VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech in Machine Design
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21

M.Tech in Machine Design

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MMD11	Mathematical Methods In Engineering	03	--	02	03	40	60	100	4
2	PCC	20 MMD12	Design Of Vibration Control Systems	03	--	02	03	40	60	100	4
3	PCC	20 MMD13	Continuum Mechanics	03	--	02	03	40	60	100	4
4	PCC	20 MMD14	Fracture Mechanics	03	--	02	03	40	60	100	4
5	PCC	20 MMD15	Dynamics And Mechanism Design	03	--	02	03	40	60	100	4
6	PCC	20 MMDL16	Design Laboratory -1	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 MMD21	Advanced Finite Element Analysis	03	--	02	03	40	60	100	4
2	PCC	20 MMD22	Advanced Machine Design	03	--	02	03	40	60	100	4
3	PCC	20 MMD23	Tribology And Bearing Design	03	--	02	03	40	60	100	4
4	PEC	20 MMD24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20 MMD25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20 MMDL26	Design Laboratory -2	--	04	--	03	40	60	100	2
7	PCC	20 MMD27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20 MMD**24X**	**Course title**	**Course Code under 20** MMD**25X**	**Course title**
20MMD241	Creative Engineering	20MMD251	Automobile System Design
20MMD242	Machine Learning	20MMD252	Computational Fluid Dynamics
20MMD243	Material Handling Equipment Design	20MMD253	ROTOR DYNAMICS
20MMD244	Design Of Robotic System	20MMD254	Design Of Intelligent Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MMD31	Design For Manufacture And Assembly	03	--	02	03	40	60	100	4
2	PEC	20MMD32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20MMD33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20MMD34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20MMD35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20MMDI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under 20MMD32X	**Course title**	**Course Code under 20MMD33X**	**Course title**
20 MMD321	Mechatronics System Design	20 MMD 331	Smart Materials And Structures
20 MMD 322	Nanoscale Modeling And Simulation	20 MMD 332	Design Optimization
20 MMD 323	Composite Materials Technology	20 MMD 333	Design Of Hydraulic & Pneumatic Systems
20 MMD 324	Experimental Mechanics	20 MMD 334	Computer Application In Design

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20MMD41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

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MATHEMATICAL METHODS IN ENGINEERING			
Course Code	20MMD11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Errors and Simple Mathematical modeling: Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.

Engineering Applications on :

i) Deflection of Beams
ii) Whirling of shafts
iii) Terminal velocity of a freely falling body

(RBT Levels: **L1 & L2)** (Text Book:1)

Module-2

System of Linear Algebraic Equations And Eigen Value Problems: Gauss-Jordan Method, Cholesky Method, Partition method, Givens method for symmetric matrices, (RBT Levels: L1 & L2) (Text Book:3)

Module-3

Roots of Equations: Muller's method , Graeffe's roots squaring method.

Numerical solutions of ordinary differential equations: Introduction, Picard`s method of successive approximation, first order simultaneous equations by Picard`s & Runge Kutta methods. & second order equations by Picard`s & Runge Kutta methods. (RBT Levels: **L2 & L3)** (Text Book:3)

Module-4

Partial Differential Equations: Numerical solution of one dimensional wave equation, Heat equation,(Schmidt`s explicit formula)& Laplace equation(Gauss-Seidel process) by finite difference schemes. Illustrative examples on each method, (RBT Levels: **L2 & L3)** (Text Book:2)

Module-5

Sampling theory: Testing of hypothesis: Chi square test and F-test. Analysis of Variance (ANOVA): one way classification, Design of experiments, RBD.
(RBT Levels: **L2 & L3)** (Ref. Book:1)

Course outcomes:

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

1. Acquire the idea of significant figures, types of errors during numerical computation.
2. Understand statistical and probabilistic concepts required to test the hypothesis and designing the experiments using RBD.
3. Learn various numerical methods to solve system of linear equations.
4. Understand the roots of algebraic/transcendental equations and solve PDE's numerically.
5. Analyze and solve PDE's related to wave equation arising in vibration analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Ed., cGraw-Hill Edition, 2015.
2. Theory of ordinary differential equations, Coddington E., Levinson N., McGraw-Hill publishing Company, TMH Edition, 9th Reprint, 1987.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books

1. R.E, Walpole, R.H.Myres, S.L.Myres and Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson, 2012.
2. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999.
3. K Shankar Rao, "Introduction to Partial Differential Equations" Prentice - Hall of India Pvt. Lt. , 1995 Edition.
4. C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics". 6th edition, McGraw-Hill, 1995.

DESIGN OF VIBRATION CONTROL SYSTEMS			
Course Code	20MMD12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Review of Mechanical Vibrations Basic concepts: free vibration of single degree of freedom Systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers

Module-2

Transient Vibration of single Degree of freedom systems: Impulse excitation, arbitrary excitation, Laplace transform formulation, Pulse excitation and rise-time, Shock response spectrum, Shock isolation.
Random Vibrations: Random phenomena, Time averaging and expected value, Frequency Response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.

Module-3

Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.
Modal analysis &Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis

Module-4

Vibration and Noise Control : Basics Of Noise, Introduction, amplitude, frequency, wavelength and sound pressure lavel, addition, subtraction and averaging decibel; levels, noise dose lavel, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis tracking analysis sound quality analysis. Introduction to Automotive noise sources, Engine over-all noise lavels.

Module-5

Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.

Course outcomes:

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

CO1. Apply Newton's equation of motion and energy methods to model basic vibrating mechanical system, model undamped and damped mechanical systems and structures for free and harmonically forced vibrations.

CO2. Model single-and multi-degree of freedom for free and forced vibrations and determine response to vibration, natural frequencies and modes of vibration.

CO3. Apply the fundamentals of vibration to its measurement and analysis.

CO4. Solve realistic vibration problems in mechanical engineering design that involves application of most of the course syllabus.

CO5. Ability to design and develop vibrations and noise control systems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. S. S. Rao, "Mechanical Vibrations" , Pearson Education, 4th edition.
2. S. Graham Kelly," Fundamentals of Mechanical Vibration" -McGraw-Hill, 2000
3. Theory of Vibration with Application, -William T. Thomson, Marie Dillon

Reference Books

1. S. Graham Kelly," Mechanical Vibrations" , Schaum' s Outlines, Tata McGraw Hill, 2007.
2. C Sujatha," Vibrations and Acoustics – Measurements and signal analysis" , Tata McGraw Hill, 2010.

