COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

NEP 2020 Compliant

Proposed Curriculum Structure

M. Tech. (Mechanical Engineering)
Specialization: Design Engineering

(Effective from: A.Y. 2024-25)

PG Program [M. Tech. (Mechanical Engineering) Specialization: Design Engineering]
Proposed Curriculum Structure
W. e. f AY 2023-24

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.88 %
PSBC	Program Specific Bridge Course	1	3	4.41 %
PCC	Program Core Course	5	17	25 %
PEC	Program Specific Elective Course	3	9	13.24 %
LC	Laboratory Course	2	4	5.88 %
VSEC	Vocational and Skill Enhancement Course	2	18	26.47 %
OE	Open Elective	1	3	4.41 %
SLC	Self-Learning Course	2	6	8.82 %
AEC	Ability Enhancement Course	1	3	4.41 %
MLC	Mandatory Learning Course	2	--	--
CCA	Co-curricular & Extracurricular Activities	1	1	1.47 %
Total		21	68	100.0%

PG Program [M. Tech. (Mechanical Engineering) Specialization: Design Engineering]
Proposed Curriculum Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				
				L	T	P	S	Credits
1.	PSMC	PSMC- MDE-23001	Mathematical Methods in Engineering	3	1	--	2	4
2.	PSBC	PSBC-MDE-23001	Computer Aided Design	3	0	--	1	3
3	PCC	PCC-MDE-23001	Stress Analysis	3	1	--	1	4
4	PCC	PCC-MDE-23002	Advanced Vibration and Acoustics	3	--	--	1	3
3	PEC	PEC-MDE- 23001	Advance Machine Design	3	--	--	1	3
		PEC-MDE-23002	Design for manufacturing and Assembly					
		PEC-MDE_23003	Molecular Mechanics and Multi Scale Modelling					
4.	AEC	AEC-MDE-23001	Finite Element Methods	3	--	--	1	3
5.	LC	LC-MDE-23001	Lab course	--	--	4	--	2
Total Credits				**18**	**2**	**4**	**7**	**22**

PG Program [M. Tech. (Mechanical Engineering) Specialization: Design Engineering]
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Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				Credit
				L	T	P	S	
1.	OE	OE-MDE-23001	Interdisciplinary Open elective	3	--	--	2	3
2.	PCC	PCC-MDE-23003	Analysis and Synthesis of Mechanism	3	--	--	2	3
	PCC	PCC-MDE-23004	Fracture Mechanics	3	1	--	2	4
	PCC	PCC-MDE-23005	Optimization Techniques in Design	3	--	--	2	3
3.	MLC	MLC-MDE-23001	Research Methodology and Intellectual Property Rights	2	--	--	--	--
4.	MLC	MLC-MDE-23002	Effective Technical Communication	1	--	--	--	--
5.	PEC	PEC-MDE-23005	Tribology in Design	3	--	--	2	3
		PEC-MDE-23006	Robotics					
		PEC-MDE-23007	Advance Engineering Materials					
6.	PEC	PEC-MDE-23008	Mechanics of composite Materials	3	--	--	2	3
		PEC-MDE-23009	Automatic Control					
7.	CCA	CCA-MDE_23001	Liberal Learning Course	--	--	--	--	1
8.	LC	LC-MDE-23002	Lab course	--	--	4	--	2
Total Credits				**21**	**1**	**4**	**12**	**22**

***Dept offers 'Mechanics of Composite Materials' course to students of other programmes.

- Exit option to qualify for **PG Diploma in Design Engineering**:
  - Eight weeks domain specific industrial internship in June-July after successfully completing the program's first year.

PG Program [M. Tech. (Mechanical Engineering) Specialization: Design Engineering]

Proposed Curriculum Structure

Semester-III

Sr. No.	Course Code	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P	S	
1.	VSEC	VSEC-MDE-23001	Dissertation Phase – I	--	--	18	12	9
2.	SLC	SLC-MDE-23001	Massive Open Online Course -I	3	--	--	3	3
			Total Credits	**Max 12**				

Semester-IV

Sr. No.	Course Code	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P	S	
1.	VSEC	VSEC-MDE-23002	Dissertation Phase – II	--	--	18	12	9
2.	SLC	SLC-MDE-23002	Massive Open Online Course -II	3	--	--	3	3
			Total Credits	**Max 12**				

- **MOOC Courses:**
  - ✓ The MOOC Course must be by NPTEL of minimum 12 weeks (about 3 months) duration.
  - ✓ Generally, the selected course should be in line with specializations or project needs.

M Tech (Mechanical Engineering)

Specialization: Design Engineering

Semester I

(PSMC-MDE-23001) Mathematical Methods in Engineering

Teaching Scheme
Lectures: 3 hrs/week, Tutorial:1hr/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will be able to

1. Identify & solve engineering problems by applying the knowledge of differential equations.
2. Apply statistical techniques for analysis.
3. Develop and analyze mathematical models of engineering systems.

