normal to area, stressed for two bodies in line contact normal and tangent to contacts area.
Module 4	TWO DIMENSIONAL ELASTICITY PROBLEMS: Plane stress and plain strain – problems in rectangular Coordinates bending of cantilever beam loaded at the end, bending of a beam by uniform load. In polar coordinates, general equations in polar coordinates, stress distribution symmetrical about the axis, pure bending of curved bars, and displacements for symmetrical stress distributions, rotating discs. INTRODUCTION TO THREE DIMENSIONAL PROBLEMS: Uniform stress stretching of a prismatic bar by its own weight, twist o circular shafts of constant cross section, pure bending of plates.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Mechanics of materials	A.P.Boresi and O.M.Side bottom	Wiely International	2009
2	Theory of Elasticity	Timoschenko S.P. and Goodier J.N	Mc Graw hill Publishers.	1951
3	Advanced strength of materials	Den Hortog J.P.	Dover Publications	2014
4	Theory of plates and shells	S.Timoshenko	McGraw-Hill	1959
5	Strength of Materials and Theory of Structures	B.C Punmai	Laxmi Publications Pvt Limited	2004

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structural analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	ANSYS	ANSYS Inc.	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

viii. Mechanical Vibrations> <(MV)>

COURSE CODE	23MD5205	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyse free vibrations of single degree freedom systems	4	PO1,PO2,PSO1
CO2	Analyse harmonically excited vibrations of single degree freedom systems	4	PO1,PO2,PSO1
CO3	Analyse the mode shapes of two degree and multi degree vibration systems	4	PO1,PO2,PSO1
CO4	Identify the means to control and measure the vibration response of the system	4	PO1,PO2,PSO1
CO5	Analyse the vibrations of the system using analysis software	4	PO1,PO4,PSO1

Syllabus

Module 1	Classification of vibrations, Vibration analysis procedure, spring elements, damping elements, Inertia elements, harmonic motion and analysis, free vibration of undamped and damped translational and torsional systems.
Module 2	Response of an undamped and damped systems under harmonic excitation, Response of damped system under harmonic force of the base, Response of damped system under rotating unbalance, Transfer function approach, solution using frequency transfer function.
Module 3	Free vibration analysis of undamped 2DOF systems, coordinate coupling and Principal coordinates, forced vibration analysis, semidefinite system, solutions using Laplace Transform, Modelling of continuous system as multi degree of freedom systems
Module 4	Vibration control and Isolation, Vibration measurement: Transducers, Vibration pickups, frequency measuring instruments, vibration exciters, signal analysis, dynamic testing of machinery and structures, machine condition monitoring and diagnosis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Mechanical vibrations	S.S.Rao	Pearson	6th edition 2018
2	"Vibration Analysis and Control in Mechanical Systems"	C. M. Harris	CRC Press	2nd Edition, 2001
3	"Mechanical Vibrations: Theory and Applications"	S. Graham Kelly	Cengage Learning	1st Edition, 2012
4	"Vibration Analysis for Electronic Equipment"	Dave S. Steinberg	Wiley-IEEE Press	3rd Edition, 2000
5	"Mechanical Vibrations and Noise Engineering"	A. G. Ambekar	Pearson	1st Edition, 2011

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	"Certified Vibration Analyst Category I"	Vibration Institute	Proctored	Multiple Choice Questions	Vibration Institute	Certified Vibration Analyst Category I
2	"ISO 18436-2 Vibration Analyst Category I"	Mobius Institute	Proctored	Multiple Choice Questions	Mobius Institute	ISO 18436-2 Vibration Analyst Category I

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MAT LAB	MAT LAB	Commercial
2	Msc Adams	Hexagon	Commercial
3	PYTHON	PYTHON	Python

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB weekly EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB End SEM EXAM	16	

ix. DIGITAL TWIN FOR DESIGN AND MANUFACTURING (DTDM)

COURSE CODE	VAC-1	MODE	R	LTPS	2-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the principles and applications of digital twin technology in design and manufacturing	3	PO1, PO5, PSO1
CO2	Demonstrate knowledge of data acquisition and integration methods for digital twin systems	3	PO1, PO3, PSO1
CO3	Develop mathematical and physical models for digital twin representation	3	PO1, PO5, PSO1
CO4	Implement and analyze digital twin systems in design and manufacturing processes	3	PO1, PO5, PSO1

Syllabus

Module 1	Introduction to Digital Twin for Design and Manufacturing Overview of digital twin technology Role of digital twin in design and manufacturing Benefits and challenges of implementing digital twin Applications of digital twin in different industries Key components and architecture of a digital twin system
Module 2	Data Acquisition and Integration for Digital Twin Data collection and acquisition methods Sensor technologies for capturing real-time data Data preprocessing and cleaning techniques Data integration and synchronization Data storage and management for digital twin
Module 3	Modeling and Simulation in Digital Twin Mathematical and physical models for digital twin representation Model development and calibration Simulation techniques for virtual testing and validation Real-time simulation and synchronization with physical systems Model updating and optimization in digital twin
Module 4	Implementation and Use Cases of Digital Twin in Design and Manufacturing Digital twin implementation strategies and best practices Designing digital twin for specific manufacturing processes Monitoring and control using digital twin in manufacturing operations Predictive maintenance and optimization with digital twin Case studies and real-world examples of successful digital twin applications

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Digital Twin Technologies and Applications"	Michael Grieves	CRC Press	2020
2	"Digital Twin in the Factory of the Future"	Matthias Volcker	Springer	2019

