Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B++' Grade (CGPA 2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Structure and Syllabus: M. Tech. Mechanical-Design Engineering

Name of the Course: First Year M. Tech.

(Syllabus to be implemented w.e.f. 2026-27)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

FACULTY OF SCIENCE & TECHNOLOGY
Curriculum for M. Tech. (Mechanical-Design Engineering)
Choice Based Credit System Syllabus w. e. f. 2026-27
Course Type–wise Consolidated Table with Total Credits

Course Type	Course Code	Name of the Course	Credits
PCC	MDE111	Advanced Stress Analysis	3
PCC	MDE112	Advanced Vibrations and Acoustics	3
PCC	MDE113	Industrial Instrumentation	3
PCC	MDE112L	Advanced Vibrations and Acoustics Lab	1
PCC	MDE113L	Industrial Instrumentation Lab	1
PCC	MDE121	Finite Element Method	3
PCC	MDE122	Advanced Design Engineering	3
PCC	MDE123	Industrial Product Design	3
PCC	MDE121L	Finite Element Method Lab	1
PCC	MDE123L	Industrial Product Design Lab	1
PEC	MDE114	Elective I	4
PEC	MDE124	Elective II	4
PEC	MDE125	Elective III	4
RM	MDE115	Research Methodology & IPR	4
VSEC	MDE116	Mini Project I	1
VSEC	MDE126	Mini Project II	1
Total Credits			40

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

FACULTY OF SCIENCE & TECHNOLOGY

Curriculum for M. Tech. (Mechanical-Design Engineering)

Four Semester Course

Choice Based Credit System (CBCS) - (w. e. f. 2026-27)

Semester I: Theory /Tutorial/ Lab Courses

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*SA*	*FA*		*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	
PCC	MDE111	Advanced Stress Analysis	3	-	-	3	70	30	-	100
PCC	MDE112	Advanced Vibrations and Acoustics	3	-	-	3	70	30	-	100
PCC	MDE113	Industrial Instrumentation	3	-	-	3	70	30	-	100
PEC	MDE114	**Elective- I** 1. Computational Techniques in Design Engineering 2. Reliability Engineering 3. Mechanical System Design 4. Computer Aided Design	3	1	-	4	70	30	-	100
RM	MDE115	Research Methodology and IPR	3	1	-	4	70	30	-	100
PCC	MDE112L	Advanced Vibrations and Acoustics Lab	-	-	2	1	-	-	50	50
PCC	MDE113L	Industrial Instrumentation Lab	-	-	2	1	-	-	50	50
VSEC	MDE116	Mini Project–I	-	-	2	1			50	50
		Total	**15**	**2**	**6**	**20**	**350**	**150**	**150**	**650**

PCC	Program core course	**L**	Lecture	**FA**	Formative Assessment
PEC	Program Elective Course	**T**	Tutorial	**SA**	Summative Assessment
VSEC	Vocational and Skill Enhancement Course	**P**	Lab Session	**ESE**	End Semester Examination
				ISE	In Semester Evaluation
RM	Research Methodology			**ICA**	Internal Continuous Evaluation

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

FACULTY OF SCIENCE & TECHNOLOGY

Curriculum for M. Tech. (Mechanical-Design Engineering)

Four Semester Course

Choice Based Credit System (CBCS) - (w. e. f. 2026-27)

Semester II: Theory /Tutorial/ Lab Courses

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*SA*	*FA*		*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	
PCC	MDE121	Finite Element Method	3	-	-	3	70	30	-	100
PCC	MDE122	Advanced Design Engineering	3	-	-	3	70	30	-	100
PCC	MDE123	Industrial Product Design	3	-	-	3	70	30	-	100
PEC	MDE124	**Elective- II** 1. Theory and Analysis of Composite Materials 2. Engineering Design Optimization 3. Industrial Tribology 4. Advanced Engineering Materials	3	1	-	4	70	30	-	100
PEC	MDE125	**Elective- III** 1. Engineering Fracture Mechanics 2. Project Management 3. Design for Manufacture and Assembly 4. Analysis and Synthesis of Mechanisms and Machines	3	1	-	4	70	30	-	100
PCC	MDE121L	Finite Element Method Lab	-	-	2	1	-	-	50	50
PCC	MDE123L	Industrial Product Design Lab	-	-	2	1	-	-	50	50
VSEC	MDE126	Mini Project-II	-	-	2	1	-	-	50	50
		Total	**15**	**2**	**6**	**20**	**350**	**150**	**150**	**650**

PCC	Program core course	**L**	Lecture	**FA**	Formative Assessment
PEC	Program Elective Course	**T**	Tutorial	**SA**	Summative Assessment
VSEC	Vocational and Skill Enhancement Course	**P**	Lab Session	**ESE**	End Semester Examination
				ISE	In Semester Evaluation
				ICA	Internal Continuous Evaluation

SEMESTER-I

Punyashlok Ahilyadevi Holkar Solapur University

M.Tech.-Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE111: Advanced Stress Analysis

Teaching Scheme
Lectures: 03 Hours/week, 03 Credits

Examination Scheme
ESE:70 Marks
ISE: 30 Marks

Course Introduction:

Advanced Stress Analysis, an intellectual subject at the post-graduate level that aims to equip students with the comprehensive understanding of principles of elasticity along with its applications. Elastic constants and Hooke's law examines the behavior of linear elastic materials under various loading conditions. Two-dimensional problems in rectangular and polar coordinates are focused on stress and strain analysis in various elements, such as beams and cylindrical/spherical components. The concept of shear center is present in the syllabus, elucidating its role in structural stability, especially in open sections. Additionally, the course encompasses contact stresses, and their practical engineering implications.

Course Objectives: During this course, student is expected to:

1. Understand the fundamentals of elasticity and the stress-strain relationship.
2. Apply the fundamental knowledge of elasticity to analyze problems in rectangular coordinates.
3. Apply the fundamental knowledge of elasticity to analyze problems in polar coordinates.
4. Evaluate structures with open sections and locating the shear center
5. Analyze the torsion of shafts with elliptical cross-sections.
6. Analyze the contact stresses in elements with point and line contacts.

Course Outcomes:

At the end of this course, student will be able to:

1. Analyze and solve various engineering problems involving plane stress and plane strain.
2. Solve engineering problems related to structures such as beams and frames, using a rectangular coordinate system.
3. Solve engineering problems related to the cylindrical, conical and spherical structures using a polar coordinate system.
4. Determine the position of the shear center essential for predicting the distribution of shear stresses in different cross sections.
5. Analyze the torsional behavior of bars of various shapes of cross sections under different loading conditions along with angles of twist.
6. Assess the contact stresses and its distribution at contact interface.

Section I

Unit-1: Theory of Elasticity **No. of lectures- 6**

Plain stress and plane stress, relationship between elastic constants, differential equations of equilibrium, boundary conditions, compatibility equations, Airy stress function, Bi harmonic equations

Unit-2: Two Dimensional Problems in Rectangular Coordinates **No. of lectures- 6**

Solution by polynomials. Saint Venant's principle, Determination of displacements, bending of a cantilever beam with load at the end and uniform load

Unit-3: Two Dimensional Problems in Polar Coordinate System **No. of lectures- 8**

Introduction, equilibrium equations in polar coordinates, compatibility equation, pure bending of curved bar, stresses in rotating discs, strain components in polar coordinates.

Section II

Unit-4: Shear Centre **No. of lectures- 6**

Concept of shear center in symmetrical and unsymmetrical bending. Shear centre for thin wall beam section, open section with one axis of symmetry, general open and closed section.

Unit-5: Theory of Torsion **No. of lectures- 8**

Torsion of prismatic bars of solid section and thin-walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of noncircular shaft. Torsion of the elliptical shaft.

Unit-6: Contact Stresses **No. of lectures- 6**

Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, stresses for two bodies in line contact with load normal to the contact area.

Text Books:

1. Ansel C. Ugural, Saul K. Fenster, Advanced Mechanics of Materials and Applied Elasticity, Pearson / Prentice Hall
2. Richard G. Budynas, Advanced Strength and Applied Stress Analysis, McGraw-Hill
3. S.M.A Kazimi, Solid Mechanics, McGraw Hill

Reference Books:

1. Timoshenko and Goodier, Theory of Elasticity-, McGraw Hill
2. J. P. Den Hartog, Advanced Strength of Materials
3. Srinath L.S., Advanced Mechanics of Solids, McGraw Hill
4.. A. P. Boresi, Advanced Mechanics of Materials, Wiley

Punyashlok Ahilyadevi Holkar Solapur University

M.Tech.-Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE112: Advanced Vibrations and Acoustics

Teaching Scheme	Examination Scheme
Lectures: 03 Hours/week, 03 Credits	**ESE:70 Marks**
Practical: 02 Hours/week, 01 Credit	**ISE: 30 Marks**
	ICA: 50 Marks

Course Introduction:

Vibration is a common phenomenon existing in a mechanical system. Mechanical structures and systems are susceptible to vibrations, i.e. periodic changes in the physical state. Vibrations can both be a hindrance and a benefit to machines. In this course, we will learn advanced concepts in vibrations and how to interpret the measured vibrations using analytical and experimental means. The topic covered in the syllabus are damped and undamped free and forced vibration of single-DOF, Two-DOF and multi-degree-of-freedom vibratory systems using energy conservation principles, vibrations of continuous systems, random vibrations and experimental methods used in practice. Vibratory motions of solid surfaces generate acoustic waves in the surrounding air. At the end of this course, we will also learn fundamentals of transmission of these acoustic waves.

Course Objectives:

During this course, student is expected to:

1. Study basic concepts of vibration.
2. Develop analytical competency in solving vibration problems.
3. Understand the vibrations in continuous systems.
4. Study various instruments and techniques used for vibration measurement.
5. Understand the random vibrations and related concepts.
6. Develop competency in understanding plane wave transmission of sound waves.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain concepts of vibration in mechanical systems.
2. Determine analytical formulation for free and forced vibrations for single, two and multi degree freedom systems.
3. Estimate natural frequencies for standard continuous systems.
4. Describe the vibration measurement instruments and techniques for industrial / real life applications.
5. Explain the concepts used to analyze random vibrations.
6. Explain and analytically express the transmission phenomenon of sound waves.