Syllabus Contents:

Unit 1 : Ordinary and Partial Differential Equations and Concepts in Solution to Boundary Value Problems:

Ordinary linear differential equations solvable by direct solution methods; solvable nonlinear ODE's; First and second order partial differential equations; canonical forms; space of functions, projection of functions onto an orthogonal set; Fourier Series **[14 Hrs]**

Unit 2 : Major Equation Types Encountered in Engineering and Physical Sciences

Solution methods for wave equation, D'Alembert solution, potential equation, properties of harmonic functions, maximum principle, solution by variable separation method, heat (diffusion) equation, maximum principle for heat equation, methods for infinite and semi-infinite media, Fourier and Laplace Transforms **[18 Hrs]**

Unit 3: Introduction to Probability Theory

Probability Theory and Sampling Distributions. Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, and Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like $\chi 2$, t, F. **[10 Hrs]**

Text Books :

1. J. B. Doshi, Differential Equations for Scientists and Engineers, Narosa, New Delhi, 2010 (for Units I & II)
2. Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall, 2007 (for Units III & IV)

Reference Books :

1. Advanced Engineering Mathematics (9th Edition), by Erwin Kreyszig, Wiley India (2013)
2. Douglas C. Montgomery, Design and Analysis of Experiments (7th Edition), Wiley Student Edition, 2009.
3. S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 2008
4. William W. Hines, Douglas C. Montgomery, David M. Goldsman, Probability and Statistics for Engineering, (4th Edition), Willey Student edition, 2006.

(PSBC-MDE-23001) Computer Aided Design

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to:

1. Understand the principles of CAD systems and implement these principles to CAM and CAE systems.
2. Apply 2D, 3D transformations and projection transformations to solve mechanical Engineering problems
3. Get knowledge of various approaches of geometric modeling
4. Understand mathematical representation of 2D and 3D entities
5. Develop an ability to create automated solid model using CAD Customization and
6. Understand CAD/CAM data exchange formats

Syllabus Contents:

Unit 1: 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 Communications, Principle of networking, classification networks, network wring, methods, transmission media and interfaces, network operating systems,

Unit 3: 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 4 : Projections of geometric models, orthographic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations. Surface representation,

Unit 5 : 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 tolerancing, etc.

Unit 6: CAD Customization: Need of Cad customization. OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, Open GL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer). Creating automated Solid modeling using Customization through API. Data Exchange Formats Introduction to CAD/Cam data exchange formats. Direct and Indirect translators. Neutral file formats: Data Exchange format (DXF), Standard Triangular Languages (STL), Initial Graphics Exchange Specification (IGES).

References:

1. Ibrahbim Zeid, “CAD / CAM Theory and Practice”.
2. Jim Browne, “Computer Aided Engineering and Design”.
3. P. Radhakrishnan / V. Raju / S. Subramanyam, “CAD / CAM / CIM”.
4. P.N. Rao, “CAD / CAM principles and applications”, Tata Mcraw-Hill, 2002.
5. Rogers / Adams, “Mathematical Elements for Computer Graphics”.
6. Rooney and Steadman, “Principles of Computer Aided Design”, Aug. 1993.
7. Jerry Banks / John Carson / Barry Nelson / David Nicol, “Discrete-Event System Simulation”

(PCC-MDE-23001) Stress Analysis

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week,	T1, T2 – 20 marks each,
Tutorial :1hr/week	End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to

1. Students will understand the tensorial approach of continuum mechanics and will be able to comprehend modern research material.
2. Student will learn basic field equations such as equilibrium equations, compatibility and constitutive relationship.
3. Students will be able to apply basic field equations to torsion, bending and two dimensional problems, energy methods and plastic hinges.
4. Students will be proficient in framing correct boundary conditions while using FEM software packages.

Syllabus Contents:

Unit 1: Continuum & Tensors, Stress tensor,

Unit 2: Displacement and strains, compatibility relations.

Unit 3: Conservation Laws, Constitutive relations and Linear Elasticity, Dislocations and plastic deformation in metals.

Unit 4: Two dimensional problems, Torsion, Bending, Energy methods,

Unit 5: Plasticity in structures,

Unit 6: Thick cylinders and Disks, Contact stresses

References:

1. Sadd, Martin H., Elasticity: Theory, applications and Numerics, Academic Press 2005 (Text Book)
2. Srinath, L S, Advanced Mechanics of Solids, Tata McGraw Hill Education Pvt. Limited, New Delhi, 2009
3. Budynas, R. G. Advance strength and Applied Stress Analysis, Second Edition, WCB/ McGraw Hill 1999
4. Dally, J. W. and W.F. Riley, Experimental Stress Analysis, McGraw Hill International, Third Edition, 1991

(PCC-MDE-23002) Advanced Vibrations and Acoustics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The students will be able to model a given vibratory system as SDOF or MDOF system, with or without damping. He would also identify the type of given base or force excitation as periodic or a periodic. He would be able to write, mathematically, the excitations of the types such as impulse, step, ramp, half sinusoidal, or such simple arbitrary excitations.
2. The student will be able to predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations mentioned above using convolution integral; They will be able to obtain Shock Response Spectrum of SDOF systems for such excitations and understand use of the SRS.
3. The students will be able to write differential equations of motion for MDOF systems, and through the technique of decoupling and orthogonal properties of natural modes, should be able to obtain the eigen-values and mode shapes of natural vibrations and response to harmonic and arbitrary excitations.
4. The students will be able to obtain the eigen-values and mode shapes of natural vibrations and response to harmonic excitations using orthogonal properties of natural modes.
5. Student will be able to obtain natural frequencies and mode shapes of MDOF and continuous systems using computational methods such as Rayleigh-Ritz method, Holzer method, Dunckerley's method, and Stodola's method.
6. Student will know various terminologies used in acoustics and acoustic wave transmission.
7. The student will able to derive plane and spherical wave equations, and will be able to obtain sound pressure level at a given distance from a simple sound source of known strength.
8. Students will be able to understand the mechanism of hearing by human and principles of Psychoacoustics and noise control.
9. The student will be able to measure and analyze signals received from vibrating and/or noise radiating structure by use of accelerometers, microphones and signal analyzer. They should be able to carry out FFT analysis and know the dominant frequency components in the signal and their correlation with the vibration of the structure. They should be able to identify correlation between two signals being received from two sources.

