NEW HORIZON
COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC

Accredited by NAAC with 'A' Grade, Accredited by NBA

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH (PG)

MACHINE DESIGN

SCHEME AND SYLLABUS FOR I, II, III & IV SEMESTER

AY-2020-2021

FIRST SEMESTER

Sl No	Course Code	Course	BoS	Credit Distribution			Overall Credits	Contact Hours	Marks		
				L	T	P			CIE	SEE	Total
1	20MATM11	Advanced Mathematics	MAT	4	0	0	4	4	50	50	100
2	20MMD12	Advanced Finite Element Methods	MEE	4	0	0	4	4	50	50	100
3	20MMD13	Theory of Elasticity & Plasticity	MEE	4	0	0	4	4	50	50	100
4	20MMD14	Experimental Stress Analysis	MEE	4	0	0	4	4	50	50	100
5	20MMD15X	Core Elective-1	MEE	3	0	0	3	3	50	50	100
6	20MMD16	Research Methodology	MEE	3	0	0	3	3	50	50	100
7	20MMD17	Advanced FEM Lab	MEE	0	0	2	2	4	25	25	50
Total							**24**	**26**	**325**	**325**	**650**

Sub Code	Core Electives 1
20MMD151	Rapid Prototyping
20MMD152	Computer Applications in Design
20MMD153	Design for Manufacturing
20MMD154	Advanced Materials Technology

SECOND SEMESTER

Sl. No	Course Code	Course	BoS	Credit Distribution			Overall Credits	Contact Hours	Marks		
				L	T	P			CIE	SEE	Total
1	20MMD21	Mechanics of Composite Materials	MEE	4	0	0	4	4	50	50	100
2	20MMD22	Dynamics and Mechanism Design	MEE	4	0	0	4	4	50	50	100
3	20MMD23	Advanced Machine Design	MEE	4	0	0	4	4	50	50	100
4	20MMD24	Automation Engineering	MEE	4	0	0	4	4	50	50	100
5	20MMD25X	Core Elective-1	MEE	3	0	0	3	3	50	50	100
6	20MMD26	Technical Seminar	MEE	-			3	---	50	50	100
7	20MMD27	Dynamics and Mechanism Design Lab	MEE	0	0	2	2	4	25	25	50
Total							**24**	**23**	**325**	**325**	**650**

Sub Code	Core Electives 2
20MMD251	Mechatronics System Design
20MMD252	Advanced Manufacturing Planning and Control
20MMD253	Design Optimization
20MMD254	Fatigue, Creep & Fracture Mechanics
20MMD255	Advanced Theory of Vibrations

THIRD SEMESTER

Sl. No	Course Code	Course	BoS	Credit Distribution			Overall Credits	Contact Hours	Marks		
				L	T	P			CIE	SEE	Total
1	20MMD31	Tribology and Bearing Design	MEE	4	0	0	4	4	50	50	100
2	20MMD32X	Core Elective-3	MEE	3	0	0	3	3	50	50	100
3	20MMD33Y	Core Elective-4	MEE	3	0	0	3	3	50	50	100
4	20MMD34	Internship/Mini Project	MEE	-			6	-----	50	50	100
5	20MMD35	Project Phase – I	MEE	-			4	-----	50	50	100
Total							**20**	**10**	**250**	**250**	**500**

Sub Code	Core Electives 3
20MMD321	Applications of Smart Materials
20MMD322	Machine Learning
20MMD323	Simulation Process for Manufacturing

Sub Code	Core Electives 4
20MMD331	Advanced Mechanics of Solids
20MMD332	Bio and Nanomaterials
20MMD333	Advanced Non-Traditional Machining

FOURTH SEMESTER

Sl. No	Course Code	Course	BoS	Credit Distribution			Overall Credits	Contact Hours	Marks		
				L	T	P			CIE	SEE	Total
1	20MMD41	Project Phase - II	MEE	-			3	-----	50	50	100
2	20MMD42	Project Phase - III	MEE	-			3	-----	50	50	100
3	20MMD43	Evaluation of Project	MEE	-			14	-----	100	100	200
Total							**20**	**------**	**200**	**200**	**400**

SYLLABUS

FIRST SEMESTER

ADVANCED MATHEMATICS

Course Code: 20MATM11 **Credits: 04**
L: T: P : 4:0:0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MATM11.1	Evaluate the Eigen value problem and Boundary value Problem.
20MATM11.2	Remember the appropriate numerical methods to solve algebraic and transcendental equations and also to calculate a definite integral.
20MATM11.3	Analyze the Linear Models in Science and Engineering.
20MATM11.4	Analyze the functional Problems in Engineering.
20MATM11.5	Develop the ability to construct mathematical models involving partial differential equations.
20MATM11.6	Understand the appropriate numerical methods to solve Boundary Value Problems in Partial differential equations.