Section I

Unit-1: Fundamentals of vibration **No. of lectures- 4**

Review of Single degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and aperiodic excitations, Impulse response, Transient vibration, Laplace transformation formulation, Fourier transforms- definition, Relation to transfer functions, first order systems, applications.

Unit-2: Two and multi degree freedom systems **No. of lectures- 10**

Introduction, Free vibration analysis of an undamped system, Coordinate coupling and principal coordinates, Forced vibration of undamped and damped system with two degrees of freedom, Dynamic Vibration Absorber, Equation of motion for multi degree freedom system, Lagrange's equation to derive equation of motion, Free vibration of undamped system: Natural Frequency and mode shape, Free vibration of damped system: Rayleigh damping and Viscous damping, Forced vibration of multi degree freedom system, modal analysis of damped and undamped system, methods to determine natural frequencies of multi DOF system, Rayleigh's Method, Holzer method and matrix iteration method

Unit-3: Vibration of continuous systems **No. of lectures- 6**

Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous system

Section II

Unit-4: Experimental methods in vibration engineering **No. of lectures- 7**

Vibration instruments - Vibration exciters, Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, experimental modal analysis methods, Examples of vibration tests - Industrial case studies

Unit-5: Random vibrations **No. of lectures- 6**

Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response

Unit-6: Fundamentals of Acoustics **No. of lectures- 7**

Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields, simple models of sound sources, sound power, determination of sound power and intensity levels at a point due to a simple source

Internal Continuous Assessment (ICA):

Assignments (Any six Assignments):

1. Application of sensors and related instrumentation for time and frequency domain
2. Measurement of dynamic test data of machine elements
3. Solving vibration problems using suitable software
4. Dynamic analysis using suitable software
5. Numerical methods for determination of natural frequencies
6. Modal testing and analysis for natural frequencies and mode shape for structures
7. Vibration measurement and spectral analysis
8. Noise measurement and spectral analysis

Text Books:

1. J. S. Rao, K. Gupta, Theory and Practice of Mechanical Vibration, New Age International (P) Ltd.
2. W. T. Thomson, Theory of Vibration with Applications, CBS Publishers and Distributors.
3. S. S. Rao, Mechanical Vibrations, Addison Wesley Longman.
4. Lawrence E. Kinsler, Austin R. Frey, Fundamentals of Acoustics, Wiley Eastern Ltd.

Reference Books:

1. J. P. Den Hartog, Mechanical Vibrations, Dover Publications.
2. S. Graham Kelly, Mechanical Vibrations, Schaum's Outlines, Tata McGraw-Hill.
3. Leonard Meirovitch**,** Elements of Vibration Analysis, McGraw-Hill.
4. Clarence W. de Silva, Vibration: Fundamentals and Practice, CRC Press.
5. Michael Rettinger**,** Acoustic Design and Noise Control, Chemical Publishing Co.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE113: Industrial Instrumentation

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Practical: 02 Hours/week, 01 Credit	**ISE : 30 Marks**
	ICA : 50 Marks

Course Introduction: Industrial instrumentation is a critical field that plays a vital role in various industries by ensuring efficient and reliable processes, quality control, and safety. It involves the application of measurement and control devices to monitor, regulate, and automate industrial processes. These instruments are designed to measure various physical parameters, such as temperature, pressure, flow rate, level, humidity, and more.

Course Objectives:

During this course, student is expected to:

1. Know about the basics of instrumentation and static and dynamic characteristics of instruments
2. Study the measurement techniques of acceleration, Vibration and density
3. Understand the various temperature, vibration and sound measurement techniques
4. Study the principles and concepts of condition monitoring and signature analysis

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the basic principles and functional elements of instruments, including their representation and typical applications in various industries.
2. Differentiate between static and dynamic characteristics of instruments and analyze their static performance parameters to make appropriate instrument selections.
3. Identify various transducer elements used for measurements, such as displacement, force, torque, power, pressure, vacuum, and flow.
4. Evaluate temperature measurement techniques using thermocouples, RTD (Resistance Temperature Detector), thermistors, radiation, and optical pyrometers.
5. Examine the measurement of vibration and sound using instruments like vibrometers, accelerometers, seismic instruments, sound level meters, and conduct noise analysis using analog filters and frequency analyzers
6. Demonstrate knowledge of the fundamental principles of condition monitoring and signature analysis.

Section I

Unit-1: Introduction to Instrumentation **No. of lectures- 04**

Introduction to Instruments and the representation, Typical Applications, Functional Elements, Classification of instruments, Microprocessor Based instrumentation, Standards & Calibration

Unit-2: Static and Dynamic characteristics of instruments **No. of lectures- 06**

Static and Dynamic characteristics of instruments, Static performance parameters, Selection of instrument, Dynamic performance, characteristics Like time lag, dead zone, fidelity etc., types of inputs, zero order, first order & second order Instruments, dynamic response for step input & periodic harmonic input only

Unit-3: Measurements by using Transducer element **No. of lectures- 10**

Transducer elements, Intermediate elements, Indicating and recording elements, Displacement measurement, Force measurement, Torque and power measurement, Pressure and vacuum measurement, flow measurement

Section II

Unit-4: Measurement of temperature **No. of lectures- 05**

Temperature measurement: Thermocouples, R.T.D., Thermistors, Radiation & Optical, Pyrometer

Unit-5: Measurement of vibration & Sound **No. of lectures- 05**

Measurement of vibration& Sound, vibrometer, accelerometers, Seismic instrument, Sound Level Meter, Noise analysis Signal and systems Analysis: Analog Filters & Frequency Analyzers, Frequency analysis, Harmonic & Transient Testing, Random Force Testing

Unit-6: Condition monitoring and Signature Analysis Applications **No. of lectures- 10**

Condition monitoring and Signature Analysis Applications: Vibration & Noise monitoring Permanent Monitoring System, Wear Behavior Monitoring, Corrosion Monitoring, Data acquisition Systems, Data Display & Storage

Internal Continuous Assessment (ICA):

A) Assignments-

1. Assignment on static and dynamic characteristics of instrument
2. Signal & system analysis.
3. Assignment on Microprocessor & computer application in measurements.

B) Experiments (Any Three Experiments)

1. Measurements of mechanical parameters: a) Displacement b) Force c) Torque d) Speed
2. Measurement of hydraulic parameters: a) Pressure b) Flow
3. Measurement of thermal parameters: Temperature: Industrial thermo couples, Resistance thermometer, Pyrometer.
4. Measurement of vibration parameter: a) Displacement, Velocity and Acceleration-Accelerometer b) Frequency –Vibration Analyzer
5. Measurement of Sound parameters (Microphone): a) Sound intensity level b) Sound Power level c) Sound Pressure level
6. Condition monitoring & signature analysis applications.

Text Books :

1. Alok Barua, Fundamentals of Industrial Instrumentation, Wiley Publication.
2. K. Krishnaswamy, Industrial Instrumentation, New Age International.
3. Chennakesava R. Alavala, Principles of Industrial Instrumentation, Cengage Learning India.

Reference Books :

1. B. C. Nakra, K. K. Choudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill.
2. Rangan, Sharma, Instrument Devices and Systems, Tata McGraw-Hill.
3. Ernest O. Doebelin, Measurement Systems: Applications and Design, McGraw-Hill.
4. D. S. Kumar, Mechanical Measurement and Control.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE114(1): Elective–I: Computational Techniques in Design Engineering

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial : 01 Hour/week, 01 Credit	**ISE : 30 Marks**

Course Introduction: Computational Methods in Engineering brings to light the numerous uses of numerical methods in engineering. It clearly explains the application of these methods mathematically and practically, emphasizing programming aspects when appropriate.

Course Objectives:

During this course, student is expected to:

1. Study basic numerical analysis techniques which are used to solve science and engineering problems
2. Understand common numerical methods and how they are used to obtain approximate solutions to mathematical problems
3. Study about application of numerical methods to obtain approximate solutions to mathematical problems

Course Outcomes:

At the end of this course, student will be able to:

1. Identify the errors that can occur in numerical calculations, including those related to interpolation techniques.
2. Demonstrate proficiency in applying the least square method to fit linear and non-linear functions to data and mathematical modeling to physical problems.
3. Solve linear systems of equations using the Gauss Elimination method with pivoting, factorization method, and iterative methods like Gauss-Jacobi and Gauss-Seidel methods.
4. Apply numerical integration methods to approximate definite integrals and utilize numerical differentiation techniques like the central difference formula.
5. Solve ordinary differential equation using various numerical methods.
6. Solve different types of partial differential equations using appropriate numerical techniques.

Section I

Unit-1: Interpolation **No. of lectures-07**

Errors in numerical calculations, Interpolation by central differences, sterling Bessel and Everett Formulae, Interpolation Formula for unequal Intervals, Lagrange's interpolation formula, Newton's divided difference formula

Unit-2: Curve Fitting and mathematical modeling **No. of lectures- 07**

Least square method for linear and non-linear functions, weighted least square methods, Mathematical Modeling of Physical Problems, modeling Concept, Modeling of Linear Differential Equations of Second order.

Unit-3: Solution of Linear System of Equations and Eigen value problems **No. of lectures-06**

Gauss Elimination with Pivoting, factorization method, Iterative methods, Gauss Jacobi method, Gauss Siedel method, power method to solve Eigen value problems, Eigen vectors-Jacobi method

Section II

Unit-4: Numerical Integration and differentiation **No. of lectures-07**

Numerical Integration by Newton-Cotes formula, Romberg's method and Gauss Quadrature, numerical differentiation by central difference formula

Unit-5: Numerical solution of Ordinary Differential Equation **No. of lectures-07**

Picard's Method, Euler's and Modified Euler's Method, Runge-Kutta Method (up to fourth order), Predictor-Corrector Methods, Milne, Adams Bashforth Moulten Methods

Unit-6: Numerical solution of Partial differential equations **No. of lectures-06**

Solution of Laplace equations, parabolic equations and hyperbolic equations.