CONTINUUM MECHANICS			
Course Code	20MMD13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Analysis of Stress: Definition and Notation for forces and stresses. Body force, surface force, components of stresses, equations of equilibrium, specification of stress at a point. Principal stresses, maximum and minimum shear stress. Boundary conditions. Stress components on an arbitrary plane, stress invariants, octahedral stresses, decomposition of state of stress, deviator and spherical stress tensors, stress transformation.

Module-2

Deformation and Strain: Deformation, strain Displacement relations, strain components, The state of strain at a point, , Principal strain, strain invariants, Strain transformation, Compatibility equations, Cubical dilatation, spherical and deviator strains, plane strain, Mohr's circle, and compatibility equation Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems.

Module-3

Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation of simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems. Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem.

Module-4

Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate. Thermal Stresses: Introduction, Thermo-elastic stress -strain relations, thin circular disc, long circular cylinder.

Module-5

Torsion of Prismatic Bars: Introduction, Torsion of circular cross section bars, Torsion of elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open tubes. Elastic Stability: Axial compression of prismatic bars, Elastic stability, buckling load for column with constant cross section.
Viscoelasticity: Linear Viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation.

Course outcomes:

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

CO1. Treat general stresses and deformations in continuous materials

CO2. Formulate and solve specific technical problems of displacement, strain and stress.

CO3. Perform experiments with stresses and deformations.

CO4. Model and analyse the stresses and deformations of simple geometries under an arbitrary load in solids

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. 1 Timoshenko and Goodier, "Theory of Elasticity"-'Tata McGraw Hill, New Delhi,3rd edition , 1970
2. L S Srinath "Advanced Mechanics of Solids"- Tata McGraw Hill, New Delhi, 3rd edition, 2010
3. G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press, Boca Raton, 2010

Reference Books

1. Batra, R. C., Elements of Continuum Mechanics, Reston, 2006.
2. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw-Hill, 1970
3. Dill, Ellis Harold, Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, CRC Press , 2006.
4. Sadhu Singh," Theory of Elasticity"- Khanna publisher, 4th edition, 2013

FRACTURE MECHANICS			
Course Code	20MMD14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Fracture mechanics principles: Introduction and historical review, sources of micro and macro cracks. stress concentration due to elliptical hole, strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, elliptical cracks, numerical problems.

Module-2

Plasticity effects, Irwin plastic zone correction, and Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, plastic constraint factor. The thickness effect, and numerical problems.
Determination of stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test; standard test, and specimen size requirements.

Module-3

The energy release rate, and criteria for crack growth. The crack resistance (R curve), compliance, J integral, tearing modulus and stability.
Elastic Plastic Fracture Mechanics (EPFM): Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD, use of J integral, and limitation of J integral.

Module-4

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.**

Module-5

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, mixed mode (combined) loading and design criteria.

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

C01	Develop basic fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
C02	Be able to select appropriate materials for engineering structures to insure damage tolerance.
C03	Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
C04	Understand the relationship between crack tip opening displacement, SIF and ERR and application of such parameters for ductile and brittle materials.
C05	Understanding of experimental techniques to determine the critical values of parameters at crack tip.
C06	Understand and appreciate of the status of academic research in field of fracture mechanics.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

1. David Broek, "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011
2. Anderson , "Fracture Mechanics-Fundamental and Application", T.L CRC press1998.

Reference Books

1. Karen Hellan , “Introduction to fracture mechanics”, McGraw Hill, 2nd Edition
2. S.A. Meguid , “Engineering fracture mechanics” Elsevier Applied Science, 1989
3. Jayatilaka, “Fracture of Engineering Brittle Materials”, Applied Science Publishers, 1979
4. Rolfe and Barsom , “Fracture and Fatigue Control in Structures” , Prentice Hall, 1977
5. Knott , “Fundamentals of fracture mechanisms”, Butterworths, 1973

DYNAMICS AND MECHANISM DESIGN			
Course Code	20MMD15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, unique mechanisms.
Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method, Numerical examples.

Module-2

Generalized Principles of Dynamics: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum.
Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Numerical examples.

Module-3

Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle. Numerical examples.

Module-4

Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages
Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.

Module-5

System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances.
Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. Numerical examples.

Course outcomes:

At the end of the course the student will be able to:
CO1. Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.
CO2. Formulate equations of motion for complicated mechanical systems /linkages and hods for solving these equations.
CO3.Understand multi body dynamics in mechanical engineering design

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. K.J.Waldron&G.L.Kinzel , “Kinematics, Dynamics and Design of Machinery”, Wiley India, 2007.
2. Greenwood, “Classical Dynamics”, Prentice Hall of India, 1988.

Reference Books

1. J E Shigley, “Theory of Machines and Mechanism” -McGraw-Hill, 1995
2. A.G.Ambekar , “Mechanism and Machine Theory”, PHI, 2007.
3. Ghosh and Mallick , “Theory of Mechanism and Mechanism”, East West press

Design Laboratory			
Course Code	20MMDL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
1	**Modal analysis** **Goal:** Modal analysis of a prestressed structure plate with a hole**.**
2	**Harmonic analysis** **Goal:** Determine the harmonic response of a steel beam carrying with minimum two members mounted on beam considering damping ratio
3	**Transient analysis** **Goal:** Determine the transient response of a steel beam considering damping ratio
4	**Random Vibration** **Goal:** Determine the displacements and stresses of the model airplane wing due to an acceleration Power Spectral Density (PSD)
5	**Trip cost optimization** **Goal:** Find the optimum speed of travel to minimize the cost of a trip, assuming the traveler's time.
6	**Parametric modeling and axisymmetric probl**em **Goal:** Build a parametric, axisymmetric model, optimum design is one that performs the intended function, meets all design constraints, and uses the least amount of material (or cost or some other criterion).
7	**Topological optimization** **Goal:** A steel plate is subjected to a tensile or compressive pressure load. Determine a shape suitable for the loading.
8	**large deflection in beams** **Goal:** Determine the displacement using both a linear and nonlinear (large-deflection) analysis, then

Note: The above analysis can be performed by using any FEA/CAE packages

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

Course outcomes:

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5),
Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

ADVANCED FINITE ELEMENT ANALYSIS			
Course Code	20MMD21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Basics of Finite Element Analysis: Shape function of the linear bar element, quadratic bar element, 2-D Constant strain triangular element, 2-D linear triangular element, 4 noded quadrilateral element, 9-noded quadrilateral element and scrindipidy elements. Stiffness, traction and body force equations for 1-D 2 noded element, 2-D truss element, CST element and 4 noded quadrilateral elements and related problems.