Mapping of CO v/s PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MATM11.1	3	3	2	2	1	1	1	1	1	2	1	1
20MATM11.2	3	3	3	3	2	1	1	1	2	3	1	2
20MATM11.3	3	3	3	3	3	1	1	1	3	1	1	1
20MATM11.4	3	3	2	3	1	1	1	1	1	3	1	2
20MATM11.5	3	3	3	2	2	1	1	1	2	2	1	2
20MATM11.6	3	3	2	2	2	1	1	1	2	2	1	2

Course Syllabus:

Module No.	Contents of Module	Hours	COs
1.	**System of Linear Algebraic Equations and Eigen Value Problems:** Iterative methods – Jacobi's method, Gauss-Seidel method, Eigen values and Eigen vectors of real symmetric matrices–Power method, Jacobi method, Givens method. Boundary value problem, solution of BVP by Finite difference method.	**9**	**20MATM11.1**
2.	**Numerical Methods:** Roots of Equations, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration. Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Bairstow's Method. Numerical Integration-Newton's-Cotes quadrature formula: Trapezoidal rule, Simpsons $1/3^{rd}$, $3/8^{th}$ rules, Gaussian integration, Romberg integration.	**9**	**20MATM11.2**

3.	**Linear Transformation:** Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering. Orthogonality and Least Squares: Inner product, length and Orthogonality, Orthogonal sets, Orthogonal projections, The Gram-Schmidt process, Least Square problems, Inner product spaces.	**9**	**20MATM11.3**
4.	**Calculus of variation:** Concept of functional-Euler's equation- functional dependence of first and higher order derivatives- functional on several dependent variables- isoperimetric problems.	**9**	**20MATM11.4 20MATM11.5**
5.	**Laplace Transform Method:** Solution of Heat, Wave and Laplace equation by the method of separation of variables. D'Alemberts solution of Wave Equation, Laplace transforms methods for one dimensional heat and wave equations.	**9**	**20MATM11.6**

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, 2014, ISBN: 978-81-265-5423-2.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty third Edition, 2014, ISBN: 978-81-7409-195-5.
3. B.S.Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, Eleventh Edition, 2013, ISBN: 978-81-7409-248-9.
4. K. Sankar Rao**,** Introduction to Partial Differential Equations, PHI Learning publisher, Third Edition, 2014, ISBN: 978-81-203-4222-4.

Reference Books:

1. Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, ISBN: 978-0-273-71923-6.
2. Dennis G. Zill and Michael R. Cullen,, Advanced Engineering Mathematics, Jones and Barlett Publishers Inc., Fourth Edition, 2015, ISBN: 978-0-763-77994-8.
3. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, Fourth Edition, 2016, ISBN: 978-0-07-063419-0.
4. Anthony Craft, Engineering Mathematics, Pearson Education, Fourth Edition, 2013, ISBN: 978-0-130-26858-7.

Assessment Pattern:

1. CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	**Tests (25 Marks)**	**Assignments (25 Marks)**
Remember	5	5
Understand	5	5
Apply	10	5
Analyze	2.5	5
Evaluate	2.5	5
Create	-	-

2. SEE- Semester End Examination (50 Marks)

Bloom's Category	Questions (50 Marks)
Remember	10
Understand	10
Apply	20
Analyze	5
Evaluate	5
Create	--