3	"Digital Twin Driven Smart Design"	Fei Tao	Wiley	2020
4	"Data-Driven Design and Construction"	Rudiger Ebendt	Springer	2019
5	"Simulation Modeling and Analysis"	Averill M. Law	McGraw-Hill Education	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Digital Twin Professional (CDTP)	Digital Twin Consortium	Yes	Online	Digital Twin Consortium	CDTP Certification
2	Certified Simulation Professional (CSP)	American Society of Mechanical Engineers (ASME)	Yes	Online	ASME	CSP Certification

Tools used in Practical / Skill: N A

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1			
2			

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

x. MACHINE LEARNING WITH PYTHON (MLWP)

COURSE CODE	VAC-2	MODE	R	LTPS	2-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping

CO1	Apply machine learning techniques	3	PO1, PO5, PSO1
CO2	Apply Computational techniques to solve supervised learning problems	3	PO1, PO3, PSO1
CO3	Apply Statistical learning techniques to solve unsupervised learning problems	3	PO1, PO5, PSO1
CO4	Apply support vector machine method to solve classification problems.	3	PO1, PO5, PSO1

Syllabus

Module 1	Towards Intelligent Machines Well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured / Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques
Module 2	Supervised Learning: Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Over fitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metris for assessing classification.
Module 3	Statistical Learning: Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning: A probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.
Module 4	Support Vector Machines (SVM): Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly seperable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, and Regression by Support vector Machines.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Applied Machine Learning	M.Gopal	TMH	2018
2	Machine Learning: An Algorithmic Perspective	Stephen Marsland	Taylor & Francis (CRC) 1st Edition	2014
3	Machine Learning Methods in the Environmental Sciences, Neural Networks,	William WHsieh,	Cambridge Univ Press. 1 edition	2009
4	pattern classification	Richard o. Duda, Peter E. Hart and David G. Stork,	Wiley &Sons	2001
5	Machine Learning	Peter Flach	Cambridge	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Machine learning	IBM	Y	Online	IBM	Supervised Machine Learning: Regression | Coursera
2	Machine Learning	AWS	Y	On line	AWS	AWS Certified Machine Learning - Specialty Certification | AWS Certification | AWS (amazon.com)

Tools used in Practical / Skill: N A

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1			
2			

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

xi. Lean Manufacturing> <(LM)>

COURSE CODE	23MD51A1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply Lean principles: Understand and apply the principles of Lean Manufacturing, including waste elimination, standardized work, value stream mapping, and continuous improvement.	2	PO1, PSO1
CO2	Optimize processes: Analyze and optimize manufacturing processes to identify and eliminate waste, reduce variability, and improve efficiency.	2	PO1, PSO1
CO3	Implement visual management: Develop skills to implement visual cues, metrics, and displays to enhance communication, transparency, and problem-solving.	3	PO1, PSO1

CO4	Foster continuous improvement: Create a culture of continuous learning, problem-solving, and improvement using methodologies like PDCA and Kaizen.	3	PO1, PSO1
CO5	Apply Lean Manufacturing principles and tools in a hands-on laboratory setting to optimize manufacturing processes.	3	PO1, PSO1
CO6	<CO for Skill – can be deleted otherwise>		

Syllabus

Module 1	Introduction to Lean Manufacturing – • History and evolution of Lean Manufacturing • Principles and philosophy of Lean, including the Toyota Production System • Lean culture and mindset • Key concepts such as customer value, waste, and continuous improvement
Module 2	Waste Elimination and Value Stream Mapping • Identifying the eight types of waste (TIMWOODS) • Value stream mapping to analyze and improve the flow of materials and information • Techniques for waste elimination, such as 5S, visual management, and error-proofing (Poka-Yoke) • Implementing continuous improvement methodologies like Kaizen events
Module 3	Standardized Work and Just-in-Time Production • Establishing standardized processes, work instructions, and procedures for consistency and quality • Implementing just-in-time production to meet customer demand with minimal inventory and lead times • Kanban systems and pull production techniques • Balancing workloads and leveling production
Module 4	Continuous Improvement and Lean Tools • Creating a culture of continuous improvement and problem-solving • Applying the PDCA (Plan-Do-Check-Act) cycle and other improvement methodologies • Exploring additional Lean tools and techniques like SMED, TPM, and Six Sigma • Data analysis and measurement techniques for performance monitoring and decision-making

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer"	Jeffrey Liker	McGraw-Hill,	2004
2	Lean Thinking: Banish Waste and Create Wealth in Your Corporation	Jmes P. Womack and Daniel T. Jones	Free Press,	2003
3	Lean Thinking: Banish Waste and Create Wealth in Your Corporation	Pascal Dennis	Productivity Press,	2007
4	The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to 100 Tools for Improving Quality and Speed" by Michael L. George, John Maxey, David T. Rowlands, and Malcolm Upton	Michael L. George, John Maxey, David T. Rowlands, and Malcolm Upton	McGraw-Hill Education,	2004

5	Lean Manufacturing for the Small Shop	Gary Conner	Society of Manufacturing Engineers (SME),	2001

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Lean Six Sigma Green Belt Certification Certification Provider	International Association for Six Sigma Certification (IASSC)	Y	Multiple-choice questions	IASSC	https://www.iassc.org/six-sigma-certification/green-belt-certification/
2	Lean Six Sigma Black Belt Certification Certification	American Society for Quality (ASQ)	Y	Multiple-choice questions	ASQ	https://asq.org/cert/six-sigma-black-belt

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	5S Methodology	Manufacturing, Services, Healthcare, etc	Manufacturing, Services, Healthcare, etc
2	Manufacturing, Services, Healthcare, etc	Any Industry	Both (Various methodologies, templates, and software available)