Module-2

Axisymmetric Solids: Structures of Revolution, Axisymmetric Solid Iso-P Elements, Iso-P Quadrilateral Ring Elements, A Complete Axisymmetric FEM Program. Axisymmetric Solid Benchmark Problems

Module-3

General Solids: Solid Elements: Overview. The Linear Tetrahedron, The Quadratic Tetrahedron. The 8-Node Hexahedron. The 20-Node Hexahedron. Pyramid solid elements: a successful application of morphing.

Module-4

Dynamic Analysis using Finite Element Method: Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices – element equations –solution of eigenvalue problems – vector iteration methods – normal modes – transient vibrations – modeling of damping – mode superposition technique – direct integration methods

Module-5

Applications in Heat Transfer & Fluid Mechanics: One dimensional heat transfer element – application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions – Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D.

Course outcomes:

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

CO1. Explain the fundamentals of finite element methods

CO2. Develop the knowledge to analyses, structures under static and dynamic conditions.

CO3. Selection of numerical techniques for solving engineering problems

CO4. Explore the use of finite element method knowledge to implement industrial project

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Chandrupatla T. R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall, 2003.
2. Reddy, J. N. An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3. The Finite Element Method in Engineering, S. S. Rao, Fifth Edition, Elsevier Publications.
4. Thomas Apel and Olaf Steinbach, "Advanced Finite Element Methods and Applicatons", Springer Publications, ISBN 978–3–642–30315–9, 2013

ADVANCED MACHINE DESIGN			
Course Code	20MMD22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr' s theory and modified Mohr' s theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

Module-2

Stress-Life(S-N) Approach: S-N curves, Statistical nature of fatigue Test data, General SN behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach. Strain-Life (ε-N)approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

Module-3

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.
Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean Stress effects and Haigh diagrams, Numerical examples.

Module-4

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life Estimation using stress life approach, Numerical examples.
Notch strain analysis: Strain– life approach, Neuber' s rule, Glinka' s rule, applications of Fracture mechanics to crack growth at notches, Numerical examples.

Module-5

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Abrasive wear, Corrosion wear.
Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength, Surface fatigue failure modes, Design to avoid Surface failures

Course outcomes:

At the end of the course the student will be able to:
CO1. Apply state of the art design methodology namely design by analysis and damage tolerant design to mechanical components.
CO2. Distinguish different design criteria and their procedure to carry out the design of mechanical components.
CO3. Design machine components which are subjected to fluctuating loads.
CO4. Design machine components using techniques like stress life approach, Strain life approach and Fracture mechanics approach.
CO5. Define the various statistical aspects of fatigue using different probability distribution plots

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. RalphI. Stephens,Ali Fatemi, Robert, Henryo. Fuchs, " Metal Fatigue in engineering" , John Wiley New York, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack.A. Collins, John Wiley, New York 1992.
3. Robert.L.Norton , " Machine Design" , Pearson Education India, 2000

Reference Books

1. S.Suresh , " Fatigue of Materials" , Cambridge University Press, -1998
2. Julie.A.Benantine, " Fundamentals of Metal Fatigue Analysis" , PrenticeHall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol .19,2002.

TRIBOLOGY AND BEARING DESIGN			
Course Code	20MMD23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.

Module-2

Hydrodynamic Lubrication: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

Module-3

Hydrostatic Bearings: Hydrostatic thrust bearings , hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.

EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

Module-4

Antifriction bearings: Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings,Equations for porous bearings and working principal, Fretting phenomenon and its stages.

Module-5

Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

Course outcomes:

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

01	Design or choose efficient tribological systems such as rolling element bearings, hydrodynamic bearings, and dry sliding bearings, for the needs of a specific application.
C02	Select compatible materials for minimizing friction and wear in machinery.
C03	Explain the concepts advanced bearings like magnetic bearings, porous bearings and gas lubricated bearings.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000.

Reference Books

1. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.

CREATIVE ENGINEERING			
Course Code	20MMD241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, technology and business on creativity, force field analysis, market pull & technology push, attribute of a creative person, creative thinking in groups, creating a creative climate. CREATIVITY & PRODUCT DESIGN Need or identification of a problem, market survey, data collection, review & analysis, problem definition, Kipling method, challenge statement, problem statement initial specifications

Module-2

Idea Generation Brain storming, analogy technique or synectics, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making, CREATIVE THINKING PROBLEM / OPPORTUNITY Pictures of situation, environment, quantification, Heros, boundary conditions, record discuss-clarify-verify, recording of ideas, evaluation of ideas, detail design, prototyping, product deployment, useful life assessment, recycling.

Module-3

Emotional Design Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective- design by individual and design in groups, designs with personality – machines that senses emotions and induce emotions- Robots, personality products, products for games, fun, people and places; Simulation – dimensional or mathematical, virtual simulation, physical simulation, scale down models.

Module-4

Theory Of Inventive Problem Solving (Triz) Common features of good solutions – resolve contradiction, use available resource, increase the ideality, trade-off, inherent contradiction, 30 key TRIZ principles – multifunction, preliminary action, compensation, nested doll, blessing in disguise, segmentation, separation, regional influences, symmetry change, opaque & porous, inflate and deflate, color, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, equipotential, static & dynamic, continuous & intermittent, servo systems, smart systems, dimensions

Module-5

Application Of Ceda Approach: (a) Cooking stove for rural India; (b) utilizing solar energy; (c) water filtration systems; (d) automation in healthcare; (e) technologies for law enforcement; (f) application of robots to reduce human fatigue (g) Layout of berths in a railway coach.

Course outcomes:

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

CO1. Explain the steps involved in the creative thinking process

CO2. Apply the various techniques for stimulating creativity and innovation thinking

CO3. Analyze the techniques to design and develop new products.

CO4. Synthesize the creative design with analysis to develop new products

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Amaresh Chakrabarti, Creative Engineering Design Synthesis, Springer, 2009
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479
3. Donald A. Norman,Emotional Design, Perseus Books Group New York , 2004, ISBN 123-1-118- 027-6
4. Kalevi Rantanen & Ellen Domb, Simplified TRIZ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748

MACHINE LEARNING			
Course Code	20MMD242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias - Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.

Module-2

Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles - Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing - Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis dimension.

Module-3

Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Hornclause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol - Support Vector Machines: Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.

Module-4

Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies - Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. KNearest-neighbor algorithm. Case-based learning - Text Classification: Bag of words representation. Vector space model and cosine similarity. Relevance feedback and Rocchio algorithm. Versions of nearest neighbor and Naive Bayes for text.

Module-5

Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. K-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data - Language Learning: Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.

Course outcomes:

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

CO1. Choose the learning techniques with this basic knowledge

CO2. Apply effectively genetic algorithms for appropriate applications.

CO3. Apply bayesian techniques and derive effectively learning rules.