Syllabus Contents:

Unit 1

Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function

Unit 2

Free, damped and forced vibrations of two degree of freedom systems, use of Lagrange's equations to derive the equations of motion, normal modes and their properties, multi degree of freedom systems, Eigen values and Eigen vectors, mode summation method.

Unit 3

Continuous Systems, Vibrations of strings, bars, shafts and beams, discretised models of continuous systems and their solutions using Rayleigh – Ritz method, Mode summation method,

Unit 4

Vibration Control, Methods of vibration control, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for Eigen-value calculations, Stodola method, Holzer's method,

Unit 5

Plane and Spherical acoustic waves, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, transmission through three media, Resonators and filters, Absorption of sound waves in fluids : Phase log between pressure and condensation, viscous absorption of plane waves, heat conduction as a source of acoustic attenuation,

Unit 6

Speech, Hearing and Noise, The voice mechanism, acoustic power output of a speech, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre, beats, aural harmonics and combination tones, masking by pure tones, masking by noise.

References:

1. Thomson W.T., "Theory of Vibrations with applications", George Allen and Unwh Ltd. London, 1981.
2. S.S. Rao, Addison, "Mechanical Vibrations", Wesley Publishing Co., 1990.
3. Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition.
4. S. Timoshenko, "Vibration problems in Engineering", Wiley, 1974.
5. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.
6. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.

(PEC-MDE-23001) Advance Machine Design

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Students will realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centred market.
2. Students will demonstrate the ability to identify needs of the customer and convert them in to

technical specifications of a product.

3. Students will be able to generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.
4. Students will understand the principals used while designing for manufacture, assembly, emotions and maintenance.
5. Students will know various methods of rapid prototyping and reverse engineering to test and modify the designs.
6. Students will be able to design the components considering strength based reliability.

Syllabus Contents:

Unit 1: Development processes and organizations, Product Planning

Unit 2: Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing

Unit 3: Design for manufacture, assembly, maintenance

Unit 4: Design for Reliability, strength based reliability, parallel and series systems, robust design

Unit 5: Industrial design: Design for Emotion and experience, Introduction to retrofit design, Human behavior in design

Unit 6: Various methods of Rapid Prototyping & Reverse Engineering, their applications, advantages and disadvantages.

Text Books:

1. George E Dieter, "Engineering Design", McGraw Hill Company, 2000.

References:

1. Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi. 2012
2. Karl T. Ulrich, Steven Eppinger, "Product Design and development "
3. Kiran Fernandes, Vishesh Raja "Reverse Engineering "(Springer series in Advance (Mfg.)
4. Chua Chee Kai, Leong Kah Fai, "Rapid prototyping- Principles and applications in Manufacturing", John Wiley & sons Inc.
5. Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.

(PEC-MDE-23002) Design for Manufacture and Assembly

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to

1. Comprehend the product development cycle
2. Identify the manufacturing issues that must be considered in the mechanical engineering design process
3. Apply the principles of assembly to minimize the assembly time
4. Make out the effect of manufacturing process and assembly operations on the cost of product
5. Apply tools and methods to facilitate development of manufacturable mechanical designs.

Syllabus Contents:

Unit 1 :
Introduction : Need Identification and Problem Definition; Concept Generation and Evaluation; Embodiment Design

Unit 2 :
Selection of Materials and Shapes: Properties of Engineering Materials; Selection of Materials; Selection of Shapes; Co-selection of Materials and Shapes

Unit 3 :
Selection of Manufacturing Process: Review of Manufacturing Processes; ; Design for Bulk Deformation Processes: Design for Sheet Metal Forming Processes; Design for Machining; Design for Powder Metallurgy; Design for Polymer Processing; Co-selection of Materials and Processes

Unit4 :
Assembly Processes: Review of Assembly Processes; Design for Welding; Design for Brazing and Soldering; Design for Adhesive Bonding; Design for Joining of Polymers; Design for Heat Treatment;

Unit 5 :
Design for Reliability and Quality: Failure Mode and Effect Analysis; Design for Quality; Design for Reliability; Approach to Robust Design

Unit 6 :
Modern methods of Manufacturing: Rapid Prototyping & Reverse Engineering, their applications,

Text Books :

G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.

References:

1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 2003.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 2000.

3. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.

(PEC-MDE-23003) Molecular Mechanics and Multiscale Modelling

Teaching Scheme

Lectures : 3 hrs / week

Examination Scheme

T1, T2: 20 marks

End Sem. Exam: 60 marks

Course Outcomes:

Students should be able to:

1. Deal with molecular dynamics simulations at the nano-scale level and perform bottom-up approach in an efficient way.
2. Perform FEM simulations at macro-scale by using nano-scale mechanical properties .
3. Use the knowledge of fracture at nano-scale as well as macro-scale.
4. Deal with interdisciplinary field problems, e.g nano-scale MD simulations and macro-scale FEM simulations
5. Use the knowledge to explore naturally available hierarchical materials, which outperform artificial materials in terms of mechanical properties
6. Apply contents of the lecture to natural as well as artificial materials.

Unit 1: Introduction and motivation of multi-scale modeling (05 Hrs)

Need of multi-scale modelling, Current and potential applications, Future scope of multiscale modelling inresearch and development, Challenges.

Unit 2: Theoretical background of molecular dynamics (08 hrs)

Basic molecular dynamics algorithm, Potential Energy ,Non-bonded interactions : van der Waals interactions, electrostatic interactions, embedded-atom method , Bonded interactions : covalent, Integration Algorithms : verlet Algorithm, velocity Verlet Algorithm, predictor-corrector.