Text Books:

1. B. S. Grewal, Numerical Methods for Science and Engineering, Khanna Publications.
2. M. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International.
3. P. K. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand Publications.

Reference Books:

1. S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw- Hill.
2. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International.
3. Paolo Ferro et al. Computational Techniques and Smart Manufacturing, Routledge/CRC Press,

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE114(2): Elective–I: Reliability Engineering

Teaching Scheme	Examination Scheme
Lectures: 03 Hours/week, 03 Credits	**ESE: 70 Marks**
Tutorial: 01 Hour/Week, 01 Credit	**ISE: 30 Marks**

Course Introduction:

Reliability is a critical aspect of any system's performance, ensuring its ability to function consistently and flawlessly over time. This subject covers introduction to Reliability and Failure Data Analysis, analyzing failure patterns to improve system resilience, Key Reliability measures, such as Mean Time To Failure (MTTF), Mean Time Between Failures (MTBF), Failure Rate, Various reliability models, evaluation of reliability systems, availability and maintainability, reliability testing are also included in the syllabus.

Course Objectives: During this course, student is expected to:

1. Understand the fundamental concepts and terms related to reliability engineering, including the life cycle of a system, failure analysis, probability theory, and reliability measures.
2. Learn techniques for analyzing failure data, including data collection methods, estimation of performance measures, and fitting probability distributions to data.
3. Familiarize with reliability measures such as reliability function, cumulative distribution function, probability density function, hazard rate function, and their applications in assessing system reliability.
4. Study basic reliability models, including constant failure rate models, renewal and Poisson processes, and various probability distributions (e.g., Weibull, Rayleigh, Normal, Lognormal) to analyze time-dependent failures and redundancy.
5. Learn methods for evaluating system reliability, including reliability block diagrams, series, parallel, and mixed configurations, as well as techniques like network reduction and cut and tie set approach.
6. Gain a comprehensive understanding of reliability engineering concept

.

Course Outcomes: At the end of this course, student will be able to:

1. Analyze and interpret failure data, estimate distribution parameters, and assess the reliability of systems based on empirical methods.
2. Develop a comprehensive understanding of reliability measures and their importance in assessing the performance and behavior of engineering systems.
3. Apply various basic reliability models to real-world scenarios, considering factors like time-dependent failures and redundancy.
4. Evaluate the reliability of complex systems using techniques such as reliability block diagrams and network reduction.
5. Describe the concepts of maintainability and availability, including measures like MTTR, downtime analysis, and stochastic point processes.
6. Explain the reliability testing methodologies, including life testing, burn-in testing, acceptance testing, and accelerated life testing

Section I

Unit-1: Reliability and Failure Data Analysis **No. of lectures-08**

Reliability: - Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of failure, typical engineering failures and their causes, theory of probability and reliability, rules of probability, random variables, discrete and continuous probability distributions.

Failure Data Analysis: Data collection and empirical methods, estimation of performance measures for ungrouped Complete data, grouped complete data, analysis of censored data, fitting probability Distributions graphically (Exponential and Weibull) and estimation of distribution parameters.

Unit-2: Reliability Measures **No. of lectures-06**

Reliability function–R(t), cumulative distribution function (CDF)–F(t), probability density Function (PDF) – f(t), hazard rate function-λ(t), Mean time to failure (MTTF) and Mean time Between failures (MTBF), median time to failure (tmed), mode (tmode), variance (σ2) and Standard deviation (σ), typical forms of hazard rate function, bathtub curve and conditional Reliability

Unit-3: Basic Reliability Models **No. of lectures-06**

Constant failure rate (CFR) model, failure modes, renewal and Poisson process, two Parameter exponential distribution, redundancy with CFR model, time-dependent failure Models, Weibull, Rayleigh, Normal and Lognormal distributions, burn-in screening for Weibull, redundancy, three parameter Weibull, calculation of R(t), F(t), f(t), λ(t), MTTF, tmed, tmode, σ2 and σ for above distributions.

Section II

Unit-4: Reliability Evaluation of Systems **No. of lectures-06**

Reliability block diagram, series configuration, parallel Configuration, mixed configurations Redundant systems, high level versus low level redundancy, kout-of-n redundancy, and complex Configurations, network reduction and decomposition methods, cut and tie set approach for Reliability evaluation.

Unit-5: Maintainability and Availability and Design for Reparability and Maintainability **No. of lectures- 10**

Concept of maintainability, measures of maintainability, meantime to repair (MTTR), analysis of downtime, repair time distributions, stochastic point processes, maintenance concept and procedures, availability concepts and definitions, important availability measures.

Reliability design process and design methods, reliability allocation, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used, maintainability design process, quantifiable measures of maintainability, repair versus replacement.

Unit-6: Reliability Testing **No. of lectures- 04**

Product testing, reliability life testing, burn-in testing, and acceptance testing, accelerated life testing and reliability growth testing

Text Books:

1. Charles E. Ebeling, An Introduction to Reliability and Maintainability Engineering, Tata McGraw-Hill.
2. L. S. Srinath, Reliability Engineering, East-West Press.
3. Roy Billinton, Ronald Norman Allan, Reliability Evaluation of Engineering Systems: Concepts and Techniques, Springer.
4. Patrick D. T. O’Connor, David Newton, Richard Bromley, Practical Reliability Engineering, John Wiley & Sons.

Reference Books:

1. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, Maintenance, Replacement and Reliability: Theory and Applications, CRC / Taylor & Francis.
2. Joel A. Nachlas, Reliability Engineering: Probabilistic Models and Maintenance Methods, Taylor & Francis.
3. B. S. Dhillon, Chanan Singh, Engineering Reliability – New Techniques and Applications, John Wiley & Sons.
4. B. S. Dhillon, Engineering Maintainability, Prentice Hall of India.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE114(3): Elective–I: Mechanical System Design

Teaching Scheme	Examination Scheme
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial : 01 Hour/Week, 01 Credit	**ISE : 30 Marks**

Course Introduction: Mechanical system design is an important engineering process that focuses on developing efficient, reliable, and cost-effective mechanical systems for different applications. The process typically includes stages such as requirements identification, conceptual design, preliminary analysis, detailed design, prototyping and testing, design improvement, and preparation for manufacturing and assembly. Successful mechanical system design also requires proper documentation, production planning, installation, and commissioning.

Course Objectives:

During this course, student is expected to:

1. Study the design aspects machine tool gearbox.
2. Study the statistical considerations in design and the defects and failure modes in components.
3. Design material handling systems.
4. Design cylinders and pressure vessels and to use IS code.
5. Select materials and to design internal combustion engine components.
6. Understand optimum design and use optimization methods to design mechanical components.

Course Outcomes:

At the end of this course, student will be able to:

1. Design machine tool gearbox.
2. Apply the statistical considerations in design and analyze the defects and failure modes in components.
3. Design material handling systems such as belt drives, conveyors and pulleys achieving a successful design outcome.
4. Design cylinders and pressure vessels and to use IS code.
5. Design various internal combustion engine components.
6. Apply optimum design for various machine components.

Section I

Unit-1: Design of Machine Tool Gear Box **No. of lectures- 8**

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gearing diagram, deviation diagram. (Note: Full design problem to be restricted up to 2 Stages only)

Unit-2: Statistical Consideration in Design **No. of lectures- 6**

Frequency distribution-Histogram and frequency polygon, normal distribution - units of central tendency and dispersion- standard deviation - population combinations - design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety.

Unit-3: Design of Belt Conveyor System for Material Handling **No. of lectures- 6**

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.

Section II

Unit-4: Design of Cylinders and Pressure Vessels **No. of lectures- 8**

Thin and thick cylinders, Lame's equation, Clavarino's and Birnie's equations (no derivation), design of hydraulic and pneumatic cylinders, autofrettage, compound cylinders, gasketed joints in cylindrical vessels (no derivation).

Unit-5: Design of I.C. Engine Components **No. of lectures- 6**

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod. Design of crank-shaft and crank-pin, (Theoretical treatment only).

Unit-6: Optimum Design and DFMA **No. of lectures- 6**

Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements- tension bar, transmission shaft and helical spring, Pressure vessel Introduction to redundant specifications (Theoretical treatment).Design for manufacture, assembly and safety General principles of design for manufacture and assembly (DFM and DMFA).