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	Assignment	7	
	Lab Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

xii. PRECISION AND QUALITY ENGINEERING (PQE)

COURSE CODE	23MD51A2	MODE		LTPS	2 0 2 0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and techniques of precision engineering for enhancing product quality.	BTL-2	PO1, PO3, PO4
CO2	Analyze and apply statistical methods for quality control and process improvement in manufacturing.	BTL-4	PO2, PO3, PO4
CO3	Explore the concepts of tolerance analysis and its significance in the design and assembly of products.	BTL-3	PO1, PO2, PO3
CO4	Comprehend the principles of metrology and apply measurement techniques to ensure product accuracy.	BTL-4	PO2, PO3, PO5
CO5	Apply precision engineering and quality control techniques through practical exercises and projects.	BTL-5	PO1, PO2, PO3, PO4, PO5, PO11 (where applicable)

Syllabus

Module 1	Introduction to Precision Engineering: Principles, applications, and role in enhancing product quality.
Module 2	Geometric Dimensioning and Tolerancing (GD&T): Standards, symbols, and techniques for design and inspection.
Module 3	Metrology and Measurement Systems: Principles, calibration, and analysis of measurement uncertainties.
Module 4	Statistical Process Control (SPC): Techniques for monitoring and improving process stability and quality.
Module 5	Practical Component: Hands-on experience with precision measurement tools, GD&T application, and SPC software.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Design for Manufacturability Handbook	James G. Bralla	McGraw-Hill Education	2011
2	Design for Manufacturability and Statistical Design	Scott K. Johnson	CRC Press	2019
3	Design for Manufacturing: A Structured Approach	Corrado Poli	Springer	2018
4	Design for Manufacturing and Assembly	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight	Marcel Dekker Inc.	2002
5	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer	2014

Global Certifications:

Mapped Global Certifications:

Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Quality Engineer (CQE)	American Society for Quality (ASQ)	Y	Multiple-Choice Questions	ASQ	Link
2	Six Sigma Green Belt Certification	International Association for Six Sigma Certification (IASSC)	Y	Multiple-Choice Questions	IASSC	Link

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Coordinate Measuring Machine (CMM)	Manufacturing	Commercial
2	Statistical Process Control (SPC) Software	Quality Assurance	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Lab Weekly exercise	7	22
	ALM (LTC, in-class Quiz, etc.)	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
In-Sem Summative	In Semester Exam	8	38
	In-Sem Exam-I	15	
	In-Sem Exam-II	15	
End-Sem Summative	End Semester Exam	24	40
	Lab End Exam	16	

xiii. Behaviour of Composite Materials> <(BCM)>

COURSE CODE	23MD51A3	MODE		LTPS	3-0-0-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Composite materials, Classifications and Manufacturing Processes	3	PO1, PSO1
CO2	Identify the behavior of composite Lamina at micro level	3	PO1, PO2, PSO1
CO3	Identify the behavior of composite Lamina at macro level	3	PO1, PO2, PSO1
CO4	Apply Failure theories to calculate stresses in composite materials	3	PO1, PO2, PSO1

Syllabus

Module 1	Introduction to composite materials, Geometric definitions, Classification of composites, Types of fibers, Types of the matrix, Hybrid composite, Scale of analysis-micro and macro mechanics approaches, Degree of Anisotropy. Manufacturing methods of the composites, Autoclave molding, Filament winding, and Resin transfer molding.
Module 2	Elastic behavior of composite lamina (Micro-mechanics), Micro-mechanics methods, Geometric aspects and elastic symmetry, Longitudinal elastic properties (Continuous fibers), Transverse elastic properties, In-plane shear properties (Continuous fibers), Longitudinal properties (short fibers)
Module 3	Elastic behavior of composite lamina (Macro mechanics approach), Stress-Strain relations: General anisotropic material, Specially orthotropic material, Transversely isotropic material, Orthotropic material under plane stress, Isotropic material.
Module 4	Standard sizes of the specimen for tensile and compressive, Fatigue tests, and Impact tests of uni-directional composites. Experimental methods for characterization and testing of composite materials. Failure of the composite materials: fiber failures, matrix failure, interface failure. Failure Theories: Tsai-Wu, Tsai-Hill, Puck criterion, Maximum stress, maximum strain.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Engineering Mechanics of Composite Materials	Issac Daniel & Ori Ishai	OUPublisher, USA	2005
2	Mechanics of Composite Materials	Autar K. Kaw	Taylor & Francis	2005
3	Mechanics of Composite Materials	R.M.Jones	Taylor & Francis	1998
4	Composite Materials	N. Chawla and K.K. Chawla	Springer	2006
5	Mechanics of Composite Materials & Structures	Madhujit Mukhopadhyay	University Press	2022

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structral Analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/
2	Fusion 360	Autodesk	Y	MCQs	Autodesk	https://www.autodesk.com/certification/overview

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	NA		
2	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignments and text book	10	
In-Sem Summative	In sem-1	20	20
	In Sem-2	20	
End-Sem Summative	End Sem Exam	40	40

xiv. DESIGN FOR MANUFACTURING (DFM)