ADVANCED FINITE ELEMENT METHODS

Course Code :20MMD12 **Credits : 04**
L: T:P : 4:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD12.1	**Understand** and remember the concepts of finite element methods & applications of FEM in 1-D bar element
20MMD12.2	**Analyze** the fundamental problems with all possible boundary conditions in 2-D bar elements
20MMD12.3	**Evaluate** various problems on beams and Truss elements
20MMD12.4	**Remember** the different heat transfer and fluid flow problems
20MMD12.5	**Understand** the dynamics problems using FEM and Eigen values for free and transient responses
20MMD12.6	**Apply** the concepts in industrial related case studies.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD12.1	3	2	2	2	2	2	1	1	1	1	1	2
20MMD12.2	2	3	2	3	3	2	1	1	1	1	1	2
20MMD12.3	2	3	2	3	3	2	1	1	1	1	1	2
20MMD12.4	2	3	2	3	3	2	1	1	1	1	1	2
20MMD12.5	2	3	3	3	3	3	1	1	1	1	1	2
20MMD12.6	2	3	2	2	2	3	1	1	1	1	1	2

SYLLABUS			
Module No.	**Contents of the Module**	**Hours**	**COs**
1	Introduction to Finite Element Method, One-Dimensional Elements: Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design. Mathematical Preliminaries, Introduction to weighted residual methods. Basic Equations and Potential Energy Functional, 1-D Bar Element, Strain matrix, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, ANSYS report on 1-D bar element with different boundary condition (At least 3)	**9**	20MMD12.1 20MMD12.2
2	Two-Dimensional Elements-Analysis, Applications and Problems: Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), and Shape functions for Higher Order Elements (TRIA 6, QUAD 8). Basic Equations and Potential Energy Functional, Lagrange family Shape functions for Higher Order Elements, Journals on shape function	**9**	20MMD12.3
3	Structural analysis through FEM: 1–D Beam Element, 2–D Beam Element, Deflection equation, shape functions and stiffness matrixes, tetrahedral element characteristics, Composite element with eight nodes, Axis-symmetry with plane strain and plane stress. Problems on various loadings, Report on practical application of trusses and beam problems.	**9**	20MMD12.4 , 20MMD12.5
4	FEM analysis of Heat Transfer and Fluid Flow: Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media, ANSYS report on thermal problems.	**9**	20MMD12.5
5	FEM for Dynamic: System of springs, Formulation for point mass and distributed masses, Consistent element mass matrix, Lumped mass matrix, Evaluation of Eigen values and Eigen vectors, Applications to bars, stepped bars, and beams, Free –response Eigen values for first and second order problems, Transient response. Case study and analogy with mathematical formulations	**8**	20MMD12.6

Text Books:

1. **Chandrupatla T. R**.,**"**Finite Elements in engineering"- 4th Edition, PHI, 2015, ISBN- 978-0132162746
2. **Gilbert Strang.,"**An Analysis of the Finite Element Method" Wellesley-Cambridge; 3rd edition-2014, ISBN- 978-0980232707

Reference Books:

1. **Rao S. S**. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, 2015. ASIN: B01FEKGUMM
2. **Saeed Moaveni ,** "Finite Element Analysis: Theory and Application with ANSYS" (4th Edition) - Pearson; 4th edition - 2014, ISBN- 978-0133840803
3. **J.N.Reddy**, "Finite Element Method"- McGraw -Hill International Edition. 3rd Revised 2012, ISBN-978-0070607415

ASSEMENT METHOD:

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

THEORY OF ELASTISITY AND PLASTISITY

Course Code : 20MMD13 **Credits: 04**
L: T:P : 4:0:0 **CIE Marks: 50**
Exam Hours : 03 **SEE Marks: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD13.1	**Understand** basic concepts of elasticity and plasticity of materials.
20MMD13.2	**Remember** the different types of stresses acting on a body.
20MMD13.3	**Understand** problems of plain stress and plain strain conditions.
20MMD13.4	**Analyze** Fourier series to sole 2-D problems of Cartesian and Polar co-ordinates.
20MMD13.5	**Apply** the knowledge of engineering applications in plasticity.
20MMD13.6	**Evaluate** the problems on different metal forming processes.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD13.1	3	2	2	2	1	2	1	1	1	1	1	2
20MMD13.2	3	2	2	3	1	2	1	1	1	1	1	2
20MMD13.3	2	2	2	3	3	2	1	1	1	1	1	2
20MMD13.4	2	2	2	3	3	2	1	1	1	1	1	2
20MMD13.5	2	2	3	3	1	3	3	1	1	1	1	2
20MMD13.6	2	3	2	2	1	3	1	1	1	1	1	2