Text Books:

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill.
2. R. C. Juvinall, Fundamentals of Machine Component Design, Wiley India.
3. Mechanical System Design- Siddiqui, Manoj Kumar Singh; New Age International
4. An Introduction to Engineering Design Method- V Gupta and PN Murthy, TMH, New Delhi
5. Machine Design -Dieter

Reference Books:

1. PSG College of Technology, Design Data Book, PSG College of Technology.
2. IS 2825, Code for Unfired Pressure Vessels.
3. S. K. Basu, D. K. Pal, Design of Machine Tools, Oxford and IBH.
4. Singiresu S. Rao, Engineering Optimization Theory and Practice, John Wiley
5. System Analysis and Project Management- Devid I Cleland, William R King,

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE114(4): Elective–I: Computer Aided Design

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hours/week, 03 Credits	**ESE: 70 Marks**
Tutorial: 01 Hour/Week, 01 Credit	**ISE: 30 Marks**

Course Introduction:

This course aims to provide students with a conceptual understanding of the principles underlying CAD systems and their practical implementation. By the end of this course, students will possess a solid foundation in CAD principles, 2D and 3D transformations, geometric modeling approaches, mathematical representations, and the fundamentals of FEM. The course will let students to create, analyze, and optimize designs efficiently, making you well-equipped for real-world engineering and design challenges

Course Objectives:

During this course, student is expected to:

1. Provide basic foundation in computer aided design / manufacturing
2. Understand the fundamentals used to create and manipulate geometric models
3. Get acquainted with the basic CAD software designed for geometric modeling
4. Learn working principles of NC machines CNC control and part programming
5. Understand concept of Group Technology, FMS and CIM

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the fundamental principles of Computer-Aided Design (CAD) systems and describe their impact on the engineering design process.
2. Apply 2D and 3D geometric transformation techniques used in computer graphics and CAD modeling.
3. Demonstrate projection transformation methods to represent 3D objects accurately in 2D engineering drawings for design and manufacturing applications.
4. Analyze and compare different geometric modeling approaches used for developing complex and precise engineering models.
5. Construct and interpret mathematical representations of 2D and 3D geometric entities used in CAD systems.
6. Apply the basic principles of the Finite Element Method (FEM) for engineering analysis and simulation in CAD/CAE environments

Section I

Unit 1: CAD Hardware and Software Systems **No. of lectures- 04**

CAD Hardware and Software, Types of systems and system considerations, input and output devices, hardware integration and networking, hardware trends, Software modules.

Unit-2: Computer Graphics and Geometric Transformations **No. of lectures- 08**

Computer Graphics Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system; inverse transformations and mapping.

Unit 3: Geometric Modeling of Curves and Surfaces **No. of lectures- 08**

Projections of geometric models, orthographic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, Introduction to Bezier Curve, B- Spline and Cubic curve, parametric representation of synthetic curves, curve manipulations. Surface representation.

Section II

Unit 4: Computer Communication and Networking Fundamentals **No. of lectures- 04**

Computer Communications, Principle of networking, classification networks, network wiring, methods, transmission media and interfaces, network operating systems

Unit 5: Fundamentals of Solid Modeling **No. of lectures- 08**

Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSF), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling-based applications: mass properties calculations, mechanical tolerance, etc.

Unit 6: Finite Element Modeling and System Simulation **No. of lectures- 08**

Finite Element Modeling and Analysis, Finite Element Analysis, finite element modeling, mesh generation mesh requirements, semiautomatic methods, fully automatic methods, design and engineering applications, System Simulation, need of simulation, areas of applications, when simulation is appropriate tool / not appropriate, concept of a system, components of a system, discrete and continuous systems, model of a system, type of models, types of simulation approaches.

Text Books:

1. P. N. Rao, CAD/CAM Principles and Applications, Tata McGraw-Hill.
2. Rogers, Adams, Mathematical Elements for Computer Graphics.
3. Rooney, Steadman, Principles of Computer Aided Design.
4. Jerry Banks, John Carson, Barry Nelson, David Nicol, Discrete Event System Simulation.

Reference Books:

1. Ibrahim Zeid, CAD/CAM Theory and Practice.
2. Jim Browne, Computer Aided Engineering and Design.
3. P. Radhakrishnan, V. Raju, S. Subramanyam, CAD/CAM/CIM.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech. - Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE115: Research Methodology and IPR

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hours/week, 03 credits	**ESE: 70 Marks**
Tutorial : 01 Hour/Week, 01 credit	**ISE : 30 Marks**

Course Introduction:

In the context of "Research Methodology & IPR," researchers and scholars explore how research practices intersect with intellectual property considerations. This includes understanding how to appropriately cite and use existing works, navigating copyright issues in research publication, managing intellectual property generated through research, and potentially commercializing research outcomes through patents and licensing.

Overall, "Research Methodology & IPR" is a dynamic and evolving field that plays a crucial role in guiding researchers and innovators in conducting ethical, high-quality research while also respecting and protecting intellectual property rights.

Course Objectives: During this course, student is expected to:

1. Demonstrate a solid understanding of research aims, objectives, and hypotheses.
2. Apply appropriate research design principles to address research questions effectively.
3. Select and justify suitable data collection methods based on research goals.
4. Differentiate between various types of intellectual property rights.
5. Explain the legal framework and protections associated with each type of intellectual property.
6. Recognize the rights and responsibilities of creators and innovators under IPR laws.

Course Outcomes: At the end of this course, student will be able to:

1. Explain the fundamental concepts of research, including research aims, objectives, and hypotheses.
2. Identify various research designs, their strengths, and limitations.
3. Analyze and interpret research data using relevant techniques for research problem.
4. Identify the intersection of research practices and intellectual property considerations.
5. Identify intellectual property assets generated through research and assess their potential value.
6. Apply the process of filing patent applications and drafting patent claims.

Section I

Unit-1: Introduction to Research **No. of lectures-08**

Defining Research, Scientific Enquiry, Hypothesis, Scientific Method, Types of Research, Research Process and steps in it. Research Proposals – Types, contents, sponsoring agent's requirements, Ethical, Training, Cooperation and Legal aspects

Unit-2: Research Design **No. of lectures-06**

Meaning, Need, Concepts related to it, categories; Literature Survey and Review, Dimensions and issues of Research Design, Research Design Process – Selection of type of research, Measurement and measurement techniques, Selection of Sample, Selection of Data Collection Procedures, Selection of Methods of Analysis, Errors in Research.

Unit-3: Research Problem **No. of lectures-06**

Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem-solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method.

Section II

Unit-4: Nature of Intellectual Property **No. of lectures-08**

Patents, Designs, Trade and Copyright. Process of Patenting & Development: technological research, innovation, patenting, development. International Scenario International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Unit-5: Patent Rights **No. of lectures-06**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and data bases. Geographical Indications.

Unit-6: New Developments in IPR **No. of lectures-06**

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR

Text Books

1. C. K. Kothari, Research Methodology Methods and Techniques, New Age International Publishers.
2. Prabuddha Ganguli, IPR Unleashing the Knowledge Economy, Tata McGraw-Hill.
3. Ranjit Kumar, Research Methodology A Step by Step Guide for Beginners.

Reference Books

1. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, Management Research Methodology, Pearson Education.
2. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley and Sons.
3. John W. Creswell, Research Design Qualitative Quantitative and Mixed Methods Approaches, Sage Publications.
4. Debora Halbert, Resisting Intellectual Property, Taylor and Francis.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in the New Technological Age.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-I

MDE116: Mini-Project-I

Teaching Scheme
Practical : 02 Hours/Week, 01 credit

Examination Scheme
ICA: 50 Marks

Course Objectives:

1. To understand the product development process including planning and budgeting through a mini project.
2. To develop the ability to plan and organize various activities involved in project execution.
3. To identify a research problem in the field of Design Engineering through literature survey.
4. To develop skills in simulation, modeling and preliminary design using engineering software tools.

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

1. Identify and analyze an engineering problem relevant to Design Engineering.
2. Conduct literature review and formulate objectives and methodology for a mini project.
3. Develop simulation models or preliminary design concepts using suitable engineering tools.
4. Prepare a technical report and present the proposed work effectively

Guidelines:

1. Each student shall select a mini project topic related to Design Engineering under the guidance of an allotted Project Guide.
2. The project topic should preferably be related to the student's future M.Tech dissertation work.
3. Students must perform literature review using journals, patents, and technical databases.
4. Use of analysis software, simulation tools, and design software is encouraged.
5. Students should prepare a technical report including objectives, literature review, and proposed methodology.
6. The progress of the mini project should be evaluated through periodic reviews

Weekly Activity Plan		
Week	**Work to be carried**	**Hours**
Week 1-2	Mini-project guide allotment, topic selection and project planning	03
Week 3-4	Literature review and identification of research problem	04
Week 5-6	Use analysis software, research tools, advanced methods, standards, and practices	04
Week 7-8	Simulation/modeling using appropriate software tools	04
Week 9-10	Preliminary design and analysis	04
Week 11-12	Preparation of technical report and seminar presentation	04

SEMESTER-II

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE121: Finite Element Method

Teaching Scheme
Lectures : 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

Examination Scheme
ESE : 70 Marks
ISE : 30 Marks
ICA : 50 Marks

Course Introduction:

The Finite Element Method (FEM) has emerged as an essential and irreplaceable tool within the domains of engineering and science. It enables us to address intricate problems that would otherwise be impractical or prohibitively expensive to solve using conventional analytical approaches. This course caters to a diverse audience, including aspiring engineers, experienced researchers, and individuals with a keen interest in comprehending the intricacies of computational simulations. By undertaking this course, you will acquire fundamental theoretical knowledge and invaluable practical skills required to immerse oneself in the intricacies of FEM.

Course Objectives: During this course, student is expected to:

1. To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
2. To provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
3. To study approximate nature of the finite element method and examination of convergence results.
4. To provides some experience with a commercial FEM code and some practical modeling exercises

Course Outcomes: At the end of this course, student will be able to:

1. Explain the principles and applications of the Finite Difference Method and Finite Element Method
2. Describe the principles of variational and weighted residual approaches and their application in FEM.
3. Identify the different types of finite element formulations and understand the FEM process and its interpretation.
4. Analyze stress distributions and calculate stress values using FEM techniques
5. Explain the concept of Isoparametric elements and their significance in FEM analysis.
6. Apply FEM to analyze engineering problems using 1D, 2D, and 3D elements

Section I

Unit-1: Introduction **No. of lectures- 04**

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Introduction to mathematical formulation of FEM, Analytical Techniques in Solid Mechanics and Fluid Mechanics, Numerical Techniques such as FEM, BEM, FDM and FVM, Computational Mechanics and Engineering Experimentation, Role of finite element analysis in computer-aided design, Overview of CAE and major CAE software

Unit-2: Mathematical FEM Techniques **No. of lectures- 06**

Matrix Algebra, Vector, Tensors, Linear Algebra, PDE, ODE, Variation Calculus, Introduction to Variational and Weighted residual approaches, Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence criterion and patch test, Higher order elements.