COURSE CODE	23MD52C1	MODE		LTPS	2 0 2 0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and methodologies of Design for Manufacturing (DFM) and its impact on manufacturing processes.	BTL-2	PO1, PO2, PO3
CO2	Apply design techniques for optimizing part geometry, tolerances, and surface finish to improve manufacturability in machining processes.	BTL-3	PO2, PO3, PO4
CO3	Analyze and incorporate design considerations for casting, forging, and sheet metal forming processes.	BTL-3	PO2, PO3, PO4
CO4	Evaluate the design constraints and opportunities of Additive Manufacturing (AM) techniques in product development.	BTL-6	PO1, PO2, PO3
CO5	Apply DFM principles through case studies, hands-on exercises, and software simulations to optimize manufacturing processes.	BTL-3	PO2, PO4, PO5

Syllabus

Module 1	Introduction to Design for Manufacturing (DFM) principles and methodologies. Understanding the impact of design decisions on manufacturing processes.
Module 2	Design for Machining: Optimizing part geometry, tolerances, and surface finish requirements to improve manufacturability using machining processes.
Module 3	Design for Casting and Forming: Considerations for designing parts for casting, forging, and sheet metal forming processes.
Module 4	Design for Additive Manufacturing (AM): Exploring the design constraints and opportunities for utilizing AM techniques in product development.
Module 5	Practical Component: Application of DFM principles through case studies, hands-on exercises, and software simulations for manufacturing process optimization.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Design for Manufacturability Handbook	James G. Bralla	McGraw-Hill Education	2011
2	Design for Manufacturability and Statistical Design	Scott K. Johnson	CRC Press	2019
3	Design for Manufacturing: A Structured Approach	Corrado Poli	Springer	2018
4	Design for Manufacturing and Assembly	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight	Marcel Dekker Inc.	2002
5	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Manufacturing Technologist (CMfgT)	Society of Manufacturing Engineers (SME)	Yes	Online Proctored	SME	https://www.sme.org/certification/certified-manufacturing-technologist/
2	Certified SolidWorks Associate (CSWA)	Dassault Systèmes	Yes	Online Proctored	Dassault Systèmes	https://www.solidworks.com/sw/support/mcad-certification-programs.htm

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Computer-Aided Design (CAD) Software	Design	Commercial
2	Design for Manufacturing (DFM) Software	Manufacturing	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Lab Weekly exercise	7	22
	ALM (LTC, in-class Quiz, etc.)	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
In-Sem Summative	In Semester Exam	8	38
	In-Sem Exam-I	15	
	In-Sem Exam-II	15	
End-Sem Summative	End Semester Exam	24	40
	Lab End Exam	16	

xv. Design for Sustainability (DFS)

COURSE CODE	23MD52B1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Understanding the Principles and Importance of Sustainability	Understand	PO5, PO6
CO2	Applying Life Cycle Assessment and Environmental Impact Assessment in Design	Apply	PO1, PO2
CO3	Implementing Sustainable Design Strategies and Principles	Apply	PO1, PO2
CO4	apply Sustainable Manufacturing, Supply Chain, and Assessment Tools	Apply	PO5, PO6, PO7
CO5	apply principles of sustainability in engineering design and develop sustainable solutions	Apply	PO5, PO6, PO7

Syllabus

Module 1	Introduction to Sustainability: Definition and Principles of Sustainability, Importance of Sustainable Design, Environmental, Social, and Economic Dimensions Life Cycle Assessment: Introduction to Life Cycle Assessment (LCA), Life Cycle Thinking and Stages of LCA, Environmental Impact Assessment in Design, Interpretation and Limitations of LCA Results.
Module 2	Sustainable Design Strategies: Design for Disassembly and End-of-Life Management, Material Selection and Substitution, Energy Efficiency and Renewable Energy Integration, Water Conservation and Waste Reduction, Design for Recyclability and Upcycling Sustainable Product Design: Design Principles for Sustainable Products, Eco-design and Design Guidelines, Cradle-to-Cradle Design Concepts, Sustainable Packaging Design
Module 3	Sustainable Manufacturing and Supply Chain Lean Manufacturing and Waste Reduction, Green Supply Chain Management, Closed-Loop Systems and Circular Economy, Social and Ethical Considerations in Manufacturing
Module 4	Sustainable Design Assessment Tools Sustainable Design Standards and Certifications (e.g., LEED, BREEAM), Environmental Product Declarations (EPDs), Carbon Footprint Analysis, Social Life Cycle Assessment
Module 5	apply principles of sustainability in engineering design

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Sustainable Design: A Critical Guide	David Bergman	Bloomsbury	-
2	Cradle to Cradle: Remaking the Way We Make Things	William McDonough, Michael Braungart	North Point Press	2002

3	The Upcycle: Beyond Sustainability—Designing for Abundance	William McDonough, Michael Braungart	North Point Press	2013
4	Sustainability in Engineering Design	Ramachandran S.	CRC Press	2019
5	Design for Sustainable Change	Stephen Lehmann, Roberta Tassi	Bloomsbury	2019
6	Engineering Design	G. E. Dieter	McGraw-Hill	-

Global Certifications:

Mapped Global Certifications:						
Sl. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Sustainability Excellence Associate*	International Society of Sustainability Professionals	Y	75 objective questions	International Society of Sustainability Professionals - online	https://sustainability-excellence.gbci.org/sea

- Global certification is only optional for this course

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Any modelling tool like- Solidworks, Fusion 360	Dassault Systemes, Autodesk	Commercial
2	Any stress Analysis tool – Ansys, Hyperworks, Nastran	Ansys, Altair, MSC-Hexagon	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xvi. CONCURRENT MANUFACTURING> <(CM)>

COURSE CODE	23MD52B2	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and concepts of concurrent manufacturing	2	PO2,PSO1
CO2	Apply concurrent engineering techniques in product development	3	PO1,PSO1