Unit 3: Common statistical ensembles and temperature couplings (08 hrs)

Common statistical ensembles : microcanonical (NVE) ; canonical (NVT) ; Isothermal-Isobaric (NPT), Ensemble : advantages, limitations and usages, Temperature couplings : velocity scaling

; Berendsen ; Andersen ; Nosé-Hoover, Temperature coupling : advantages, limitations and usages

Unit 4: Molecular dynamics simulations and mechanical properties at nanoscale (08 hrs)
Initialization : crystal structure, initial atom velocities, Energy minimization : Steepest descent (SD), conjugate gradient (CG), Newton-Raphson, Equilibration : different types of equilibration, importance, influence on the output , Extration of mechanical properties : Virial stress, force, response functions (for example, constant volume heat capacity), entropic properties, radial distribution function , Non-equilibrium molecular dynamics : Calculate viscosity, thermal conductivity

Unit 5 Theoretical background of continuum mechanics (06 hrs)
Concept of a continuum ,Kinematics : motion and deformation , Governing equations Simple examples : tensile, compression, bending tests.

Unit 6 Multiscale modelling : bottom-up approach (06 hrs)
Scale bridging — Bottom-up approach — Applications, e.g., spider silk, nacre — Analysis of multi-phasic materials — Examples of advanced materials

Text Books:

1. Frenkel, D., and Smit, B. (2001). Understanding molecular simulation: from algorithms to applications (Vol. 1). Elsevier.
2. Rapaport, D. C. (2004). The art of molecular dynamics simulation. Cambridge university press.
3. Leach, A. R., and Leach, A. R. (2001). Molecular modelling : principles and applications. Pearson education

References:

1. Allen, M. P. (2004). Introduction to molecular dynamics simulation. Computational soft matter : from synthetic polymers to proteins, 23(1), 1-28.
2. Engquist, B., Lötstedt, P., Runborg, O. (Eds.). (2009). Multiscale modeling and simulation in science (Vol. 66). Springer Science Business Media.
3. Patil, S.P, Shendye, P, and Markert, B. (2020). Molecular dynamics simulations of silica aerogel nanocomposites reinforced by glass fibers, graphene sheets and carbon nanotubes. A comparison study on mechanical properties. Composites Part B Engineering, 107884.
4. Herman J.Govednik, M. Patil, S.P. and Markert, B. (2020). Molecular Dynamics Simulation Study of the Mechanical Properties of Nanocrystalline Body-Centered Cubic Iron. Surfaces, 3(3), 381– 391.

(AEC-MDE-23001) Finite Element Method

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each,
	End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The student will be able to classify a given problem on the basis of its dimensionality as 1-D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear.
2. The students will be able to develop system level matrix equations from a given mathematical model of a problem following the Galerkin weighted residual method or principle of stationary potential.
3. While demonstrating the process mentioned in 2 above, he will be able to identify the primary and secondary variables of the problem and choose correct nodal degrees of freedom and develop suitable shape functions for an element, implement Gauss-Legendre scheme of numerical integration to evaluate integrals at element level, and assemble the element level equations to get the system level matrix equations. He will also be able to substitute the essential boundary conditions correctly and obtain the solution to system level matrix equations to get the values of the field variable at the global nodes.
4. The student will be able to state three sources of errors in implementing FEM and suggest remedies to minimize the same for a given problem, viz. Modelling errors, Approximation errors, and numerical errors.
5. The student will be able to obtain consistent and lumped mass matrices for axial vibration of bars and transverse vibration of beams and obtain fundamental frequency of natural vibration using the methods mentioned in the curricula.
6. The students will be able use MATLAB for implementation of FEM to obtain elongations at nodes of a bar subjected to traction and concentrated loads and prescribed boundary conditions
7. The students will be able to use commercial software like ANSYS or ABAQUS for implementation of FEM to obtain stress concentration due to a small hole in a rectangular plate subjected to traction on edges and concentrated loads at points on the edges and prescribed boundary conditions.

Syllabus Contents:

Unit 1: Introduction, Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc,

Unit 2: Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions,

Unit 3: Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss-Legendre scheme of numerical integration, Nodal degrees of freedom,

Unit 4: Finite element formulation, variational, weighted residual and virtual work methods, 1-D and 2-D problems from Structural Mechanics – Bar and Beam problem,

Unit 5: Plane stress and plane strain problems, Axi-symmetric problems – Axi-symmetric forces and geometry, computer implementation, higher order elements, Iso-parametric formulation,

Unit 6: Eigen-value problems, Natural axial vibration of bars and transverse vibration of beams, Methods to find Eigen-values and Eigen-vectors.

References:

1. Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
2. Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 3rd ed. 2002
3. Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981.
4. Reddy J N, "Finite element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, Ed. 2, 2003
5. Bathe K.J., Cliffs, N.J. "Finite Element Procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.

(LC-MDE-23001) Lab Course

Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/week	End sem -100

Course Outcomes:

At the end of the course Students will be able to

1. Use various experimental techniques relevant to the subject.
2. Acquire hands on experience on the various test-rigs, experimental set up.
3. Function as a team member
4. Develop communication skills.
5. Write technical reports.
6. Use different software's.
7. Develop attitude of lifelong learning.

Syllabus Contents:

The lab practice consists of experiments, tutorials and assignments decided by the course supervisors of the program core courses and program specific elective courses.