Unit-3: Finite Element Analysis Concepts **No. of lectures- 10**

Introduction to 1D and 2D elements**,** Energy techniques in Mechanics, Concept of functional, Rayleigh dimensional bar element, one dimensional thermal element. Governing differential equations, Weighted Residual methods strong and weak form, one dimensional bar element, one dimensional thermal element, Types of Finite Element formulation, FEM process, interpretation of FEM, FEM history and its evolution.

Section II

Unit-4: FEM analysis of 1D and 2D Elements **No. of lectures- 05**

Direct Stiffness method, DOF, nodes, elements, boundary conditions, assembly and solution of displacement equations, Shape functions, derivation of shape functions for 1D, 2D and 3D elements, polynomial, Hermite polynomial and Lagrangian polynomial shape functions, convergence of shape functions. Stress calculations and examples. Steady-state heat transfer formulation of 1D element for conduction and convection problem, boundary conditions and solving for temperature distribution

Unit-5: Isoparametric Formulation **No. of lectures- 05**

Concept of Isoparametric elements, Terms Isoparametric, super parametric and subparametric Isoparametric formulation of bar element, Coordinate mapping - Natural coordinates, Area coordinates (for triangular elements), higher order elements (Lagrangian and serendipity elements). Convergence requirements- patch test, Uniqueness of mapping - Jacobian matrix.

Unit-6: Applications of FEM to Engineering problems **No. of lectures- 10**

Finite Elements: 1D, 2D, 3D elements, element classification, mesh refinement, mesh validity checks, sub modeling and sub structuring. Structural Analysis: Static analysis, buckling analysis, modal analysis, transient analysis, spectrum analysis, nonlinear analysis (Geometric non linearity, material non linearity and contact non linearity). Thermal Analysis: Conductive, Convective and radiation analysis. Coupled Field Analysis, Fatigue analysis, CFD (elementary level).

Internal Continuous Assessment (ICA)

Part A

1. Minimum Five assignments based on topics from Unit 1 to Unit 5

Part B (Any three assignments from Unit no. 06):

1. 1D structural and thermal analysis.
2. 3D structural and thermal analysis.
3. 3D structural analysis.
4. Assignment on fatigue analysis using FEA.
5. Assignment on applications of FEA and future developments.

Text Books:

1. S. S. Rao, The Finite Element Method in Engineering, Pergamon.
2. J. N. Reddy, Introduction to Finite Element Method.

Reference Books:

1. T. R. Chandrupatla, A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall India.
2. T. Chandra Patla, A. D. Belugundu, Introduction to Finite Element Method.
3. G. S. Krishna Murthy, Finite Element Analysis: Theory and Programming.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE122: Advanced Design Engineering

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
	ISE : 30 Marks

Course Introduction: This course will explore the exciting world of design engineering, taking your engineering knowledge to the next level and honing your skills to tackle complex and innovative design challenges. Advanced Design Engineering is a comprehensive course that delves into the principles, methodologies, and techniques used in designing high speed cams, introduction to tribology, hydrodynamic lubrication and hydrodynamic journal bearing, Hydro static and Elasto-hydrodynamic bearings, etc. This course focuses on the functions of reliability and application of reliability in design, Fatigue Analysis and Design for manufacturing and Assembly, etc.

Course Objectives:

During this course, student is expected to:

1. Study the design of high-speed cams
2. Understand the Tribology aspects in design.
3. Study the hydrodynamic lubrication and hydrostatic bearings
4. Understand the hydrostatic and elasto-hydrodynamic bearings
5. Study the application of reliability in design
6. Understand fatigue analysis and design for manufacturing and assembly

Course Outcomes:

At the end of this course, student will be able to:

1. Design high speed cams for a particular application.
2. Apply the tribology aspects in design of a component.
3. Determine the hydrodynamic journal bearing dimensions.
4. Explain hydrostatic and elasto-hydrodynamic bearings
5. Apply the concepts of reliability in design.
6. Explain the fatigue behavior and design for manufacturing and assembly

Section I

Unit-1: Design of High Speed Cams **No. of lectures- 05**

Types of cams, Kinematic design, Standard contours, combined motion and polynomial approaches, CEP and CPM cams, Importance of SVAJ diagrams, Dynamic design of cams-rigid body analysis and elastic body analysis, Polydyne Cams**.**

Unit-2: Introduction to Tribology **No. of lectures-05**

Introduction, Friction, Wear, Wear Characterization, Lubrication, Newton's law of viscous forces, effect of pressure and temperature on viscosity

Unit-3:Hydrodynamic lubrication & Hydrodynamic journal bearing **No. of lectures- 10**

Pressure development mechanism, Converging and diverging films and pressure induced flow, Reynolds's equation with assumptions**.** Introduction to idealized full journal bearings, Load carrying capacity of idealized full journal bearings, Somerfield number and its significance (Numerical Treatment).

Section II

Unit-4: Introduction to Hydro static & Elasto-hydrodynamic bearings **No. of lectures-04**

Introduction to hydrostatic and electrostatic bearings, principle of hydrostatic lubrication, types of hydrostatic bearings, restrictor design and flow control methods, load carrying capacity and stiffness analysis of hydrostatic bearings, performance characteristics and stability of hydrostatic bearings, principle of electrostatic bearings, electrostatic force generation and electrode configuration, design parameters and control of electrostatic bearings, applications of hydrostatic and electrostatic bearings in precision engineering and MEMS

Unit-5: Introduction to Reliability in Design **No. of lectures-07**

Definitions of Reliability function, Terms use in reliability, Failure distribution function, Hazard rate, MTTF, MTBF and MTTR, Failure data analysis, Reliability of systems – Series, parallel and combined systems, Calculation of reliability terms for exponential, Rayleigh and We bull failure distribution function. Methods of improving reliability. Numerical problems

Unit-6: Fatigue Analysis and Design for manufacturing and Assembly **No. of lectures- 09**

Introduction, Fatigue strength, Factors affecting fatigue behavior, high cycle and low cycle fatigue, Cumulative damage in fatigue, and fatigue under complex Stresses Design for manufacturing and Assembly

Text Books:

1. Robert L. Norton, Machine Design: An Integrated Approach, Pearson Education.
2. Joseph E. Shigley, Charles R. Mischke, Richard G. Budynas, Mechanical Engineering Design, McGraw-Hill.
3. Bhandari V. B., Design of Machine Elements, Tata McGraw-Hill.

Reference Books:

1. Juvinall R. C., Marshek K. M., Fundamentals of Machine Component Design, Wiley.
2. Hamrock B. J., Schmid S. R., Jacobson B. O., Fundamentals of Machine Elements, McGraw-Hill.
3. Hall A. S., Holowenko A. R., Laughlin H. G., Machine Design, Schaum Series, McGraw-Hil

Punyashlok Ahilyadevi Holkar Solapur University
M. Tech.- Mechanical (Design Engineering)
Syllabus W.E.F 2026-27
Semester-II
MDE123: Industrial Product Design

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Practical : 02 Hours/week, 01 Credit	**ISE : 30 Marks**
	ICA: 50 Marks

Course Introduction:

It has been observed that the most successful economies are based on innovation and creativity led entrepreneurship by successful product and service to consumer and industry. The main objective of the course is to acquaint the students with the practical knowledge regarding conceptualization, design and development of industrial and consumer product using modern tools. The need and importance of industrial design, new product, the product life cycle, the product design process, the application of economical consideration in product design, various product design tools such as CAD, QFD, concurrent approach should able to apply for specific examples/ case studies in included in the syllabus. The concept of Ergonomics and Aesthetics in context of the industrial product design should be understood with the help of case studies.

Course Objectives:

During this course, student is expected to:

1. Understand the importance of design and development of industrial design
2. Analyze the effect of display size, shape, color and function in industrial and consumer products
3. Analyze existing products for improvements using modern approach
4. Evaluate products for its function, ergonomics and aesthetics
5. Design new products/devices using industrial design principles

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the importance of ergonomics and aesthetics in industrial product design
2. Apply industrial design methodology while designing new products.
3. Analyze existing products for improvements according to need of customer and industry.
4. Evaluate products for aesthetic/ergonomic concepts, cost and product life cycle
5. Design new products/devices using industrial design principals, and modern approach such as QFD and concurrent approach.
6. Apply the economic and environment considerations in Design

Section I

Unit-1: Introduction **No. of lectures- 06**

Need of Industrial design, Concept development process, Design and development process of industrial products, Assessing the quality of Industrial design, Problems faced by industrial designer, Types of models used in industrial design-Clay studies, Mock ups, scale models, Prototypes.

Unit-2: Industrial Product Design **No. of lectures- 06**

Design of industrial and consumer products, setting specification, requirements and rating, their importance in the design. Study of market requirements and manufacturing aspects of industrial designs, Challenges of Product development

Unit-3: Aesthetic and Ergonomic Concepts **No. of lectures- 08**

Concept of unity and order with variety, concept of purpose, style and environment. Aesthetic expressions of symmetry, balance, contrast continuity, proportion.

Mechanics of seeing, psychology of seeing. Influence of line and form. Effect of color on product, appearance, reactions to color and color combinations. Man-Machine relationship, Use and limitations of anthropometric data, Aspects of ergonomic design of machine tools, testing equipment, instruments, automobiles, process equipment etc., interpretation of information, physiological factors, psychology factors, anatomy factors

Section II

Unit-4: New Product Development **No. of lectures- 04**

Initiation, Idea collection, creative design; brain storming; creative thinking; creative development, inventiveness; conception design. Function and use, Legal standard requirement; international standards, prototype design pre-production, inspection.