CO3	Examine Collaborate effectively in cross-functional teams and observe the benefits and challenges of concurrent manufacturing	3	PO1,PSO1
CO4	Analyze and optimize manufacturing processes for efficiency	4	PO1,PSO1
CO5	Demonstrate proficiency in using concurrent engineering tools	4	PO4,PSO1

Syllabus

Module 1	Introduction to concurrent manufacturing: principles and concepts - Overview of concurrent engineering and its importance in product development - Role of concurrent manufacturing in reducing time-to-market and enhancing product quality - Integration of design, manufacturing, and other functions for concurrent manufacturing
Module 2	- Concurrent engineering techniques in product development - Simultaneous engineering and its application in concurrent manufacturing - Design for manufacturability and design for assembly principles - Use of computer-aided design (CAD) and computer-aided engineering (CAE) tools for concurrent design
Module 3	- Collaboration in cross-functional teams for concurrent manufacturing - Team dynamics and communication strategies for effective collaboration - Cross-functional team roles and responsibilities in concurrent manufacturing - Conflict resolution techniques and decision-making in cross-functional teams
Module 4	- Analysis of manufacturing processes for efficiency - Value stream mapping and process flow analysis - Identification of bottlenecks and waste in manufacturing processes - Lean manufacturing principles and their application in concurrent manufacturing
Module 5	- Concurrent engineering tools and software - Overview of concurrent engineering software tools and their functionalities - CAD/CAM integration and data exchange for concurrent manufacturing - Simulation tools for process optimization and validation - Hands-on practice with concurrent engineering software tools

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Concurrent Engineering: Contemporary Issues and Modern Design	Fathi, Madjid	CRC Press	2nd Edition, 2021
2	Concurrent Engineering: Automation, Tools, and Techniques	William D. Herrold	Wiley-IEEE Press	1st Edition, 2018
3	Design for Manufacturability and Concurrent Engineering	David M. Anderson	CRC Press	1st Edition, 2014

4	Collaboration Engineering: Designing Concurrent Systems	B. Sena, R. De Guio, et al.	Springer	1st Edition, 2013
5	Lean Manufacturing: Tools, Techniques, and How to Use Them	William M. Feld	CRC Press	2nd Edition, 2017

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Concurrent Manufacturing Professional (CCMP)	International Society of Manufacturing Engineers (ISME)	Yes	Online Proctored	ISME	https://www.isme.org/certification/ccmp-certification
2	Certified Lean Manufacturing Practitioner (CLMP)	Lean Manufacturing Institute (LMI)	Yes	Online Proctored	LMI	https://www.lean.org/Workshops/WorkshopDescription.cfm?WorkshopId=90

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	HOME ASSIGNMENT AND TEXT BOOK	7	
	LAB WEEKLY EXERCISE	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	40	40

xvii. Advanced Finite Element Analysis (AFEA)

COURSE CODE	23MD52C1	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply finite element method to solve two dimensional structural problems	PO3	3
CO2	Apply finite element method to solve problems in Bending of plates and shells and Conforming and Non-Conforming elements.	PO3, PO4	3
CO3	Formulate and solve the Non Linear problems in - Elasto Plasticity and Large displacement formulation.	PO3, PO5	4

CO4	Formulate the Dynamic Problems problems in free, transient and forced vibration.	PO1	4
CO5	Gain hands on experience in converting a given structure into desired shape and size by applying suitable ANSYS APDL software.	PO6	4

Syllabus

Module 1	**Two Dimensional Problems:** Basic concepts of plane stress and plane strain, stiffness matrix of CST element, finite element solution of plane stress problems.
Module 2	**BENDING OF PLATES AND SHELLS**: Review of Elasticity equation – Bending of plates and shells – Finite Element formulation of plates and shell elements – Conforming and Non-Conforming elements- C_0 and C_1 Continuity elements– application and examples.
Module 3	**NON-LINEAR PROBLEM:** Introduction- Iterative Techniques – Material Non- Linearity – Elasto Plasticity – Plasticity –Viscos Plasticity – Geometric Non linearity –Large displacement formulation– application in metal forming process and contact problems.
Module 4	**DYNAMIC PROBLEMS**: Direct formulation-free, transient and forced response– Solution procedures- Subspace iterative Techniques– Houbot, Wilson, Newmark– Methods – Examples.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Finite Element Method	Zienkiewicz,O.C. and Taylor,R.L.	Mc Graw Hill International Edition	1991
2	Concept and Applications of Finite Element Analysis	Cook R.D	John Wiely and Sons Inc	1989
3	Finite Element Procedure in Engineering Analysis	BatheK.J.,	PrenticeHall	1990

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structural analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	ANSYS	ANSYS Inc.	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xviii. Fracture Mechanics><(FM)>

COURSE CODE	23MD52C2	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Crack growth and fracture mechanics	4	P02
CO2	Development of stress field equations in fracture mechanics	4	P01
CO3	Know the various methods for evaluating stress intensity factors	4	P01
CO4	Understand how to perform fracture toughness testing and crack growth phenomenon	4	P02
CO5	Evaluate the behaviour of fracture in mechanical structure/components	4	PO2