SEMESTER –II

(PCC-MDE-23003) Analysis and Synthesis of Mechanisms

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will be able to

1. develop analytical equations describing the relative position, velocity and acceleration of all moving links.
2. select, configure, and synthesize mechanical components into complete systems.
3. Use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.
4. Formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical and analytical methods.
5. Analyze and animate the movement of planar and spherical four-bar linkages.
6. students will be able to apply modern computer-based techniques in the selection, analysis, and synthesis of components and their integration into complete mechanical systems.
7. Finally Students will demonstrate ability to think creatively, participate in design challenges, and present logical solutions.

Syllabus Contents:

Unit 1

Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.

Unit 2

Curvature Theory: Fixed and moving centrodes, inflection circle, Euler-Savary equation, cubic of stationary curvature.

Unit 3

Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms.

Unit 4

Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers.

Unit 5

Coupler Curves : Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

Unit 6

Kinematic Analysis of Spatial Mechanisms, Denavit-Hartenberg parameters, Velocity and acceleration analysis of spatial linkages. matrix method of analysis of spatial mechanisms

References:

1. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
2. Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition
3. Hamilton H.Mabie,"Mechanisms and Dynamics of Machinery",John Wiley and sons New York
4. S.B.Tuttle,"Mechanisms for Engineering Design" John Wiley and sons New York
5. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.
6. A.G. Erdman and G.N. Sandor, "Mechanism Design – Analysis and Synthesis", (Vol. 1 and 2), Prentice Hall India, 1988.
7. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall of India.
8. J.E. Shigley and J.J. Uicker, "Theory of Machines and Mechanisms", 2nd Edition, McGraw-Hill, 1995.
9. Robert J. Schilling, "Fundamentals of robotics Analysis and control" Prentice Hall publication.

(PCC-MDE-23004) Fracture Mechanics

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Students will be able to use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, J integral, Crack tip opening displacement.
2. Students will be able to manage singularity at crack tip using complex variable.
3. Students will understand important role played by plastic zone at the crack tip.
4. Students will learn modern fatigue and will able to calculate the fatigue life of a component with or without crack in it.
5. Students will learn modern sophisticated experimental techniques to determine fracture toughness and stress intensity factor.

Syllabus Contents:

Unit 1:

Modes of fracture failure, Brittle and ductile fracture,

Unit 2:

Energy release rate: crack resistance, stable and unstable crack growth.

Unit 3

Stress intensity factor: Stress and displacement fields, edge cracks, embedded cracks.

Unit 4:

Crack tip plasticity: Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement.

Unit 5:

Test methods for determining critical energy release rate, critical stress intensity factor, J-Integral. Finite element analysis of cracks

Unit 6:

Fatigue failure: Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load. Environment-assisted cracking. Dynamic mode crack initiation and growth, various crack detection techniques.

References:

1. Kumar, Prashant, "Elements of Fracture mechanics", .McGraw-Hill Education Pvt. Limited, New Delhi, 2009
2. Maiti, Surjya Kumar, "Fracture Mechanics : Fundamentals and Applications, Cambridge University Press, Delhi, 2015
3. Gdoutos, E.E. (2005). Fracture Mechanics - An Introduction, Springer, Dordrecht, (2005).
6. Ramesh, K. . Engineering fracture mechanics, NPTEL

(PCC-MDE-23005) Optimization Techniques in Design

Teaching Scheme
Lectures: 3 hrs/week,
Tutorial :1hr/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam -
60

Course Outcomes:

At the end of the course students will be able to:

1. Formulate an optimization problem.
2. Apply algorithms for unconstrained optimization.
3. Apply algorithms for constrained optimization.
4. Find the optimum solution using nontraditional optimization techniques.

Syllabus Contents:

Unit 1: Introduction to optimization, classification of optimisation problems, classical optimisation techniques,

Unit 2: Linear programming, simplex method and Duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's methods,

Unit 3: Non-Linear Programming: - One dimensional minimization, unconstrained and constrained minimization, direct and indirect methods,

Unit 4: Geometric programming, Optimum design of mechanical elements like beams, columns, gears, shafts, etc.

Unit 5: Introduction to multi-objective optimization, genetic Algorithms, Operators, applications in multi-objective optimization.

References:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 2005.
2. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980.
3. Kalyanmoy Deb, "Evolutionary multi-objective optimization, Willey, New York.
4. S. S. Stricker, "Optimising performance of energy systems" Battelle Press, New York, 1985.
5. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
6. L.C.W. Dixon, "Non-Linear Optimisation - Theory and Algorithms", Birkhauser, Boston, 1980.
7. R.J. Duffin, E.L. Peterson and C.Zener "Geometric Programming-Theory and Applications", Willey, New York, 1967.

8. G.B. Dantzig "Linear Programming and Extensions Princeton University Press", Princeton, N. J., 1963.
9. R. Bellman "Dynamic Programming-Princeton" University Press, Princeton, N.J. 1957.

(MLc-MDE-23001) Research Methodology and Intellectual Property Rights

Teaching Scheme	**Examination Scheme**
Lectures: 1 hrs/week	End-Sem Exam - 100

Course Outcomes:

At the end of the course, students will be able to

1. Understand research problem formulation and approaches of investigation of solutions for research problems
2. Learn ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits.