CO4. Choose and differentiate Clustering & Unsupervised Learning and Language Learning

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks
1. Tom M. Mitchell , "Machine learning", McGraw Hill 1997 2. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006. 3. Rajjan Shinghal, "Pattern Recognition", Oxford Press, 2006.
Reference Books
1. Ethem Alpaydin, "Introduction to machine learning", PHI learning, 2008. 2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001. 3. .R.O. Duda, P.E. Hart and D.G. Stork, Pattern Classification, Wiley-Interscience, 2nd Edition, 2000. 3. T. Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2nd Edition, 2009

MATERIAL HANDLING EQUIPMENT DESIGN			
Course Code	20MMD243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Elements of Material Handling System,Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment.

Selection of Material Handling Equipment: Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.

Module-2

Conveyor Design: Introduction to apron conveyors, Pneumatic conveyors, Belt Conveyors, Screw conveyors and vibratory conveyors and theirapplications, Design of Belt conveyor-Belt selection procedure and calculation of drop energy, Idler design.

Module-3

Design of hoisting elements: Welded and roller chains -Hemp and wire ropes -Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs-lifting magnets -

Grabbing attachments -Design of arresting gear -Brakes: shoe, band and cone types

Module-4

Design of cranes: Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes

Module-5

Design of Bucket Elevators: Introduction, Types of Bucket Elevator, Design of Bucket Elevator - loading and bucket arrangements, Cage elevators , shaft way, guides, counter weights.

Packaging and storage of bulk materials: Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system

Course outcomes:

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

C01	Select appropriate equipment for material handling and understand the basic roles of the different equipment.
C02	Apply appropriate techniques for improving existing material handling systems; recognize the importance of safety and applicatons of optimization techniques to material handling.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Conveyor Equipment Manufacturer's Association, "Belt conveyors for bulk materials" 6th edition,The New CEMA Book
2. Rudenko N., "Materials handling equipment ", Elnvee Publishers, 1970
3. Ishwar GMulani and Mrs.Madhu I Mulani, "Engineering Science and application design for belt conveyor", Madhu I. Mulani, 2002.
4. Spivakovsy A.O. and Dyachkov V.K., "Conveying Machines, Volumes I and II" , MIR Publishers, 1985.
5. Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
6. Boltzharol, A., "Materials Handling Handbook", The Ronald press company 1958.
7. Kulwiac R. A., 'Material Handling Hand Book', 2nd edition, JohnWilly Publication, NewYork.
8. James M. Apple, 'Material Handling System Design', John-Willlwy and Sons Publication, NewYork

DESIGN OF ROBOTIC SYSTEM			
Course Code	20MMD244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

History of service robotics – Present status and future trends – Need for service robots – applications examples and Specifications of service and field Robots. Non-conventional Industrial robots. Classification, applications, sensing and perception, social and ethical implications of robotics.

Module-2

Autonomous Mobile robots: Kinematics, locomotion, perception, motion planning and control, localization and mapping. Road map path planning, intelligent unmanned vehicles. Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness.

Module-3

Field Robots: Collision Avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications. Industrial applications like cleaning robots, wall painting robots, wall plastering robots, vehicle equipment and building robots etc Load carrying robots. IDE detection and diffusion robots.

Module-4

Underwater robots: Kinematics and dynamics, modeling and simulation, navigation, guidance and control. Marine data collection (Temperature, other environment parameters).

Module-5

Aerial robots: Basics of aerial robots, sensors and actuators, modelling and control of small Unmanned Aerial vehicles, guidance and navigation of small range aerial robots, Autonomous indoor flight control Air defence robots.

Course outcomes:

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

CO1. Demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics.

CO2. Apply spatial transformation to obtain forward kinematics equation of robot manipulators.

CO3. Solve inverse kinematics of simple robot manipulator.

CO4. Analyze robots for underwater application.

CO5. To select type of robot for specific application.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Roland Siegwart, Illah Reza Nourbakhsh, DavideScaramuzza, Introduction to Autonomous Mobile Robots, Bradford Company Scituate, USA, 2004
2. RiadhSiaer, The future of Humanoid Robots- Research and applications, Intech Publications, 2012.

Reference Books

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
2. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, Field and Service Robotics, Springer, 2011

AUTOMOBILE SYSTEM DESIGN			
Course Code	20MMD251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Body Shapes: Aerodynamic Shapes, drag forces for small family cars.
Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit

Module-2

Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.

Module-3

Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston &piston rings for small family cars (max up to 3 cylinders)

Module-4

Transmission System: Design of transmission systems – gearbox (max of 4- speeds), differential suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.

Module-5

Cooling System: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of emissions, exhaust gas emission testing

Course outcomes:

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

CO1. Gain an insight into aspects of vehicle design, operation and maintenance, which will be useful for taking up a position in the automotive industry.

CO2. Apply the knowledge in creating a preliminary design of automobile subsystems.

CO3. Identify construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.

CO4. Identify Modern technology and safety measures used in Automotive Vehicles.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Design of Automotive Engines, -A.Kolchin&V. Demidov, MIR Publishers, Moscow.
2. The motor vehicle, Newtonsteeds &Garratte-Iliffee&sonsLtd.,London.
3. I.C. Engines -Edward FObert,International text book company.

Reference Books

1. Introduction to combustion-Turns.
2. Automobile Mechanic-, N.K.Giri, Khanna Publications, 1994
3. I.C. Engines -Maleev, McGraw Hill book company, 1976
4. Diesel engine design- HeldtP.M.,Chilton companyNew York.
5. Problems on design of machine elements- V.M. Faires &Wingreen, McMillan Company.,1965
6. Design of I.C.Engines -John Heywood, TMH.

COMPUTATIONAL FLUID DYNAMICS			
Course Code	20MMD252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods Governing equations of fluid dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.

Module-2

Mathematical behavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points. Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids

Module-3

Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization. Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, artificial dissipation and dispersion.

Module-4

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, a Gauss Siedel iteration method, point- and line-successive over-relaxation methods, and alternative direction implicit methods. Hyperbolic equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes.

Module-5

Scalar representation of navier-stokes equations: Equations of fluid motion, numerical algorithms: FTCS explicit, FTBCS explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, BTCS and BTBCs implicit algorithms, applications. Grid generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation. Finite volume method for unstructured grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements Numerical solution of quasi one-dimensional nozzle flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows.

Course outcomes:

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

CO1. To derive the stepwise procedure to completely solve a fluid dynamics problem using computational methods.

CO2. To explain the governing equations and understand the behavior of the equations.

CO3. To determine the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations.