Unit-5: Economic and Environment Considerations in Design **No. of lectures-10**

Economic Considerations: Selection of material, Design for Production (DFP), impact of DFP on other factors, Use of standardization, value analysis and cost reduction, break even analysis

Environment Considerations: Need, Guidelines, Product Life Cycle assessment, Techniques to reduce environmental impact

Unit-6: Modern approaches to product design **No. of lectures-06**

Concurrent Design, Quality Function Deployment (QFD), Computer Aided Industrial Design, Rapid Prototyping

Internal Continuous Assessment (ICA):

1. Case Studies:- Design Analysis of existing products (Market survey, Need identification, etc)
2. Case Studies: Design of new product devices, utility products (Concept generation and evaluation using different methods)
3. Aesthetic and ergonomic evaluation of any one consumer product and suggesting improvements
4. One Case study on Product Life Cycle Assessment
5. One case study on cost analysis and cost reduction of industrial product

Text Books:

1. Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, McGraw-Hill.
2. Mike Baxter, Product Design: Practical Methods for the Systematic Development of New Products, CRC Press.
3. Kevin Otto, Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education.

Reference Books:

1. Stuart Pugh, Total Design: Integrated Methods for Successful Product Engineering, Addison-Wesley.
2. George E. Dieter, Linda C. Schmidt, Engineering Design, McGraw-Hill.
3. Nigel Cross, Engineering Design Methods: Strategies for Product Design, Wiley.
4. David G. Ullman, The Mechanical Design Process, McGraw-Hill.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech. - Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE124 (1): Elective II: Theory and Analysis of Composite Materials

Teaching Scheme
Lectures: 03 Hours/week, 03 Credits
Tutorial : 01 Hour/ week, 01 Credit

Examination Scheme
ESE :70 Marks
ISE: 30 Marks

Course Introduction:

Theory and Analysis of Composite Materials is a specialized field of study that focuses on the properties, behavior, design, and applications of composite materials. Composite materials are engineered materials made by combining two or more distinct materials to create a new material with improved and tailored properties. These materials offer a wide range of advantages over traditional materials due to their unique combination of characteristics.

Course Objectives:

During this course, student is expected to:

1. Define and explain the fundamental concepts of composite materials, including matrix, reinforcement, and microstructure.
2. Study stress, strain, and deformation distribution within composite structures.
3. Learn mathematical and analytical methods to predict composite behavior under different loading conditions.
4. Identify and assess potential failure mechanisms and modes in composite materials.
5. Explain various manufacturing techniques used to create composite materials.
6. Design composite components for specific applications, considering factors such as load-bearing capacity and weight reduction.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the microstructure and its impact on material properties.
2. Apply mathematical and analytical methods to predict the behavior of composite materials under different loading conditions.
3. Analyze stress, strain, and deformation distribution within composite structures.
4. Analyze failure mechanisms and modes, including delamination, fiber breakage, and matrix cracking.
5. Explore various manufacturing techniques used to create composite materials
6. Design composite structures for specific applications, considering factors such as load-bearing capacity and weight reduction

Section I

Unit-1: Introduction to Composite Materials **No. of lectures-06**

Definition, Classification, Types of matrix material sand reinforcements, Characteristics & selection, Fiber composites, laminated composites, Metal matrix composite, Particulate composites and Pre-pegs, Application of Composite Materials.

Unit-2: Macro-mechanical behavior of a Lamina **No. of lectures-08**

Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Stress –strain relations for Plane Stress in an Orthotropic Material, Strengths of an Orthotropic Lamina, Numerical problems.

Unit-3: Micro-mechanical behavior of a Lamina **No. of lectures-06**

Introduction, Mechanics of Material approach to Stiffness, Elasticity approach to Stiffness, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Numerical problems

Section II

Unit-4: Macro-mechanical behavior of Laminate **No. of lectures-08**

Introduction, code, Kirch off hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Strength of Laminate, Inter-laminar Stresses.

Unit-5: Manufacturing of Ceramic materials **No. of lectures-06**

Open and closed mould processing, Hand lay-up techniques, Bag molding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection molding, Types of defects.

Unit-6: Behavior of Composite Materials **No. of lectures-06**

Introduction, Governing Equations for Bending and Buckling of Laminated Plates, Principles of fracture mechanics and effect of discontinuity in laminates, applications.

Text Books:

1. Krishan K. Chawla – Composite Materials: Science and Engineering, Springer, 4th Edition.
2. Isaac M. Daniel, Ori Ishai, Engineering Mechanics of Composite Materials, Oxford University Press.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC Press.

Reference Books:

1. Mallick P. K., Fiber-Reinforced Composites: Materials, Manufacturing and Design, CRC Press.
2. J. N. Reddy, Mechanics of Laminated Composite Plates and Shells, CRC Press.
3. R. M. Jones, Mechanics of Composite Materials, Taylor and Francis.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech. - Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE124(2): Elective II: Engineering Design Optimization

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial : 01 Hour/ week, 01 Credit	**ISE : 30 Marks**

Course Introduction:

This course introduces the fundamental concepts, techniques, and tools of engineering design optimization. Students will learn how to formulate engineering design problems, apply optimization methods, and analyze results to enhance the performance and efficiency of engineering systems.

Course Objectives:

During this course, student is expected to:

1. Define and explain the fundamental concepts of optimization as applied to engineering design.
2. Understand the principles behind gradient-based methods, evolutionary algorithms, and other optimization techniques.
3. Interpret optimization output, including optimal design variables and objective function values.
4. Identify and handle trade-offs between conflicting objectives in multi-objective optimization.
5. Design and optimize engineering components for improved performance, efficiency, and reliability.
6. Apply reliability-based design optimization concepts to ensure designs meet specified performance under uncertainty.

Course Outcomes:

At the end of this course, student will be able to:

1. Analyze and critically assess the suitability of different optimization formulations for specific design scenarios.
2. Select appropriate algorithms based on problem characteristics, optimization goals, and available resources.
3. Implement algorithms to efficiently explore design spaces and identify optimal solutions.
4. Evaluate and select optimal design alternatives considering multiple performance metrics.
5. Prepare innovative design solutions that address practical engineering challenges.
6. Design decisions that account for uncertainties and minimize potential risks.

Section I

Unit-1: Introduction to Optimization **No. of lectures-08**

Need for optimization and historical development, engineering application of optimization, Classification of optimization problems, Formulation and statement of optimization problems

Unit-2: Optimization Algorithms **No. of lectures-06**

Unconstrained optimization methods: gradient descent, Newton's method, Direct methods, random search method, grid search method, indirect search method Constrained optimization: equality and inequality constraints, Direct methods, random search method

Unit-3: Numerical Optimization Techniques **No. of lectures-06**

Discrete and continuous optimization methods, Mixed-integer programming, Convex and non-convex optimization

Section II

Unit-4: Multi-Objective Optimization **No. of lectures-08**

Pareto optimality and trade-offs, Weighted sum method and ε-constraint method, Multi-objective evolutionary algorithms: genetic algorithms, particle swarm optimization

Unit-5: Design Optimization in Engineering Applications **No. of lectures-06**

Structural design optimization: material selection, shape optimization Mechanical systems optimization: mechanism synthesis, kinematic design Thermal systems optimization: heat exchanger design, thermal management

Unit-6: Robust Design and Uncertainty **No. of lectures-06**

Incorporating uncertainties into design optimization Robust design optimization techniques Reliability-based design optimization

Text Books:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley and Sons.
2. Kalyanmoy Deb – Optimization for Engineering Design: Algorithms and Examples, PHI Learning, 2nd Edition, Prentice Hall of India.
3. Jasbir S. Arora, Introduction to Optimum Design, Elsevier Academic Press.

Reference Books:

1. Fox R. L., Optimization Methods for Engineering Design, Addison-Wesley.
2. Ravindran A., Phillips D. T., Solberg J. J., Operations Research: Principles and Practice, John Wiley and Sons.
3. R. Venkata Rao & Vimal J. Savsani , Mechanical Design Optimization Using Advanced Optimization Techniques, Springer

Punyashlok Ahilyadevi Holkar Solapur University
M. Tech.- Mechanical (Design Engineering)
Syllabus W.E.F 2026-27
Semester-II
MDE124(3): Elective II: Industrial Tribology

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hours/week, 03 Credits	**ESE: 70 Marks**
Tutorials: 01 Hour/week, 01Credit	**ISE: 30 Marks**

Course Introduction:

This course provides an in-depth exploration of the fundamental principles and applications in the field of tribology, as well as the essential concepts related to lubrication and lubricants. By the end of this course, Student will have a comprehensive understanding of the principles and applications of tribology and lubrication, equipping with valuable knowledge for tackling real-world engineering challenges and optimizing machinery performance.

Course Objectives:

During this course, student is expected to:

1. Understand the basic concepts, theories, and principles of tribology
2. Gain the knowledge of friction and wear
3. Understand the principle of hydrostatic lubrication, hydrodynamic lubrication and air/gas lubricated bearings
4. Understand the signification of lubrication and lubricants

Course Outcomes:

At the end of this course, student will be able to:

1. Explain tribology, viscosity, surface properties, and contact analysis for smooth and rough surfaces.
2. Describe friction, static and rolling laws wear mechanisms, and measurement for metals and non-metals.
3. Explain the hydrostatic lubrication principles and applications in bearings like thrust and journal bearings.
4. Elaborate the hydrodynamic theory, equations, and its application in sliding and journal bearings.
5. Explore air/gas lubricated bearings, their advantages, disadvantages, and applications to journal and thrust bearings, considering compressibility effects.
6. Discuss the significance of lubricants and lubrication.

Section I

Unit-1: Introduction **No. of lectures- 06**

Tribology in design, tribology in industry Viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations Nature of surfaces and their contact; Physic mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smoothly and rough surfaces.

Unit-2: Friction and wear **No. of lectures- 06**

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

Unit-3: Hydrostatic lubrication **No. of lectures- 08**

Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials., Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, Hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing, optimum design of hydrostatic step bearing.

Section II

Unit-4: Hydrodynamic theory of lubrication **No. of lectures- 08**

Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl, anti –friction bearing, hydrodynamic thrust bearing.

Unit-5: Air/gas lubricated bearing **No. of lectures- 07**

Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect.