Syllabus Contents: **Assignments/Presentation/Quiz/Test**

Unit 1:
[5Hrs]
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Unit 2:
[5Hrs]
Effective literature studies approaches, analysis, Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype. Analyze your results and draw conclusions or Build Prototype, Test and Redesign

Unit 3: **[5Hrs]**
Plagiarism, Research ethics, Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: **[4Hrs]**
Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 5: **[7Hrs]**

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification, Plant Patenting, Idea Patenting, Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

Unit 6: **[4Hrs]**

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: WIPO, TRIPs, Patenting under PCT

Reference Books:

1. Aswani Kumar Bansal: Law of Trademarks in India
2. B L Wadehra: Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications.
3. G.V.G Krishnamurthy: The Law of Trademarks, Copyright, Patents and Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay: The Law of Trademarks, Copyright, Patents
6. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO: WIPO Guide to Using Patent Information
9. Resisting Intellectual Property by Halbert, Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill
11. Product Design by Niebel, Mc Graw Hill
12. Introduction to Design by Asimov, Prentice Hall
13. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley.

(MLC-MDE-23002) Effective Technical Communication

Teaching Scheme	**Examination Scheme**
Lectures: 1 hr/week	100M: 4 Assignments (25M each)

Course Outcomes:

At the end of the course, Students will be able to

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts / principles of communication skills
4. Demonstrate productive skills and have a knack for structured conversations

5. Appreciate, analyze, evaluate business reports and research papers.

Syllabus Contents:

Unit 1: Fundamentals of Communication **[4 Hrs]**

7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Unit 2: Aural-Oral Communication **[4 Hrs]**

The art of listening, stress and intonation, group discussion, oral presentation skills

Unit 3: Reading and Writing **[4 Hrs]**

Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

Reference Books :

1. Raman Sharma, "Technical Communication", Oxford University Press.
2. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.
4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

(PEC-MDE-23005) Tribology in Design

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The students will be able to apply theories of friction and wear to various practical situations by analysing the physics of the process.
2. They will understand the various surface measurement techniques and effect of surface texture on Tribological behaviour of a surface.
3. They will be able to select materials and lubricants to suggest a tribological solution to a particular situation.
4. The students will be able to design a hydrodynamic bearing using various bearing charts.
5. The students will be able to understand the recent developments in the field and understand modern research material.

Syllabus Contents:

Unit 1:

Friction, theories of friction, Friction control, contact of surfaces, genesis of friction, instabilities and stick-slip motion.

Unit 2:
Wear, types of wear, theories of wear, wear prevention.

Unit 3:
Surface texture and measurement, Tribological properties of bearing materials and lubricants.

Unit 4:
Lubrication, Reynolds's equation and its limitations, idealized bearings, infinitely long pivoted and fixed slider shoe bearings,

Unit 5:
Infinitely long, short (narrow) and finite journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Design of hydrodynamic journal and slider-shoe bearings, Air lubricated bearings,, Squeeze film Circular and rectangular flat plates,

Unit 6:
Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings.

References:

1. Principles in Tribology, Edited by J. Halling, 1975
2. Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International,1994
3. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
4. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
5. "Fundamentals of Friction and wear of Materials" American Society of Metals.
6. Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler & co. pvt. ltd 1985.
7. T.A. Stolarski, "Tribology in Machine Design".

(PEC-MDE-23006) Robotics

Teaching Scheme
Lectures: 3 hrs/week,
Tutorial :1hr/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course outcomes:
At the end of the course students will be able to

1. Understand basic concepts related with robotics
2. Know various subsystems of robotics & get the basics design & selection parameters of it.

3. Apply the principles of kinematics and dynamics to understand motion and control of robots.
4. Apply tools and methods to understand modelling programming and simulations of robotic systems
5. Make out the effect of the associated knowledge & to observe recent updates in the field of robotics.

Syllabus Contents:

Unit 1: **Introduction**: - Basic Concepts, Robotics and automation, Robot anatomy, Classification, structure of robots, resolution, accuracy, repeatability, point to point and continuous path robotic systems. Associated parameters i.e., resolution, accuracy, repeatability, Compliance, etc. **[6 hrs]**

Unit 2: Robot Grippers & Sensors: - Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system, Characteristics of sensing devices, Selections of sensors, Classification & applications of sensors. Need for sensors & vision system in the working and control of a robot. **[8 hrs]**

Unit 3: Drives & Control Systems: - Free body diagram Types of Drives, Actuators and its selection while designing a robot system. Types of Controllers, Introduction to closed loop control, second order linear systems and their control, control law partitioning, trajectory-following control, modelling and control of a single joint, Present industrial robot control systems and introduction to force control. **[6 hrs]**

Unit 4: Kinematics: - Transformation matrices & their arithmetic, link & joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic & geometrical methods.
Velocities & Static forces in manipulators: Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain.
Dynamics: - Introduction to Dynamics, Trajectory generations, Manipulator Mechanism Design **[8 hrs]**

Unit 5: Transmission Systems for Robotics: - Basic motion conversion devices, Problems at efficient power transmission. Concept & related terms of power transfer. Modeling of Mechanical System & robots: - Solid Modeling for robots by using simulation software, Elements of modeling and related terms, Transfer function and Characteristic Equations.
Machine Vision System: - Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. **[6 hrs]**

Unit 6: Robot Programming: - Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II……etc, Features of each type and development of languages for recent robot systems. Artificial Intelligence: Introduction to Artificial Intelligence, AI techniques, Need and application of AI.

General Topics in Robotics: Economical aspects for robot design, Socio-Economic aspect of robotisation, Safety for robot and associated mass, New Trends & recent updates, International Scenario for implementing robots in Industrial and other sectors. Future scope for robotisation. **[6 hrs]**

Text Books:

1. Richard D. Klafter, Thomas A. Chemielewski, Michael Negin, Robotic Engineering: An Integrated Approach, Prentice Hall India, 2002.
2. Groover M. P., Wiess M., Nagel R. N. and Odery N. G. Industrial Robotics- Technology, Programming and Applications, McGraw Hill Inc. Singapore 2000.

References:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004
2. K.S. Fu, R.C. Gonzales, C.S.G. Lee, Robotics: Control, Sensing, Vision & Intelligence, MGH, 1987.
3. Shimon Y. Nof, Handbook of Industrial Robotics, John Wiley Co, 2001.
4. Niku, Saeed B. Introduction to Robotics Analysis, Systems Applns, Pearson Ed. Inc.

(PEC-MDE-23007) Advance Engineering Materials

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week,	T1, T2 – 20 marks each,
Tutorial :1hr/week	End-Sem Exam - 60

Course outcomes:

At the end of the course the students will be able to

1. Comprehend the microstructures and phase diagrams of ferrous and non ferrous materials.
2. Apply the learning of various phase diagrams to analyze the phases.
3. Apply mechanical testing of composites, semi and super conducting materials for various applications.
4. Select the materials like polymers, superalloys, high temperature materials for industrial and domestic applications.

Unit I - Ferrous Materials

Introduction, Fe-C phase diagram, various invariant reactions observed in Fe-C phase diagram, steel, low carbon steel, dual phase steels, micro alloying steels, weathering steels, free cutting steels, medium carbon steels, high strength structure steels, ausformed steels, martensitic stainless steels, Tool materials – classification, properties, heat treatment of high-speed steel, Tool for cold and hot forming, tools for high-speed cutting, TTT diagram, cast iron, Grey cast iron, white cast iron, malleable cast iron, nodular cast iron or ductile iron, vermicular graphite iron, properties and applications.

Unit II – Non-Ferrous Materials, Super Alloys, Bio-Materials
Introduction, Types of Non-Ferrous materials, Cu and Cu alloys, properties and applications, aluminum, cast aluminum alloys, wrought aluminum alloys, properties and Applications, Ti and its alloys, properties and applications Mg and its alloys, properties and applications, super alloys: Ni, Fe and Co based alloys, properties and applications, bio-materials, bio compatibility, applications and properties.

Unit III – Polymeric Materials
Introduction to thermoplastic and thermo-setting plastics, industrial polymerization method, processing of plastic materials, processes used for thermoplastic materials, injection moulding, extrusion, blow moulding and thermo forming, properties and applications, Processes used thermosetting materials, compression moulding, transfer moulding and injection moulding, Ceramic materials: processing of ceramics, forming – pressing, dry pressing, isostatic pressing, hot pressing, slip casting , extrusion, thermal treatment, vitrification, properties and applications, Engineering ceramics – alumina, silicon nitrite, silicon carbide, magnetic materials, magnetic fields, Types of magnetism, soft magnetic materials, properties and applications.

Unit IV – Composite Material, Semi and Super Conducting Materials
Composite materials properties and applications, Metal matrix composites, scope, properties and applications, Methods of fabrication, Polymer matrix composites, scope, properties and applications, Methods of fabrication, Ceramic matrix composite, scope, properties and applications. Methods of fabrication, Mechanical properties of composites – tensile elastic and fatigue properties, Fracture modes in composites, Plastic deformation, joining and machining of composite materials, Mechanical testing of composite materials, Examples of some critical applications of composite materials.

Unit V – Advanced Materials and Properties of Metal and Alloys:

Smart materials: classification, piezo electric materials, Rheological materials, smart gets, chromic materials, thermo-responsive materials magneto-strictive materials, elertro-stricitve materials, nanotechnology materials synthesis, properties, carbon nanotechnology tubes and applications.

Coatings and High- Temperature Materials: Introduction to high temperature Materials, Characteristics of engineering materials at high temperature, oxidation, high temperature corrosion, Creep, thermal fatigue, erosion, aging, structural changes, material damage, crack propagation, damage mechanics, life time analysis.

High temperature materials: Carbon alloy steels, Stainless steels, super alloys and titanium and its alloys, ceramics, composites, Refractory metals, alloys and Structural inter-metallic and high temperature polymers. Coatings: Thermal barrier coatings, Oxidation resistant coatings.

Unit VI – Selection of Materials

Philosophy of material selection, relationship to available resources, concept of resource base, Criteria for selection of engineering materials – service requirements, ease of manufacturing, availability of materials and cost effectiveness, Selection for mechanical properties like strength, toughness, stainless, fatigue, creep and temperature resistance, Selection for surface durability like for corrosion resistance, wear resistance, Relationship between material selection and material processing, Identification of required properties.

Ashby charts for materials selection, application of statistics in materials, properties of ferrous and non-ferrous alloys, ceramics and polymers for light and heavy structural, corrosion resistant, high temperature, low-temperature and cryogenic, wear resistant, magnetic, electrical and electronic applications, pressure vessels and boilers, bearings, tools, medical implants and prostheses application, Composites, shape memory alloys, metallic glasses, nanocrystalline materials. Importance of failure analysis and its relationship to material selection, fundamental causes of failure, General practice in failure analysis, Identification and characterization of ductile and brittle type of failures, Identification and characterization of fatigue failures.

Text Books

1. Sidney Avner, Introduction to Physical Metallurgy, McGraw Hill Publication, 2nd Edition.
2. Gowariker, V. R., Viswanathan, N. V. and Shreedhar, J. Polymer Science, New Age International, New Delhi, 2005.
3. Chanda M., Introduction to Polymer Science and Chemistry, CRC Press, Taylor and Francis Group, FL, USA, 2006.