CO4. To verify variations of SIMPLE schemes for incompressible flows and Variations of Flux Splitting algorithms for Compressible flows.

CO5. To identify various methods of grid generation techniques and application of finite difference and finite volume methods to various thermal problems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Numerical Heat Transfer and Fluid Flow - S.V. Patankar, Hemisphere Publishing Company.
2. Computational Fluid Dynamics - T.J. Chung, Cambridge University Press 2003
3. Computational fluid flow and heat transfer - K. Murlidhar and T. Sounderrajan, Narosa Publishing Co.
4. Computational fluid mechanics and heat transfer - D. A. Anderson, J. C. Tannehill, R.H. Pletcher, Tata McGraw-Hill Publications 2002
5. Computational fluid dynamics - J.A. Anderson, McGraw-Hill Publications 1995
6. An Introduction to Computational Fluid DynamicsVersteeg, H.K. and Malalasekara, W., , Pearson Education, 2010.

ROTOR DYNAMICS			
Course Code	20MMD253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

FluidFilmLubrication:Basictheoryoffluidfilmlubrication,derivationofgeneralizedReynoldsequations,boundaryconditions,fluid film stiffness and damping coefficients, stability and dynamic response for hydrodynamic journal bearing, and two lobe journal bearings.
Stability of Flexible shafts:
Introduction,equationofmotionofaflexibleshaftwithrigidsupport,radialelasticfrictionforces,rotary friction, friction Independent of velocity, friction dependent on frequency, different shaft stiffness constants, gyroscopic effects, nonlinear problems of large deformation applied forces, instability of rotors in magnetic field.

Module-2

Critical Speed: Dunkerley's method, Rayleigh's method, Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, simple model with one concentrated mass at the center.

Module-3

Element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions.

Module-4

Turbo rotor System Stability by Finite Element Formulation: General turbo rotor system, generalized forces and co-ordinates system, assembly element matrices, consistent mass matrix formulation, Lumped mass model, linearised model for journal bearings, system dynamic equations. Fix stability analysis, non-dimensional stability analysis, unbalance response and transient analysis.

Module-5

Blade Vibration: Centrifugal effect, Transfer matrix and finite element approaches.

Course outcomes:
At the end of the course the student will be able to:
CO1. Provides the student understanding of modeling rotating machine elements theoretically.
CO2. Upon completion of this course, students will have gained an understanding of the design, application, and reliability evaluation of bearings in rotating machinery applications.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin , “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie , “Matrix Methods in Elasto Mechanics”, McGraw-Hill, 1963.
4. Timosenko , “Vibration Problems in Engineering”, Oxford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

DESIGN OF INTELLIGENT SYSTEMS			
Course Code	20MMD254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Overview of Artificial Intelligence: Artificial Intelligence and its Application areas; Knowledge Representation and Search: The Predicate Calculus: The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor; Structures and strategies for state space search: Introduction, Structures for state space search ,Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/Or Graphs.

Module-2

Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues.
Control and Implementation of State Space Search: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.

Module-3

Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs.
Knowledge Intensive Problem Solving: Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems
Planning: Introduction to Planning, Algorithms as State-Space Search, Planning graphs.

Module-4

Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving;
Uncertain Knowledge and Reasoning: Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use. Representing Knowledge in Uncertain Domain: Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network

Module-5

Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems
Artificial Neural Networks: ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks.
Artificial Intelligence Current Trends: The Science of Intelligent Systems, AI: Current Challenges and Future Directions

Course outcomes:

At the end of the course the student will be able to:
CO1. Explore various Artificial Intelligence problem solving techniques.
CO2.Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature in AI problems.
CO3. Apply the AI techniques to solve various AI problems.
CO4. Analyze and compare the relative challenges pertaining to design of Intelligent Systems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. George F Luger, Artificial Intelligence – Structures and Strategies for Complex problem Solving, 6th Edition, Pearson Publication, 2009, ISBN-10: 0-321-54589-3, ISBN-13: 978-0-321-54589-3
2. Stuart Russel, Peter Norvig, Artificial Intelligence A Modern Approach, 3rd Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3. Elaine Rich, Kevin Knight, Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709, ISBN-13: 978-0070087705
4. Grosan, Crina, Abraham, Ajith, Intelligent Systems-A Modern Approach, Springer-Verlag Berlin Heidelberg 2011, ISBN 9783642269394, 2011.

DESIGN LABORATORY -2			
Course Code	20MMDL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	Experiments
1	Geometric Instability (Buckling): Buckling of Arch Purpose: Run both linear and nonlinear buckling analyses of an arch. Goal: Become familiar with the procedure for performing eigenvalue buckling, adding a geometric imperfection, and running **nonlinear buckling analysis.**
2	Viscoelasticity: Compression of Block Purpose: Run an analysis of the compression and release of a rubber block to see creep and recovery of elastic strains. Goal: Become familiar with input and post processing of viscoelastic materials
3	Forming of Sheet Purpose: Run a creep problem which uses power law creep on a pressure-loaded metal sheet. Goal: Solve a model with implicit creep which experiences an applied pressure. Become familiar with creep limit cutback contro**l.**
4	Plate with Hole Purpose: Compare Mises and Hill yield criteria. Goal: Solve a nonlinear analysis of three plates with holes.
5	Thermal-Electric-Mechanical Analysis of Thermal Actuator Goal: To perform a thermal-electrical-mechanical evaluation of a MEMS thermal actuator
6	Evaluation of Piezoelectric Actuator Goal: To evaluate a piezoelectric actuator – Static analysis to determine the deflection – Modal analysis determine lowest modes and frequencies – Harmonic analysis to determine the deflection caused by an alternating current
7	Surface Based Constraint Using Contact with MPC Option Purpose: Demonstrate how to use the new contact MPC option for applying a surface based constraint to a structure. Goal: Apply a translational and rotational displacement load to a structure and simulate both a rigid and flexible response (similar to CERIG and RBE3 type behaviors)

Note: The above analysis can be performed by using any FEA/CAE packages

TECHNICAL SEMINAR			
Course Code	20MMD27	CIE Marks	100
Number of contact Hours/week (L:P:SDA)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20XXX27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

DESIGN FOR MANUFACTURE AND ASSEMBLY			
Course Code	20MMD31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Effect of Materials and Manufacturing Process on Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process cost per unit property, weighted properties and limits on properties methods. Tolerances Analysis: Process capability ,mean, varience, skewness ,kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances relevant to manufacturing and assembly, tolerance stacks, effects on assembly, methods of eliminating tolerance stacks, Geometries tolerances, Geometric tolerances, Surface finish,Reviewof relationship between attainable tolerance grade san different machining process. Cumulative effect of tolerance-Sure fit law and truncated normal allowance.