Unit-6: Lubrication and lubricants **No. of lectures- 05**

Introduction, dry friction; Boundary lubrication; classic hydrodynamics, hydrostatic and elasto-hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses; SAE classification, recycling, disposal of oils, properties of liquid and grease lubricants; lubricant additives, general properties and selection.

Text Books:

1. B. Bhushan, Introduction to Tribology, John Wiley and Sons.
2. J. A. Williams, Engineering Tribology, Cambridge University Press.
3. Gwidon W. Stachowiak, Andrew W. Batchelor, Engineering Tribology, Butterworth-Heinemann.

Reference Books:

1. Rabinowicz E., Friction and Wear of Materials, John Wiley and Sons.
2. Suh N. P., Tribophysics, Prentice Hall.
3. Czichos H., Tribology: A Systems Approach to the Science and Technology of Friction, Lubrication and Wear, Elsevier.
4. Hutchings I. M., Shipway P., Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann.

Punyashlok Ahilyadevi Holkar Solapur University
M. Tech. - Mechanical (Design Engineering)
Syllabus W.E.F 2026-27
Semester-II
MDE124(4): Elective II: Advanced Engineering Materials

Teaching Scheme	Examination Scheme
Lectures : 03 Hours/week, 03 Credits	ESE : 70 Marks
Tutorials : 01 Hour/week, 01 Credit	ISE : 30 Marks

Course Introduction:

Advanced Material Engineering is a specialized field within materials science and engineering that focuses on the study, design, and development of new and innovative materials with enhanced properties for specific applications. This course includes Materials Structure and Properties, and influences on their mechanical, thermal, electrical, and optical properties.

Course Objectives:

During this course, student is expected to:

1. Gain a comprehensive understanding of the principles, concepts, and properties of various advanced materials, including metals, ceramics, polymers, composites, and nanomaterial.
2. Develop the ability to select appropriate materials based on their properties and microstructure to meet specific engineering requirements and design innovative materials for specific applications.
3. Acquire knowledge of advanced manufacturing and processing techniques used to fabricate and shape advanced materials, such as additive manufacturing, nano and composite materials.
4. Understand the significance of advanced materials in various engineering fields

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the structure, properties, and behavior of advanced materials, including metals, ceramics, polymers, composites, and nanomaterials.
2. Select materials based on their properties and tailor their composition and microstructure to meet specific engineering requirements.
3. Explain advanced manufacturing and processing techniques used to fabricate and shape advanced materials, such as additive manufacturing, nano and composite materials.
4. Describe the significance of advanced materials in various engineering fields.
5. Assess the performance of advanced materials under different operating conditions.
6. Develop competency in understanding in the field of advanced engineering materials.

Section I

Unit-1: Introduction to ferrous and nonferrous alloys **No. of lectures-08**

Types of steels, composition, properties applications, types of cast irons: composition, properties applications, Heat treatments of steels such as annealing, normalizing, Hardening & tempering, definition, concept, objectives. Copper alloys, Aluminum alloys, Fusible Alloys.

Unit-2: Materials for powder metallurgy **No. of lectures-06**

Manufacturing of metal/non metal powders (conventional and modern methods), Powder mixing and blending, Powder compaction, Mechanical, thermal and thermo-mechanical compacting processes, Sintering theories, mechanisms, types, variables, Secondary operations Performed on Powder Metallurgical components.

Unit-3: Composites and Nano materials **No. of lectures-06**

Definition and characteristics, advantage and limitations of composite materials, Significance and objectives of composite materials, current status, Classification of composite materials, Constituent materials and properties, Properties of typical composite materials,
Nano materials - Definition, length scales, effect of particle size on thermal, mechanical, electrical, magnetic, and optical properties of the nanomaterial, Inspiration from Nature about nanotechnology. Synthesis of nanomaterial: Top down approaches like soft lithography, Bottom-up approaches like gas condensation, chemical vapor deposition

Section II

Unit-4: Electric - Magnetic Materials & its properties **No. of lectures-08**
Electrical and Thermal Conduction in Solid metal and conduction by electrons, factors affecting electrical resistivity, Resistivity Mixture Rule, Skin Effect. Electrical Conductivity of Non-Metals: Ionic Crystals and Glasses, Semiconductors, Thermal Conductivity, Thermal Resistance, Magnetic properties and magnetic alloys, Soft and Hard Magnetic materials, Ferrites. Introduction to Shape Memory Alloys, properties and Applications.

Unit-5: Ceramic materials **No. of lectures-06**
Introduction to ceramics, Comparison of properties with metals and polymers, bonding-covalent and ionic, important ceramics structures, Effect of Chemical Forces on Physical Properties: Melting Points, Thermal Expansion & Surface Energy. Chemical Equilibrium, Chemical Stability, Phase diagrams and their importance.

Unit-6: Polymer materials **No. of lectures-06**
Types, properties and applications of Plastics such as Thermoplasts and Thermo sets. Natural polymers like Rubber, Chemical Composition of the Rubber Phenolic and Amino Resins, Unsaturated polyester resins, Epoxy resins and Polyurethanes, silicone rubbers and miscellaneous thermosetting resins, Proteins, Protein structures etc.

Text Books:

1. C. Barry Carter, M. Grant Norton, Ceramic Materials: Science and Engineering, Springer, New York.
2. M. N. Rahaman, Ceramic Processing and Sintering, Marcel Dekker Inc., New York.
3. William F. Smith, Foundations of Materials Science and Engineering, McGraw-Hill International Edition.
4. N. Braithwaite, G. Weaver, Electronic Materials (Materials in Action Series), Butterworth-Heinemann Publication.
5. B. S. Murty, P. Shankar, Textbook of Nanoscience and Nanotechnology, Universities Press (India) Private Limited.

Reference Books:

1. Klaus Schroder, Electronic, Magnetic and Thermal Properties of Solids, Marcel Dekker, New York.
2. Kenneth J. Klabunde, Ryan M. Richards (Editors), Nanoscale Materials in Chemistry, John Wiley and Sons.
3. Randall German, Sintering Theory and Practice, Wiley-Interscience.
4. ASM Handbook, Volume 7: Powder Metal Technologies and Applications, ASM International.
5. W. D. Callister, Materials Science and Engineering, John Wiley and Sons

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech. - Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE125(1): Elective III: Engineering Fracture Mechanics

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial: 01 Hours/week, 01 credit	**ISE : 30 Marks**

Course Introduction:

Fracture mechanics is the mechanical analysis of materials containing one or more cracks to predict the conditions when failure is likely to occur. It is the field of mechanics concerned with the study of the propagation of cracks in materials. It uses methods of analytical solid mechanics to calculate the driving force on a crack and those of experimental solid mechanics to characterize the material's resistance to fracture.

Course Objectives:

During this course, student is expected to:

1. Study the concept of failure in members with pre-existing flaws.
2. Acquire basic skills, to work professionally as an engineer for applying fracture mechanics theory and to calculate stress areas and the "energy release rate" around crack tips and crack growth due to fatigue.
3. Examine Failure of structural components from the mechanics and micro structural points of view.
4. Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain structural failure mode.
2. Calculate the crack propagation rate
3. Analyze and calculate stress intensity factors (SIF) for various crack geometries, including edge cracks and embedded cracks.
4. Analyze the behavior of crack tip plasticity and comprehend the influence of plate thickness on crack tip plasticity
5. Analyze the fatigue behavior of materials and structures
6. Solve the high Temperature Materials Problems.

Section I

Unit-1: Introduction **No. of lectures-04**

Kinds of failure, historical aspects, brittle and ductile fracture, modes of fracture failure.

Unit-2: Fracture Criteria **No. of lectures-08**

Griffith criterion, Irwin's Fracture Criterion, Stress Intensity Approach, Stress intensity factor, Surface energy, energy release rate, crack resistance, R curve for brittle crack, stable and unstable crack growth, critical energy release rate

Unit-3: Stress intensity factor **No. of lectures- 08**

Stress and displacement fields, edge cracks, embedded cracks, SIF for different geometry, critical stress intensity factor

Section II

Unit-4: Crack tip plasticity **No. of lectures-08**

Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement, Test methods for determining critical energy release rate, critical stress intensity factor, J- Integral: clip gauge, load displacement test, etc.

Unit-5: Fatigue mechanics **No. of lectures-08**

S-N diagram, fatigue limit, fatigue crack growth rate, Paris law, Crackpropagation, effect of an overload, crack closure, variable amplitude fatigue load. Environment- assisted cracking. Dynamic mode crack initiation and growth, various crack detection techniques

Unit-6: Creep **No. of lectures-04**

Creep and Stress Rupture, high Temperature Materials Problems, Time dependent Mechanical Behavior, The creep curve, the stress rupture test, structural changes during creep

Text Books:

1. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press.
2. Prashant Kumar, Elements of Fracture Mechanics, McGraw-Hill Education.
3. David Broek, Elementary Engineering Fracture Mechanics, Springer.

Reference Books:

1. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley and Sons.
2. Tada H., Paris P. C., Irwin G. R., The Stress Analysis of Cracks Handbook, ASME Press.
3. Suresh S., Fatigue of Materials, Cambridge University Press.
4. Knott J. F., Fundamentals of Fracture Mechanics, Butterworth-Heinemann.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE125(2): Elective III: Project Management

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial: 01 Hours/week, 01 credit	**ISE : 30 Marks**

Course Introduction: Project management is a systematic approach to planning, organizing, executing, and controlling the various aspects of a project to achieve specific objectives within defined constraints. It involves coordinating resources, people, and tasks to complete a unique project, often with a defined start and end date.