Reference Books

1. Cowie, J. M. G., Polymers: Chemistry and Physics of Modern Materials, Blackie Academic & Professional, Glasgow, 1991.
2. Odian George, Principles of Polymerization, Fourth Edition, Wiley International, Jersey, USA, 2004.
3. Flory P.J., Principles of Polymer Chemistry, Sixteenth Printing, Cornell University Press, New York, 1995.

(PEC-MDE-23008) Mechanics of Composite Materials

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course outcomes:

At the end of the course students will be able to

1. Demonstrate role of constituent materials in defining the average properties and response of composite materials on macroscopic level.

2. Apply knowledge for determination of failure envelopes and stress-strain behavior of laminates.
3. Demonstrate advantages by design of structures with composite materials than with conventional materials.
4. Develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.

Syllabus Contents:

Unit 1. Introduction: -
Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus.
Processing of FRP Composites: Materials-Fibers and Matrix, Fundamentals, Manufacturing processes for thermoset and thermoplastic matrix composites **[05 hrs]**

Unit 2. Basic Concepts and Characteristics: -
Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials **[05 hrs]**

Unit 3. Elastic Behaviour of Unidirectional Lamina: -
Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters **[06 hrs]**

Unit 4. Strength of Unidirectional Lamina: -
Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories **[06 hrs]**

Unit 5. Elastic Behaviour of Laminate: -
Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates

Hygrothermal Effects: - Hygrothermal effects on mechanical behaviour, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage. **[07 hrs]**

Unit 6. Stress and Failure Analysis of Laminates: -

Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials **[07 hrs]**

References:

1. Isaac M. Daniels, Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. P. K. Mallick, "Fiber-Reinforced Composites", CRC Press, 2008.
4. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 2003.
5. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
6. Mazumdar S. K., "Composite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.
7. Robert M. Jones, "Mechanics of Composite Materials", Taylor and Francis, Inc., 1999.

(PEC-MDE-23009) Automatic Control

Teaching Scheme
Lectures: 3 hrs/week,
Tutorial:1 hr/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

Course Outcomes:

Students will be able to

1. Describe the basic features and configurations of control systems.
2. Find the transfer function for linear, time-invariant translational mechanical systems and produce analogues electrical and mechanical circuits.
3. Describe quantitatively the transient response of first and second order systems.
4. Apply frequency response techniques for stability analysis.

Syllabus Contents:

Unit 1: Introduction to Automatic Control System
Definition and types, Performance specifications, Design process, Block diagrams, Laplace transform and Transfer function [6 Hrs]

Unit 2: Mathematical Modeling

Translational mechanical system, Rotational mechanical system, Electrical system, Linearization of nonlinear systems, Numerical [6 Hrs]

Unit 3: Transient Response Analysis

Poles and zeros, First order system, Second order system, Underdamped second order system-I, Underdamped second order system - II [8 Hrs]

Unit 4: Stability and Steady State Error

Definition of stability, Routh-Hurwitz criterion, Routh-Hurwitz criterion- special cases, Steady state errors, Static error constants [8 Hrs]

Unit 5: Root Locus Technique

Define root locus, sketching of root locus- I, sketching of root locus- II, Sketching of root locus-III, Numerical examples and second order approximation.

PI controller design, PD controller design, PID controller design, LAG compensation, LEAD and LAGLEAD compensation [6 Hrs]

Unit 6: Application of MATLAB in Automatic Control

State space representation, converting a transfer function to state space, converting from state space to transfer function, Controller design, Controller design and Controllability

Transfer function, poles, zeros, response, Steady state error, root locus, Design via root locus, compensation–I, Design via root locus, compensation-II, State space method [6 Hrs]

Textbooks:

1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India,5thEdition, 2010.
2. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, 6th Edition, 2010.
3. Rudrapratap, "Getting started with MATLAB", Oxford university press, 12^{th} Edition,2009

(LC-MDE-23002) Lab course

Teaching Scheme	Examination Scheme
Lectures: 2 hrs/week	End-Sem Exam - 100

Course Outcomes:

At the end of the course Students will be able to

1. Use various experimental techniques relevant to the subject.

2. Function as a team member
3. Develop communication skills.
4. Write technical reports.
5. Use different software’s.
6. Develop attitude of lifelong learning.
7. Acquire hands on experience on the various test-rigs, Experimental set up.

Syllabus Contents:

The lab practice consists of experiments, tutorials and assignments decided by the course supervisors of the program core courses and program specific elective courses.

SEMSETER – III

(VSEC-MDE-23001) Dissertation Phase - I

Teaching Scheme
Lectures: 14 hr/week

Examination Scheme
End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
2. Students will be able to use different experimental techniques.
3. Students will be able to use different software/ computational/analytical tools.
4. Students will be able to design and develop an experimental set up/ equipment/test rig.
5. Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
6. Students will be able to either work in a research environment or in an industrial environment.

Syllabus Contents:

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.

The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

SLC-MDE-23001 Massive Open Online Course –I

MOOC Courses:

- ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
- ✓ Generally the selected course should be in line with specializations or project needs.

SEMESETER IV

(VSEC-MDE-23002) Dissertation Phase – II

Teaching Scheme	**Examination Scheme**
Lectures: 18 hr/week	End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will develop attitude of lifelong learning and will develop interpersonal skills to deal with people working in diversified field will.
2. Students will learn to write technical reports and research papers to publish at national and international level.
3. Students will develop strong communication skills to defend their work in front of technically qualified audience.

Syllabus Contents:

It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.

The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.

SLC-MDE-23002 Massive Open Online Course –I

MOOC Courses:

- ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
- ✓ Generally the selected course should be in line with specializations or project needs.