Module-2

Selective Assembly: Interchangeable part manufacture and selective assembly, deciding the number of groups Group tolerance of Mating parts equal, Model total and group tolerances of shaft equal. Control of axial play- Introducing secondary machining operations, laminated shims, examples. Assemble advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Datum Features: Functional datum, Datum for manufacturing, changing the datum. Examples

Module-3

Design Considerations: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and machined holes. Identifying the possible an probable parting line. Casting requiring special and cores. Designing tool viates and cores. Welding considerations: requirements and rules, redesign of components for welding; case studies. Component Design: Component design with machining considerations link design fortuning components-milling, Drilling and other related processes including finish- machining operations.

Module-4

Forging considerations -Requirements and rules -Redesign of components for forging and Case studies. True positional theory: Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerance, virtual size concept, floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, and Paper layout gauging. Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

Module-5

Approaches to design for assembly-Qualitative evaluation procedures, knowledge based approach, Computer aided DFA methods. Assimilability measures. Booth royd-Dewhurst DFA method-Redesign of simple product-Case studies.

Course outcomes:

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

C01. Describe the different types of manufacturing systems and compare their suitability for economic production of various components and products.

C02. Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.

C03. Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Harry Peck," Designing for Manufacturing",PitmanPublications,1983.
2. Dieter," Machine Design" - McGraw-Hill Higher Education, -2008
3. R.K.Jain, "EngineeringMetrology",KhannaPublishers,1986
4. Product design for manufacture and assembly-Geoffrey Boothroyd, Peterdew hurst, Winston Knight, Mercel dekker. Inc. CRCPress, Third Edition
5. MaterialselectionandDesign, Vol.20-ASMHandbook.
6. Alan Redford and Chal, (1994) Design for Assembly-Principles and Procedures. McGraw Hill International.
7. JamesG.Bralla,(1986)HandBookofProductDesignforManufacturing.McGrawHillCo

MECHATRONICS SYSTEM DESIGN			
Course Code	20MMD321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Definition and introduction to Mechatronic Systems. Modelling & Simulation of physical systems. Overview of Mechatronic products and their functioning. Measurement systems, control systems, simple controllers. Study of sensors and transducers, Pneumatic and Hydraulic Systems, Mechanical actuation systems, Electrical actuation systems, Real time interfacing and hardware components for Mechatronics.

Module-2

Electrical Actuation Systems: Electrical systems, mechanical switches, solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, electro-mechanical systems, hydro-mechanical systems, pneumatic systems.

Module-3

Signal Conditioning: Signal conditioning, the operational amplifier, protection, filtering, Wheatstone bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, Pulse-modulation. MEMS and Micro systems: Introduction, working principle, materials for MEMS and Micro systems, Micro system fabrication process, overview of Micro Manufacturing, Micro system Design, and Micro system packaging.

Module-4

Data Presentation Systems: Basic System Models, System Models, and Dynamic Responses of System.

Module-5

Advanced Applications in Mechatronics: Fault Finding, Design arrangements and practical case studies, Design for manufacturing, User- friendly design

Course outcomes:

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

CO1. Describe mechatronic systems and overview of control systems & actuators.
CO2. Identify and describe the different types of actuators used in mechatronic systems.
CO3. Differentiate between various sensors, transducers and actuators and their applications.
CO4. Identify and describe the different types of speed- and position feedback devices.
CO5. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.
CO6. Discuss the importance of feedback in controlling physical systems with the use of examples.
CO7. Explain the principle of operation of ac induction motor, dc motor, servomotor and stepper motor.
CO8. Identify and describe the types of controllers used in mechatronic systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1 W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999 2. HSU “MEMS and Microsystems design and manufacture” - Tata McGraw-Hill Education, 2002

Reference Books

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics” - IEEE Press, 1 Edition, 1996
2. Shetty and Kolk “Mechatronics System Design” - Cengage Learning, 2010
3. Mahalik “Mechatronics” - Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics” - Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”– . Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments” - Pergamon Press, 1971.

NANOSCALE MODELING AND SIMULATION			
Course Code	20MMD322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Definition of a model, modeling in materials science; Simulation vs. modeling; Simulation techniques for nano, micro, meso and continuum scales; Nanoscale and microscale - molecular dynamics and Monte Carlo techniques.

Module-2

Statistical Mechanics: Microstate, Macrostate, Distribution Laws, Indistinguishable particles, statistical mechanics and thermodynamics laws; Maxwell Botzmann statistics.

Module-3

Monte Caro Simulation: Principles of equilibrium; Monte Carlo simulation estimator; Importance of sampling, acceptance ratio, continuous time MC, Ising model and Metropolis algorithm; Simulation of Interfaces; Analysis of MC data; Out of equilibrium simulation; MC simulation in surface science; Implementation of MC algorithms.

Module-4

Molecular Dynamics: Introduction, Interatomic potentials, Equations of motion, integration, Pair Distribution, constraints and free energy; Time correlation functions and spherical densities; Velocity autocorrelation functions; Time correlation function and relaxation times; Applications in nano materials.

Module-5

Overview of Modelling, Simulation and Visualization Software: LAMMPS, ABMER, Folding@home, GROMACS, NAMD, VMD, XMD, Materials Studio.

Course outcomes:

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

CO1. Differentiate between simulation and modelling of nano materials
CO2. Apply knowledge of various concepts related to nano sized materials
CO3. Implementation of Monte Caro algorithms for Nano materials.
CO4. Calculate the interatomic potential for Nano materials.
CO5. Analyse nano material using different modelling software.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Newman, M.E.J. and Barkema, G.T., "Monte Carlo Methods in Statistical Phyiscs", Oxford University Press. 1999
2. Lee, J. G., "Computational Materials Science – An Introduction", CRC Press. 2012
3. Wolfson, M.M. and Pert, G. J., "An Introduction to Computer Simulation", Oxford Press. 1999
4. Raabe, D., Computational Materials Science: The Simulation of Materials Microstructures and Properties, Wiley-VCH 2005
5. Landau, D.P. and Binder, K., "A Guide to Monte Carlo Simulation in Statistical Physics", Cambridge University Press. 2005
6. Frenkel, D. and Smith, B., "Understanding Molecular Simulation", Academic Press. 1996

COMPOSITE MATERIALS TECHNOLOGY			
Course Code	20MMD323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction

Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths. Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations.

Module-3

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation).

Module-4

Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures. Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

Module-5

Manufacturing and Testing: Layup and curing - open and closed mould processing, Hand lay- up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests– Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

Course outcomes:

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

CO1. Understand the use of fibre-reinforced composites in structural applications.