Course Objectives:

During this course, student is expected to:

1. Get introduced with project management
2. Understand the work content and related terms in project management
3. Learn about implementing the project management tools
4. Learn about developing project plan
5. Study the project implementation
6. Learn the management of Special Projects

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the project management significance
2. Describe the work content and related terms in project management
3. Apply the various project management tools
4. Develop a project Plan
5. Implement a Project in scientific manner
6. Demonstrate the process of management of special projects

Section I

Unit-1: Introduction to Project management **No. of lectures- 04**

Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization

Unit-2: Work definition **No. of lectures- 06**

Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks

Unit-3: Project Management tools: **No. of lectures- 10**

Use of at least one tool - viz. Microsoft Project / HTPM (Harvard Total Project Manager)/ Primavera Use of tools to make Gantt Charts, PERT charts and allocation of resources etc, Project Crashing Project Finance.

Section II

Unit-4: Developing Project Plan (Baseline) **No. of lectures- 05**

Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

Unit-5: Project Implementation **No. of lectures- 05**

Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management and materials management. Post-Project Analysis.

Unit-6: Management of Special Projects **No. of lectures- 10**

Management of SE/NPD/R&D/Hi-Tech/Mega Projects

Text Books:

1. K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill.
2. K. Nagarajan, Project Management, New Age International Publishers.
3. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling and Controlling, John Wiley and Sons.

Reference Books:

1. Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw-Hill.
2. Jack R. Meredith, Samuel J. Mantel, Project Management: A Managerial Approach, John Wiley and Sons.
3. Clifford F. Gray & Erik W. Larson – Project Management: The Managerial Process, McGraw-Hill, 7th Edition.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE125(3): Elective III: Design for Manufacturing and Assembly

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial: 01 Hours/week, 01 credit	**ISE : 30 Marks**

Course Introduction:

This course aims to equip students with a comprehensive understanding of design principles for manufacturability, encompassing strength, mechanical factors, mechanisms selection, evaluation methods, and process capability, including feature and geometric tolerances, assembly limits, datum features, and tolerance stacks. Additionally, it explores the crucial factors influencing form design, such as working principles, materials, manufacturing considerations, and design solutions for welded members, forgings, and castings. Furthermore, the course covers component design with an emphasis on machining and casting considerations, along with techniques for reducing environmental impact and designing for the environment, enabling students to develop sustainable and efficient engineering solutions.

Course Objectives:

During this course, student is expected to:

1. The Design for Manufacturing and assembly is challenging subject, the aim of present course is to introduce and aware students about the basic design process which based on different aspects of manufacturing as well assembly.
2. Student will have idea about different criteria made on design such as machining and casting. They also have knowledge on Environment factors.

Course Outcomes:

At the end of this course, student will be able to:

1. Describe general design principles for manufacturability.
2. Explain the factors influencing on Form Design.
3. Apply machining considerations for efficient design, economy, assembly, and accessibility in products.
4. Design castings considering parting lines, minimizing cores, machined holes, and economizing designs using DFMA.
5. Explore environmental objectives, DFE methods, lifecycle assessment, and responsible product design with practical applications.
6. Explain the reduction of environmental impact through sustainable design practices and standards.

Section I

Unit-1: Introduction **No. of lectures- 04**

General design principles for manufacturability: strength and mechanical factors, mechanisms selection, evaluation method, Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.

Unit-2: Factors influencing form Design **No. of lectures- 08**

Working principle, Material, Manufacture, Design- Possible solutions, Materials choice, Influence of materials on form design, form design of Welded members, forgings and castings.

Unit-3: Component Design-I **No. of lectures- 08**

Machining Consideration: Design features to facilitate machining drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clamp-ability, Design for accessibility, Design for assembly.

Section II

Unit-4: Component Design- II **No. of lectures- 10**

Casting Consideration: Redesign of castings based on parting line considerations, minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA.

Unit-5: Design for the Environment **No. of lectures- 06**

Introduction, Environmental objectives, Global issues Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method.

Unit-6: Techniques to reduce environmental impact **No. of lectures- 04**

Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

Text Books

1. Geoffrey Boothroyd, Peter Dewhurst, Winston Knight, Product Design for Manufacture and Assembly, CRC Press.
2. David G. Ullman, The Mechanical Design Process, McGraw-Hill.
3. K. G. Swift, J. D. Booker, Process Selection: From Design to Manufacture, Butterworth-Heinemann.

Reference Books

1. George E. Dieter, Linda C. Schmidt, Engineering Design, McGraw-Hill.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, Wiley.
3. Geoffrey Boothroyd, Assembly Automation and Product Design, CRC Press.
4. P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding, Tata McGraw-Hill.

Punyashlok Ahilyadevi Holkar Solapur University

M. Tech.- Mechanical (Design Engineering)

Syllabus W.E.F 2026-27

Semester-II

MDE125(4): Elective III: Analysis and Synthesis of Mechanisms and Machines

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Tutorial: 01 Hours/week, 01 credit	**ISE : 30 Marks**

Course Introduction: Mechanisms and machines play a crucial role in various engineering applications, ranging from simple everyday devices to complex industrial systems. The synthesis and analysis of mechanisms and machines involve designing, optimizing, and understanding their performance and behavior. It includes synthesis, kinematic and dynamic analysis of machines and mechanisms. Overall, the synthesis and analysis of mechanisms and machines are essential processes in engineering to ensure the creation of efficient, reliable, and safe systems for various applications. These concepts are studied in-depth in mechanical engineering and related disciplines. Engineers use computer-aided design (CAD) software and simulation tools to model, analyze, and optimize mechanisms and machines before they are manufactured and put into operation.

Course Objectives:

During this course, student is expected to:

1. Study the basic concepts of machines and mechanisms.
2. Learn about the kinematic analysis of complex mechanisms.
3. Get acquainted with the dynamic analysis of mechanisms.
4. Study the various graphical methods for synthesis of mechanisms.
5. Learn about the various analytical methods for synthesis of planer mechanisms.
6. Study the kinematic analysis of spatial mechanisms.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the construction and design parameters of mechanisms.
2. Analyze the simple and complex mechanisms for kinematics.
3. Analyze the simple and complex mechanisms for dynamics.
4. Analyze mechanisms for their performance in terms of motion, path and body guidance.
5. Design and synthesize the mechanisms in real life applications by applying analytical methods.
6. Analyze spatial mechanisms using matrix method.

Section I

Unit-1: Basic Concepts **No. of lectures- 4**

Definition and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom

Unit-2: Kinematic Analysis of Complex Mechanisms **No. of lectures- 5**

Velocity-acceleration analysis of complex Mechanisms by the normal acceleration and auxiliary point methods.

Unit-3: Dynamic Analysis of Planar Mechanisms and Curvature theory **No. of lectures- 11**

Inertia forces in linkages, kinetic, static Analysis of Mechanisms by matrix method. Analysis of elastic mechanisms, beam element, displacement fields for beam element, element mass and stiffness matrices, system matrices, elastic linkage model, equations of motion.

Fixed and moving centrodes, inflection circle, Euler- Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms.

Section II

Unit-4: Graphical Synthesis of Planar Mechanisms **No. of lectures- 7**

Type, number and dimensional synthesis, function Generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev Spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, center point and circle point curves, Bermester points, Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation.

Unit-5: Analytical synthesis of Planar Mechanisms **No. of lectures- 7**

Analytical synthesis of four-bar and slider- crank mechanism, Freudenstein's equation, synthesis for four accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers. Complex numbers method of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad Method, Robert Chebychev theorem, Cognates

Unit-6: Kinematic Analysis of Spatial Mechanisms **No. of lectures- 6**

Denavit- Hartenberg parameters, matrix method of analysis of spatial mechanisms.

Text Books:

1. J. J. Uicker, G. R. Pennock, J. E. Shigley, Theory of Machines and Mechanisms, Oxford University Press.
2. A. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and Synthesis, Prentice Hall.
3. Thomas Bevan, Theory of Machines, CBS Publishers.

Reference Books:

1. Robert L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill.
2. Amitabha Ghosh, Asok Kumar Mallik, Theory of Mechanisms and Machines, East-West Press.
3. Joseph E. Shigley, John J. Uicker, Theory of Machines and Mechanisms, McGraw-Hill.
4. R. S. Khurmi, J. K. Gupta, Theory of Machines, S. Chand Publications.

Punyashlok Ahilyadevi Holkar Solapur University
M. Tech.- Mechanical (Design Engineering)
Syllabus W.E.F 2026-27
Semester-II
MDE126: Mini-Project-II

Teaching Scheme	Examination Scheme
Practical : 02 Hours/Week, 01 credit	ICA: 50 Marks

Course Objectives:

1. To apply design engineering concepts for solving practical engineering problems.
2. To develop skills in design, simulation, and implementation of real-time engineering applications.
3. To build competence in technical documentation, presentation, and research publication.

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

1. Plan, design and execute a mini project in the Design Engineering domain.
2. Develop and implement a real-time engineering solution or prototype model.
3. Prepare a comprehensive technical report based on the project work.
4. Present and demonstrate the project effectively through a seminar.
5. Explain the process of research publication, patents, and copyright

Guidelines:

1. Each student shall design and demonstrate the mini project under the supervision of a faculty guide.
2. The project area should preferably be related to the dissertation work planned in the second year.
3. The project should involve design analysis, simulation, or experimental validation.
4. Hardware implementation or software simulation should be carried out wherever applicable.
5. Submission of mini project report is mandatory for internal assessment.
6. Publication of a research paper or preparation for patent filing based on the project work is encouraged.
7. Mini project work should preferably be completed in laboratory/research environment

Weekly Activity Plan		
Week	**Work to be carried**	**Hours**
Week 1-2	Guide allotment, topic finalization, project planning considering societal, environmental and economic aspects	03
Week 3-4	Literature review, problem specification and methodology finalization (Review-1)	04
Week 5-6	Simulation and analysis using software tools; hardware/software platform selection	04
Week 7-8	Implementation of design model and block level design (Review-2)	04
Week 9-10	Mini project report writing and planning for publication/patent	04
Week 11-12	Demonstration of project work and final evaluation	04