SYLLABUS			
Module No.	**Contents of the Module**	**Hours**	**COs**
1	Introduction: Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, Specification of stress at a point Principal stresses and Mohr's diagram in three dimensions Boundary conditions .Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress, Stress transformation	***9***	20MMD13.1
2	Introduction to Strain: Deformation, Strain Displacement relations, Strain components, the state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation Stress -Strain Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants. Formulation of Elasticity Problems Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal thermo	***9***	20MMD13.2, 20MMD13.3
3	Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation for 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. Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, Pure bending of curved bar, Strain components in polar co- ordinates, Rotating disk and cylinder.	***9***	20MMD13.4
4	Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material. Stress - Strain Relations, Plastic stress-strain relations, Prandtl Roeuss Saint Venant, Levy - Von Mises, Experimental verification of the Prandtl-Rouss equation, Yield locus, Symmetry convexity, Normality rule	***9***	20MMD13.5
5	Application to problems: Uniaxial tension and compression, bending of beams, Torsion of rods and tubes, Simple forms of indentation problems using upper bounds. Problems of metal forming: Extrusion, Drawing, Rolling and Forging	***8***	20MMD13.6

Text Books:

1. Timoshenko and Goodier, "Theory of Elasticity"-'McGraw Hill Book Company, 2014.
ASIN: B019TM4WQ2

2. **Clive L. Dym** ,"Solid Mechanics: A Variational Approach" , Springer; - 2015, ISBN- 978-1489992482

3. Sadhu Singh, "Theory of Plasticity and Metal forming Process," Khanna Publishers, Delhi, 2016,ASIN: B01JXN3TGQ

Reference Books:

1. T.G.Sitharam" Applied Elasticity"- Interline publishing. 2016, ASIN: B01M4N2FMJ

2. Andrzej Sluzalec ," Theory of Metal Forming Plasticity "- Springer, 2014, ISBN- 978-3540406488

3. **L S Srinath**" Advanced Mechanics of Solids "- Tata McGraw Hill Company, 3rd Edition, 2012, ISBN-978-0070702608

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	10		
Understand	5		
Apply	5	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

EXPERIMENTAL STRESS ANALYSIS

Sub Code : 20MMD14 | **Credits : 04**
L: T: P : 4:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD14.1	**Know** about the different types of strain gauges.
20MMD14.2	**Remember** the different strain analysis methods.
20MMD14.3	**Understand** the experimental investigation on photo elastic materials & models.
20MMD14.4	**Learn** about stresses on 2-D and 3-D models.
20MMD14.5	**Understand** the different types of coating methods.
20MMD14.6	**Knowledge** about displacement measurement using Holography.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD14.1	3	2	2	2	1	2	1	1	1	1	1	2
20MMD14.2	3	2	2	3	1	2	1	1	1	1	1	2
20MMD14.3	3	2	2	3	3	2	1	1	1	1	1	2
20MMD14.4	2	2	2	3	3	2	1	1	1	1	1	2
20MMD14.5	2	2	3	3	1	3	3	1	1	1	1	2
20MMD14.6	2	3	2	3	1	3	1	1	1	1	1	2

SYLLABUS

Module No.	Contents of the Module	Hours	COs
1	Electrical Resistance Strain Gages: Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods: Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gauge.	**9**	20MMD14.1
2	Photo elasticity: Nature of light, - wave theory of light,- optical interference - Polariscope stress optic law - effect of stressed model in plane and circular Polariscope, Isoclinics Isochromatics fringe order determination - Fringe multiplication techniques - Calibration Photo elastic model materials.	**8**	20MMD14.1, 20MMD14.2

3	Two Dimensional Photo elasticity Stress Analysis: Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.Three Dimensional Photo elasticity: Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Principals, Polariscope and stress data analyses.	**9**	20MMD14.3
4	Coating Methods a) Photo elastic Coating Method: Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photo elastic strain gauges b) Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. Moiré Technique: Geometrical approach, Displacement approach-sensitivity of Moiré data reduction, In plane and out plane Moiré methods, Moiré photography, Moiré grid production.	**9**	20MMD14.4
5	Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holographic interferomerty, Real-time. And double exposure methods, Displacement measurement, Isopachics.	**9**	20MMD14.5, 20MMD14.6

Text Books:

1. **Dally and Riley,** "Experimental Stress Analysis," McGraw Hill, 2013, ISBN- 978-0070152182
2. Alessandro Freddi (, "Experimental Stress Analysis for Materials and Structures Springer; 2015, ISBN- 978-3319060859