Syllabus

Module 1	**ELEMENTS OF SOLID MECHANICS**: The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation –limit analysis. **STATIONARY CRACK UNDER STATIC LOADING**: Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdale model – J integral and its relation to crack opening displacement.
Module 2	**ENERGY BALANCE AND CRACK GROWTH**: Griffith analysis–Linear Fracture Mechanics-Crack Opening displacement–Dynamic energy balance–crack arrest.
Module 3	**FATIGUE CRACK GROWTH CURVE**: Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude– effects of changing the load spectrum– Effects of Environment.
Module 4	**ELEMENTS OF APPLIED FRACTURE MECHANICS**: Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.
Module 5	**EVALUATION OF BEHAVIOUR OF FRACTURE**: Crack initiation, Crack growth, Fatigue lifecycle measurement.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Elementary Engineering Fracture Mechanics	David Broek	Fifthoff and Noerdhoff International Publisher	1978
2	Introduction of Fracture Mechanics	Kare Hellan	McGraw-Hill Book Company	1985
3	Elements of Fracture Mechanics	Preshant Kumar	Wheeler Publishing	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Fatigue & Fracture Mechanics Professional	NAFEMS	Y	MCQS	NAFEMS-Professional Simulation Engineer	https://www.nafems.org/professional-development/certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NOT APPLICABLE		
2	NOT APPLICABLE		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xix. Tribological System Design> <(TSD)>

COURSE CODE	23MD52C3	MODE		LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the surface wear and its treatment.	2	PO2
CO2	Analyze the lubricant flow and delivery in different bearings.	3	PO2
CO3	Analyze the mechanism of rolling bearings and its failure criterion.	3	PO2
CO4	Understand the tools to measure the bearing performance.	3	PO2

Syllabus

Module 1	Topography of Surfaces – Surface features – Surface interaction – Theory of Friction – Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials – friction in extreme conditions – wear, types of wear – mechanism of wear – wear resistance materials– surface treatment – Surface modifications– surface coatings.
Module 2	Lubricants and their physical properties, lubricants standards–Lubrication Regimes Hydrodynamic lubrication – Reynolds Equation, Thermal, inertia and turbulent effects –Elasto hydrodynamic and plasto hydrodynamic and magneto hydrodynamic lubrication–Hydrostatic lubrication– Gas lubrication.
Module 3	Design and performance analysis of thrust and journal bearings – Full, partial, fixed and pivoted journal bearings design – lubricant flow and delivery–power loss, Heat and temperature, rotating loads and dynamic loads in journal bearings– special bearings– Hydrostatic Bearing design. **ROLLING ELEMENT BEARINGS**: Geometry and kinematics– Materials and manufacturing processes– contact stresses– Hertzian stress equation– Load divisions– Stresses and deflection–Axial loads and rotational effects, Bearing life capacity and variable loads –ISO standards– Oil films and their effects – Rolling Bearings Failures.
Module 4	**TRIBOMEASUREMENT INSTRUMENTATION**: Surface Topography measurements– Electron-microscope and friction and wear measurements– Laser method– instrumentation-International standards– bearings performance measurements– bearing vibration measurement.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Tribology: Friction and Wear of Engineering Materials	Ian M. Hutchings	Butterworth-Heinemann	2017
2	Fundamentals of Tribology	Basim Al-Najjar	CRC Press	2019
3	Introduction to Tribology	J. Halling	Wykeham Publications	2016
4	Introduction to Tribology	B.C. Majumdar	New Age	2006
5	Tribology: Principles and Design Applications	P. Sahoo	PHI	2012

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Lubrication Specialist	STLE	Y	MCQs	STLE	https://www.stle.org/files/Certifications/About_Certification.aspx
2	Certified Lubrication Specialist					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		
2	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignments and text book	10	
In-Sem Summative	In sem-1	20	20
	In Sem-2	20	
End-Sem Summative	End Sem Exam	40	40

xx. Design of pressure Vessels and Plates> <(DPVP)>

COURSE CODE	23MD52D1	MODE		LTPS	3-0-0-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping

CO1	Apply the methods to determine stresses in cylindrical shells	4	PO1,PO2,PSO1
CO2	Analyze the stresses in pressure vessel with various closure heads	4	PO1,PO2,PSO1
CO3	Formulate basic equations for bending of rectangular plate	4	PO1,PO2,PSO1
CO4	Analyze bending stresses in circular plate	4	PO1,PO2,PSO1

Syllabus

Module 1	Methods for determining stresses, Factors affecting the design of vessels, Design approach, Terminology and ligament efficiency.Problems on strins,stresses and Ligament efficiency.
Module 2	General theory of Membrane stresses in vessels under internal pressure, Torus under Internal pressure, Thick cylinder ,Thermal stresses and their significance, Graphical determination of thermal stress in a cylindrical vessel for any thermal gradient. Bending of a pate in one and two perpendicular directions.
Module 3	Introduction-assumptions-slopes and curvatures of bent plate-strain curvature relations- moment curvature relations-equilibrium equations-rectangular plate, - rectangular plate, circular plate-summery of basic equations-basic equations in Cartesian coordinate system Method of superposition for the analysis of rectangular plates with arbitrary boundary conditions.
Module 4	Basic equations in polar co-ordinate system. Pure bending and cylindrical bending of rectangular plates Navier solution for an all-round simply supported rectangular plate-levy solution for rectangular plates-. Circular plates subjected to an arbitrary load- Symmetric bending of circular plates, circular plate subjected to asymmetric load. circular plate-boundary conditions

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Theory and Design of Pressure Vessels	John F. Harvey	CBS Publishers and Distributors	1987
2	Theory of plates	K Chandrashekara	University Press	2001
3	Approximate Methods in the Design and Analysis of Pressure Vessels and Piping	Stanley, M. Wales,	Pre ASME Pressure Vessels and Piping Conference	1997
4	Theory of elasticity	Timoshenko S.P. and Goodier J.N	McGraw-Hill Publishers	1987
5	Theory Of Plates And Shells	Timoshenko S	McGraw-Hill Publishers	1988