CO2. Develop a basic understanding of the use of composite materials, micro- mechanics of layered composites, analysis and design of composite structures and failure analysis of laminated panels.

CO3. Apply the basic micro-mechanics theories in the design of fibre reinforced composites.

CO4. Analyze the performance of composites in engineering applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

Reference Books

1. J.N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, McGraw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.
7. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

EXPERIMENTAL MECHANICS			
Course Code	20MMD324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction:Definitionofterms,calibration, standards, dimension and units,generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

Analysisof ExperimentalData: Causeand types of experimentalerrors,erroranalysis.Statisticalanalysisof experimentaldata-probabilitydistribution, Gaussian, Normaldistribution. Chi-square test, methodof least square, correlation coefficient, multivariable regression, standard deviation of mean,graphicalanalysisandcurvefitting,generalconsiderationindataanalysis.

Module-2

Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion. Basic components (storageanddisplay) of data acquisition system. Computerprogramasasubstitute forwiredlogic.
Force,TorqueandStrainMeasurement: Massbalancemeasurement,elasticelementfor forcemeasurement,torquemeasurement.Strain gages-strainsensitivityofgagemetals,gageconstruction,gagesensitivityandgagefactor,performancecharacteristics,environmentaleffects,Straingagecircuits,Potentiometer, WheatStone'sbridges,Constantcurrentcircuits.Strainanalysismethods-two elementand threeelement,rectangularanddeltarosettes,correctionfortransversestrainseffects,stressgage-planesheargage,stressintensityfactor gage.

Module-3

StressAnalysis: TwoDimensionalPhotoelasticity-natureoflight,-wavetheoryoflight,-opticalinterference-Polariscopesstressopticlaw effect ofstressed modelinplaneandcircularpolariscopes, Isoclinics, Isochromaticsfringeorder determination -Fringe multiplicationtechniques-Calibrationphotoelasticmodelmaterials.Separationmethodssheardifferencemethod,Analyticalseparationmethods, Model toprototypescaling

Module-4

ThreeDimensionalPhotoelasticity: Stressfreezingmethod,Generalslice,Effectivestresses,Stressesseparation,Shear deferencemethod, Obliqueincidencemethod,secondaryprincipalsstresses,scatteredlightphotoelasticity,Polariscopeandstressdataanalyses**.**

Module-5

CoatingMethods: a)PhotoelasticCoating Method-Birefringence coating techniques,SensitivityReinforcing and thickness effects -data reduction-Stressseparation techniques,Photoelasticstraingauges.
b)BrittleCoatingsMethod:BrittlecoatingtechniquePrinciplesdata analysis-coatingmaterials,Coatingtechniques.
c)MoireTechnique-Geometricalapproach,Displacementapproach-sensitivityofMoiredatareduction,InplaneandoutplaneMoiremethods,Moirephotography,Moiregridproduction.
Holography: Introduction, Equationforplane waves andspherical waves, Intensity, Coherence, Spherical radiator asanobject (record process),Hurter,Driffeldcurves,Reconstructionprocess,Holograpicinterferomerty, Realtimeanddoubleexposuremethods,Displacement measurement,Isopachics.

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

C01	Mount strain gages, take measurements and analyze the obtained data.
C02	Design strain gage-based transducers for measuring specific loads.
C03	Describe the different methods photo elasticity for strain measurement viz, stress freezing , and Moirés method.
C04	Undertakeexperimentalinvestigationstoverifypredictionsbyothermethods.
C05	Apply the principles and techniques of brittle coating analysis.
C06	Apply the principles and techniques of holographic interferometry.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1Holman,"ExperimentalMethodsforEngineers"7th Edition,TataMcGraw-HillCompanies,Inc,NewYork,2007.
2. R.S.Sirohi,H.C.RadhaKrishna,"Mechanicalmeasurements"NewAgeInternationalPvt.Ltd.,NewDelhi,2004
3. ExperimentalStressAnalysis-
Srinath,Lingaiah,Raghavan,Gargesa,RamachandraandPant,TataMcGrawHill,1984.
4. Instrumentation,MeasurementAndAnalysis-Nakra&Chaudhry,BCNakraKKChaudhry,TataMcGraw-HillCompanies,Inc,NewYork, SeventhEdition,2006.

Reference Books

1. MeasurementSystemsApplicationandDesign-DoeblinE.A.,4th(S.I.)Edition,McGrawHill,NewYork.1989
2. DesignandAnalysisofExperiments- MontgomeryD.C.,JohnWiley&Sons,1997.
3. ExperimentalStressAnalysis-DallyandRiley,McGrawHill,1991.
4. ExperimentalStressAnalysis-SadhuSingh,Khannapublisher,1990.
5. PhotoelasticityVolIandVolII-M.M.Frocht,.JohnWileyandsons,1969.
6. StrainGaugePrimer-PerryandLissner,McGrawHill,1962.

SMART MATERIALS AND STRUCTURES			
Course Code	20MMD331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Smart Structures: Types of smart structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, depoling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor. Beam modeling: Beam modeling with induced strain rate effects, inchworm linear motor beam modeling with induced strain actuation-single actuators, dual actuators, pure extension, pure bending harmonic excitation, Bernoulli-Euler beam model, problems, piezo-electrical applications.

Module-2

Shape memory Alloy: Experimental phenomenology, shape memory effect, phase transformation, Tanaka's constitutive model, testing of SMA wires, vibration control through SMA, multiplexing. Applications of SMA and problems. ER and MR fluids: Mechanisms and properties, fluid composition and behavior, the Bingham plastic and related models, pre-yield response, post-yield flow applications in clutches, dampers and others.

Module-3

Vibration absorbers: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications. Control of structures: Modeling, control strategies and limitations, active structures in practice.

Module-4

MEMS: Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

Module-5

Devices: Sensors and Actuators, conductivity of Semiconductors, crystal planes and orientation, Stress and Strain Relations, Flexural Beam Bending Analysis under simple loading conditions, polymers in MEMS, optical MEMS applications.

Course outcomes:

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

CO1. Understand the behavior and applicability of various smart materials.

CO2. Design simple models for smart structures & materials.

CO3. Devise experiments to verify the predictions.

CO4. Judge the appropriate application of smart materials with respect to the feasibility of their fabrication and implementation, and to the economic aspects.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Smart Materials and Structures - M. V. Gandhi and B. S. Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN : 0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267

Reference Books

1. Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin;New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN:052144487X).

DESIGN OPTIMIZATION			
Course Code	20MMD332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Engineering Design Practice: Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.

Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO.