References Books:

1. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, "Experimental Stress Analysis," Tata McGraw Hill, 2014. ISBN- 978- 0128009519

2. M.M.Frocht, "Photoelasticity Vol I and Vol II," John Wiley and sons, 2013, ASIN: B005TTIHPM

3. AS. Kobayassin (Ed), "Hand Book of Experimental Stress Analysis" SEMNCH, II Edition 2011 ISBN-978-0128009512

ASSEMENTMETHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	10		
Understand	5		
Apply	5	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

CORE ELECTIVES -1

RAPID PROTOTYPING

Sub Code	**:20MMD151**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD151.1	**Understand** the hands – on exposure to produce the prototypes and gain knowledge on additive manufacturing techniques.
20MMD151.2	**Apply** the developed product in the field of Industrial requirements.
20MMD151.3	**Create** newer materials for 3-D printing of components.
20MMD151.4	**Know** the industries in the developments of prototypes and enhance visualization.
20MMD151.5	**Apply** the latest technologies of Additive manufacturing system to overcome the limitations.
20MMD151.6	**Create** new engineering concepts in the field of medical science, architectural & other streams of engineering.

Mapping of CO v/s PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD151.1	3	2	2	2	3	2	1	1	1	1	1	2
20MMD151.2	3	2	3	2	3	2	1	1	1	1	1	2
20MMD151.3	2	2	3	2	2	2	1	1	1	1	1	2
20MMD151.4	3	2	2	2	3	2	1	1	1	1	1	2
20MMD151.5	3	2	3	2	3	2	1	1	1	1	1	2
20MMD151.6	3	2	2	2	3	2	1	1	1	1	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**Cos**
1	**Introduction:** Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **Stereo lithography**: Data preparation, process parameters, working principles, materials used, advantages and limitations.	9	20MMD 151.1
2	**Selective Laser Sintering**: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, and Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.	8	20MM D151.2
3	**Solid Ground Curing**: Principle of operation, Machine details, Applications, Laminated Object Manufacturing: Principle, of operation, LOM materials, process details, application **Concepts Modelers**: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system 5, object Quadra systems.	9	20MM D151.3
4	**Rapid Tooling**: Indirect Rapid tooling -Silicon rubber tooling —Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite ,3D keltool ,etc. **Direct Rapid Tooling** — Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool ,DMILS, ProMetal ,Sand casting tooling ,Laminate tooling soft Tooling vs. hard tooling.	9	20MM D151.4
5	**Software For RP**: Stl files, Overview of Solid view, magics, mimics, magic communicator, etc. Internet based software, Collaboration tools, **RAPID Manufacturing Process Optimization**: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Introduction to Taguchi method (Orthogonal Array, Anova, Signal to Noise ratio)	9	20MM D151.5, 20MM D151.6

Text Books:

1. Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, by Frank W Liou, 2016,ISBN-13: 978-0849334092
2. **Rapid Manufacturing,** Flham D.T & Dinjoy S.S Verlog London 2015. ISBN 978-1-4471-0703-3.
3. **Stereo Lithography and other RP & M Technologies,** Paul F. Jacobs: SME, NY 2009. **ISBN-10:** 087263467

REFERENCE BOOKS:

1. Rapid prototyping and allied manufacturing techniques, by M S Ganesha Prasad and Nagendra, 2016, **ISBN-13:** 978-9384893408
2. **Rapid Prototyping,** Terry Wohlers Wohler's Report 2000"Wohler's Association 2014.

ASSESEMENT METHOD CIE:

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

COMPUTER APPLICATIONS IN DESIGN

Course Code	**: 20MMD152**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD152.1	**Understand** the knowledge of CAD/CAM/CAE systems.
20MMD152.2	**Understand** the basic fundamentals of Graphic programming.
20MMD152.3	**Apply** the skills of geometric modeling in CAD
20MMD152.4	**Learn** about different types of spline curves.
20MMD152.5	**Understand** about CAD/CAM integration.
20MMD152.6	**Know** about the interpretation of different curves CAD/CAM integration in industries.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD152.1	3	2	2	2	1	2	1	1	1	1	1	2
20MMD152.2	3	2	2	3	1	2	1	1	1	1	1	2
20MMD152.3	3	2	2	3	3	2	1	1	1	1	1	2
20MMD152.4	2	2	2	3	3	2	1	1	1	1	1	2
20MMD152.5	2	2	3	3	1	3	3	1	1	1	1	2
20MMD152.6	2	3	2	3	1	3	1	1	1	1	1	2