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	"ASME Section VIII Division 2 Design Engineer"	American Society of Mechanical Engineers (ASME)	Proctored	Multiple Choice Questions	ASME	ASME Section VIII Division 2 Design Engineer
2	"API 510 Pressure Vessel Inspector Certification"	American Petroleum Institute (API)	Proctored	Multiple Choice Questions	API	API 510 Pressure Vessel Inspector Certification

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOK	10	
In-Sem Summative	IN SEM EXAMINATION-I	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

xxi. ENGINEERING FAILURE ANALYSIS AND PREVENTION (EFAP)

COURSE CODE	23MD52D2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs
CO1	**Understand the principles and importance of engineering failure analysis**	Understand	PO1, PO2, PO6
CO2	**Identify different failure modes and their associated mechanisms**	Apply	PO1, PO2
CO3	**Apply material selection techniques for failure prevention**	Apply	PO1, PO2, PO3
CO4	**Analyze failure cases, conduct risk assessment, and propose mitigation strategies**	Analyse	PO1, PO2, PO5

Syllabus

Module 1	Introduction to Failure Analysis and Failure Modes • Introduction to Engineering Failure Analysis • Case studies of prominent engineering failures • Mechanical failure modes: fracture, fatigue, wear, corrosion, etc.

	• Failure mechanisms: brittle fracture, ductile fracture, creep, etc. • Factors influencing failure modes and mechanisms
Module 2	Material Selection and Design Considerations • Material properties and their impact on failure • Selection criteria for materials in different applications • Material testing and characterization techniques • Design principles for robustness and reliability • Stress analysis and failure prediction • Safety factors and design codes • Failure prevention in critical components
Module 3	Non-Destructive Testing, Inspection, and Maintenance • Introduction to non-destructive testing (NDT) methods • Visual inspection, ultrasonic testing, radiography, etc. • NDT applications in failure analysis and preventive maintenance • Preventive maintenance and condition monitoring • Failure data analysis and reliability-centered maintenance • Maintenance planning and scheduling
Module 4	Case Studies, Risk Assessment, and Mitigation • Analysis of real-world failure cases • Root cause investigation and failure reconstruction • Lessons learned and recommendations for prevention • Risk assessment techniques: FMEA, FMECA, fault tree analysis • Risk management strategies and decision-making • Failure mitigation measures and their implementation

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Failure Analysis of Engineering Structures: Methodology and Case Histories	V. Ramachandran and T. R. Chandrupatla	CRC Press	
2	Introduction to the Design and Behavior of Bolted Joints	John H. Bickford	CRC Press	
3	Engineering Fracture Mechanics	David Broek	CRC Press	
4	Mechanical Behavior of Materials	Marc André Meyers and Krishan Kumar Chawla	Cambridge University Press	
5	Practical Engineering Failure Analysis	David H. H. Sheppard	CRC Press	
6	Root Cause Failure Analysis	R. Keith Mobley	Butterworth-Heinemann	

Global Certifications:

Mapped Global Certifications:						
Sl. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Not applicable					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	No Practical's for this course		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	22
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	38
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

xxii. MODELING AND SIMULATION OF MECHATRONIC SYSTEMS (MSMS)

COURSE CODE	23MD52D3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL	

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Build mathematical models of mechatronic systems such as mechanical, electrical, fluid, thermal.	3	PO1, PO2
CO2	Build mathematical models of electro-mechanical systems and representation of systems using transfer function.	3	PO1, PO2
CO3	Representation of systems using state space approach and system identification techniques to synthesize system models	3	PO1, PO4
CO4	Evaluate time response and frequency of systems.	4	PO1, PO4

Syllabus

Module 1	Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams
Module 2	mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.
Module 3	Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis

Module 4	design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL)
Module 5	Rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Modeling of Dynamical Systems	L. Ljung, T. Glad	Prentice Hall Inc	2001
2	System Dynamics: A Unified Approach	D.C. Karnopp, D.L. Margolis and R.C. Rosenberg	Wiley-Interscience	1995
3	System Simulation	G. Gordon	PHI Learning	
4	Micromechatronics, Modeling, Analysis, and Design with MATLAB	V. Giurgiutiu and S. E. Lyshevski	CRC Press	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified LabVIEW Associate Developer (CLAD)	National Instruments	Yes	Online	National Instruments	CLAD Certification
2	Certified SolidWorks Associate (CSWA)	Dassault Systèmes	Yes	Online	Dassault Systèmes	CSWA Certification

Tools used in Practical / Skill :NA

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	CNC Train Simulation Software	MTAB	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

xxiii. DESIGN OF HYBRID VEHICLES(DHV)

COURSE CODE	23MD53E1	MODE		LTPS	3 0 0 0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply theoretical knowledge and engineering principles to design and analyze hybrid vehicles.	4	PO1, PO2, PO3
CO2	Demonstrate proficiency in using industry-standard software for hybrid vehicle design and simulation.	5	PO2, PO4, PO5
CO3	Develop critical thinking and problem-solving skills related to hybrid vehicle design.	6	PO3, PO4, PO5
CO4	Apply engineering ethics and sustainability principles in the design of hybrid vehicles.	3	PO6, PO7, PO9