Module-2

Optimum Design Problem Formulation: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization.

OptimizationTheory–Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions.

Module-3

Sensitivity Analysis: Linear and Non-Linear Approximations. Gradient Based Optimization Methods– Dual and Direct.

Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods. Internal and External Responses, Design Variables in Each Discipline.

Module-4

Manufacturability in Optimization Problems: Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.

Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum.

Module-5

Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.

Course outcomes:

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

CO1. Identify and apply relevant problem solving methodologies.

CO2. Design components, systems and/ or processes to meet required specification.

CO3. Optimize an existing design with single or multiple objective functions.

CO4. Apply decision-making methodologies to evaluate solutions for efficiency, effectiveness and sustainability

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. S.S.Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. Jasbir Arora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books

1. Optimisation and Probability in System Engg-Ram, Van Nostrand.
2. Optimization methods -K. V. Mital and C. Mohan, New age International Publishers

DESIGN OF HYDRAULIC & PNEUMATIC SYSTEMS			
Course Code	20MMD333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction to Hydraulic System: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators. Control Components in Hydraulic Systems: Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.

Module-2

Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.

Module-3

Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.

Module-4

Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves. Design of Pneumatic Circuits: Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement, cascade method.

Module-5

Electro-Pneumatics: Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching. Servo System and PLC Applications in Pneumatics: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay

Course outcomes:

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

CO1 Describe the constructional features of hydraulic and pneumatic components
CO2 Apply hydraulic and pneumatic controls in the design of automated controls
CO3 Evaluate the design of hydraulic and pneumatic compTWOnts for building a circuit
CO4 Design the hydraulic and pneumatic based systems for industrial applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. S Ilango, V Soundararajan, Introduction to Hydraulics and Pneumatics, PHI Publication, ISBN- 978-81-203-3079-5.
2. Jagadeesha T, Hydraulics and Pneumatics, I K International Publication, ISBN: 978-93-84588- 90-8
3. James L Johnson, Introduction to fluid power, Cengage Learning, first edition 2003, ISBN- 981- 243-661-8
4. R Srinivasan, Hydraulic and pneumatic controls, Tata McGraw hill, second edition, 2010 ISBN – 978-81-8209-138-2.

COMPUTER APPLICATION IN DESIGN			
Course Code	20MMD334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Points, lines and planar curves: Vector algebra Shapes inside a computer: Review of geometry and trigonometry, Points in a plane: Position vectors, Angles between lines - introducing the third dimension: Scalar products, Finding normal to planes: Vector products,

Module-2

Lines in space: Vector equations: Lines in two-dimensional space, in three-dimensional space, Different parametric forms; Lines and common curves: Parametric and Cartesian forms: Linearity and non-linearity, Functions, The parabola, The circle, The ellipse, The circular helix Transformations: Matrix algebra, Tools for transformations: Matrices,

Transformations, Matrices, Adding and subtracting matrices, Multiplying matrices; Moving in a plane: Scaling, reflection and rotation: Matrices as geometric operators, Scaling position vectors, Reflecting position vectors in the axes, Rotating position vectors about the origin, Transforming polygons.

Module-3

Combining transformations: Translations, Order in combining transformations, Specific combinations of transformations, Translations, (3x3) Matrices for transformations in a plane Sizing things up: Homogeneous vectors: Simple homogeneous vectors, General homogeneous vectors, Matrix operations using homage vectors Useful manoeuvres: Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation

The third dimension: Moving along rays, points at infinity and three-dimensional transformations: Geometrical insights using homogeneous vectors, Completing consideration of (3*3) matrices, Points at infinity, Three dimensional transformations, Some specific (4x4) matrices, Local scaling, Reflections in the coordinate planes, Rotations about the coordinate axes, Translation, Overall scaling, In conclusion.

Module-4

Points of view: Projection and single point perspective: Projection from three dimensions onto a plane, Orthographic projection, The need for perspective, Single point perspective, Perspective projection, Tunnel perspective, To improve realism A greater sense of perspective: Two point and three point perspective: Improving perspective, Translation then single point perspective, Rotation then single point perspective, giving two points perspective, Rotation, translation then single point perspective improved two point perspective, Two rotations, translation then single point perspective, giving three point perspective, The three types of perspective-projection, Vanishing points and trace points Space curves and surfaces: Differentiation, Slopes of lines and planar curves: Gradient functions: Lines and curves, Slope of a straight line from its Cartesian equation, Slope of a curve from its Cartesian equation, Practical rules for differentiation, Slope of a straight line from its vector equations

Slopes of space curves: Tangents and normal, Space curves, the tangent vector to a space curve, Tangents and normal for curves in a plane, Tangents and normal's in three dimensions.

Module-5

Curve fitting: Interpolation and shape function: Lines and curves from real objects, Linear interpolation, Quadratic interpolation, Uniqueness Planes and surfaces: Bi parametric forms: sweeps and revolutions, Surface formulae and two parameters, Vector equations of planes, The vector equation of a plane, given two vectors in the plans, The vector equation of a plane, given two unit vectors in the plane, The vector equation of a plane, given three points ina plane, Parameter lines and parameter planes, Plotting a plane, The implicit form of equation of a plane, Generating a swept surface, Generating a surface of revolution Wire frame surfaces surface Tangents and normal: Partial differentiation: General surfaces, Forming a wire frame, Carved surfaces from the, Partial differentiation, Surface tangents and surface normal.

Piecewise surfaces Quadrilateral patches: Dividing up surfaces, A quadrilateral patch on a sphere, Bilinear patches, Linear Coons patches.

Course outcomes:

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

CO1. Develop expertise in generation of various curves, surfaces and volumes used in geometric modelling systems.

CO2. Design, implements, and evaluates a computer-based system, process, component, or program to meet desired needs.

CO3. Analyze a problem, and identify and define the computing requirements appropriate to its solution.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Computer Graphics, Mathematical first steps, P A Eagerton and W S Hall, Prentice Hall, Europe,1998, ISBN: 0-13-599572-8 2 CAD/CAM Concepts and Applications,
2. Chennakesava R Alavala, 1st Ed PHI, New Delhi, 2009 ISBN 978-81-203-3340-6 3
3. CAD/CAM Principles and Applications, P.N. Rao, 3rd Ed., McGraw Hill, Education Pvt Ltd., New Delhi ISBN 0-07-058373-0 4
4. Mastering CAD/CAM, Ibrahim Zeid, 2nd Ed., TMH Publishing Company Limited., New Delhi, ISBN 0-07-0634334-3

PROJECT WORK PHASE – 1			
Course Code	20MMD34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.
- ■

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20MMD35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20MMDI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20MMD41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■