Syllabus

Module 1	Introduction to Hybrid Vehicles: Hybridization principles, hybrid vehicle architectures, energy management strategies, and the role of hybridization in sustainable transportation.
Module 2	Hybrid Powertrain Technologies: Study of internal combustion engines, electric motors, batteries, power electronics, and control systems used in hybrid vehicle propulsion systems.
Module 3	Hybrid Vehicle Design: Design considerations for hybrid vehicle components, including powertrain, regenerative braking systems, energy storage, and system integration.
Module 4	Hybrid Vehicle Control Systems: Control strategies for hybrid vehicles, optimization techniques, energy management algorithms, and vehicle performance analysis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives"	Chris Mi, M. Abul Masrur	Wiley	2018
2	"Design of Alternative Energy Systems: Second Edition"	Mohammad Rasul	McGraw-Hill Education	2016
3	"Fundamentals of Electric Vehicle Drives"	Saeed Book Bank	CRC Press	2017
4	"Hybrid and Electric Vehicles: Principles and Applications"	Chris Mi	CRC Press	2013
5	"Advanced Electric Drive Vehicles"	Ali Emadi	CRC Press	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	Certified Hybrid Vehicle Design Engineer (CHVDE)	Society of Automotive Engineers (SAE)	Yes	Online Exam	SAE	https://www.sae.org/standards/content/j2882/
2	Electric Vehicle Certified Technician (EVT)	Automotive Service Excellence (ASE)	Yes	Computer-Based Test (CBT)	ASE	https://www.ase.com/Tests/ASE-Certification-Tests

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB/Simulink	Software	Commercial
2	Finite Element Analysis	Engineering	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	10	20
	Home Assignment and Book. (Min. 4 Assignments etc.)	10	
In-Sem Summative	In-Sem Exam-I	20	40
	In-Sem Exam-II	20	
End-Sem Summative	End Semester Exam	40	40

xxiv. Enterprise Resources Planning for Mechanical Engineers> <(ERP)>

COURSE CODE	23MD52O5	MODE	R	LTPS	3-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the concept of Enterprise Resource Planning (ERP) and its significance in modern organizations	2	PO3
CO2	Understand the different modules of ERP systems, including Finance, Plant Maintenance, Quality Management, and Materials Management	2	PO3
CO3	Understand ERP Implementation Lifecycle and ERP Case studies	2	PO3
CO4	Understand E-Business Architecture and the role of ERP in e-governance.	2	PO3

Syllabus

Module 1	Introduction to ERP: Enterprise – An Overview, Integrated Management Information, Business Modeling, Integrated Data Model ERP and Related Technologies Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM),Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System.
Module 2	ERP Manufacturing Prospective: MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management ERP Modules Finance, Plant Maintenance, Quality Management, Materials Management Benefits of ERP Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality Costs, Improved Information Accuracy and Design-making Capability
Module 3	ERP Implementation Lifecycle Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode) ERP Case studies E-Commerce to E-business E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications
Module 4	E-Business Architecture Enterprise resource planning the E-business Backbone Enterprise architecture planning, ERP usage in Real world, ERP implementation, Future of ERP applications ,memo to CEOE Procurement, E-Governance, Developing the E-Business Design Introduction to ERP tools JDEdwards-Enterprise One, Microsoft Dynamic CRm-Module

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Introduction to Enterprise Resource Planning Systems	Bret Wagner, Ellen Monk	Cengage Learning	2022
2	ERP: Making It Happen - The Implementers' Guide to Success with Enterprise Resource Planning	Thomas F. Wallace, Michael H. Kremzar	Wiley	2023
3	Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology	Steven H. Spewak	Wiley	2022
4	Enterprise Resource Planning: Concepts and Practice	V. K. Garg, N. K. Venkitakrishnan	PHI Learning Pvt. Ltd.	2023
5	Enterprise Resource Planning: Concepts and Practice	Vinod Kumar Garg, N.K. Venkitakrishnan	PHI Learning Pvt. Ltd.	2021

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem Exam-I	20	40
	In-Sem Exam-II	20	
End-Sem Summative	End Semester Exam	40	40

xxv. INTERNET OF THINGS IN INDUSTRIES (IOTI)

COURSE CODE	23MD52E2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand architecture of IIoT and IIOT Components	2	PO1, PO2
CO2	Understand communication Technologies of IIoT	2	PO1, PO2
CO3	Apply Visualization concepts of IIoT to design a IIoT system	3	PO1, PO2
CO4	Apply IIoT technology to design a robotic system	3	PO1, PO2

Syllabus

Module 1	Introduction to IIoT, the difference between IoT and IIoT, Architecture of IIoT, IOT node, Challenges of IIOT. Fundamentals of Control System, introductions, components, closed loop & open loop system. Introduction to Sensors, Types of sensors, working principle of basic Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors.
Module 2	Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID. Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus technology, wireless network communication.
Module 3	Front-end EDGE devices, Enterprise data for IIoT, Emerging descriptive data standards for IIoT, Cloud data base, could computing, Fog or Edge computing. Extraction from Web: Grabbing the content from a web page, Sending data on the web, Types of IoT interaction, Machine to Machine interaction (M2M).

Module 4	Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA). HMI in an automation process, ERP & MES. Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Internet of Things in the Industrial Sector	Zaigham Mahmood	Springer	2019
2	Industrial Internet of Things: Cybermanufacturing System	Sabina Jeschke	Springer	2016
3	Industrial IoT: Challenges, Design Principles, Applications, and Security	Ismail Butun	Springer	2020
4	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS AND INDUSTRY 4.0	Sudip Misra	CRC Press	2020
5	Industrial Internet of Things (IIoT)	R. Anandan	Wiley-Scrivener	2022

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA	NA	NA
2	NA	NA	NA

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignment and Textbook	10	
In-Sem Summative	Semester in Exam-I	20	40
	Semester in Exam-II	20	
End-Sem Summative	End Semester Exam	40	40