SYLLABUS			
Module No.	**Contents of the Module**	**Hours**	**COs**
1	**Introduction to CAD/CAM/CAE Systems** Overview, Definitions of CAD CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example Components of CAD/CAM/CAE Systems: Hardware Components, Vector-Refresh (Stroke-Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows- Based CAD Systems.	9	20MMD152.1, 20MMD152.2
2	Basic Concepts of Graphics Programming: Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden- Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.	9	20MMD152.3
3	Geometric Modeling Systems: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling. Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermit Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve	9	20MMD152.4
4	Representation of Curves: B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B- Spline Curves, Differentiation of a B-Spline Curve, Non uniform Rational B-Spline (NURBS) Curve, Evaluation of a NURBS Curve, Differentiation of a NURBS Curve, Interpolation Curves, Interpolation Using a Hermit Curve, Representation and Manipulation of Surfaces: Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface.	9	20MMD152.5
5	CAD and CAM Integration: Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-I CAPP, MIPLAN and Multi CAPP, Met CAPP,ICEM-PART, Group Technology, Classification and Coding, Existing Coding Systems, Product Data Management (PDM) Systems.	8	20MMD152.6

Text Books:

1. **Kunwoo Lee,** "Principles of CAD/CAM/CAE systems"-Addison Wesley, 2012,ISBN- 978-0201380361
2. **Radhakrishnan.P,**"CAD/CAM/CIM"-New Age International, 2012, ISBN- 978-8122422368

Reference Books:

1. **Ibrahim Zeid,** "CAD/CAM – Theory & Practice", McGraw Hill, 2013, ISBN- 978-0070151345
2. **Bedworth, Mark Henderson & Philip Wolfe,** "Computer Integrated Design and Manufacturing" -McGraw hill inc., 2012, ISBN- 978-0070042056

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10		5
Analyze	5	5	5
Evaluate	5	5	
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

DESIGN FOR MANUFACTURING

Course Code	**: 20MMD153**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD153.1	**Understand** basic knowledge of tolerance analysis.
20MMD153.2	**Understand** about group models & datum features.
20MMD153.3	**Learn** about the component design- machining consideration**.**
20MMD153.4	**Remember** the different types of casting consideration.
20MMD153.5	**Evaluate** the design of gauges & economic costing.
20MMD153.6	**Know** about component design & machining design.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD153.1	3	2	2	2	1	2	1	1	1	1	1	2
20MMD153.2	3	2	2	3	1	2	1	1	1	1	1	2
20MMD153.3	2	2	2	3	3	2	1	1	1	1	1	2
20MMD153.4	2	2	2	3	3	2	1	1	1	1	1	2
20MMD153.5	2	2	3	3	1	3	3	1	1	1	1	2
20MMD153.6	2	3	2	2	1	3	1	1	1	1	1	2

SYLLABUS			
Module No.	**Contents of the Module**	**Hours**	**COs**
1	TOLERANCE ANALYSIS: Introduction – Concepts, definitions and relationships of tolerance, – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis– Sensitivity Analysis – Taguchi's Approach to tolerance design.	**9**	20MMD153.1

2	SELECTIVE ASSEMBLY AND DATUM FEATURES: Selective assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1: 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 Datum features: Functional datum, Datum for manufacturing, changing the datum, examples.	**9**	20MMD153.2
3	COMPONENT DESIGN- MACHINING CONSIDERATION: Design features to facilitate machining - drills - milling cutters - keyways - Doweling rocedures, counter sunk screws - Reduction of machined area-simplification by separation - simplification by amalgamation - Design for mach inability - Design for economy - Design for clamp ability - Design for accessibility - Design for assembly.	**9**	20MMD153.3, 20MMD153.4
4	COMPONENT DESIGN – CASTING CONSIDERATION: Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA	**9**	20MMD153.5
5	DESIGN OF GAUGES: Designs of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft.	**8**	20MMD153.6

Text Books:

1. **Richard G Budynas,** "Machine Design" McGraw-Hill Education; 10 edition 2014, ISBN- 978-0073398204

2. **R.K. Jain**, "Engineering Metrology", Khanna Publishers, 2015, ISBN- 978-8174091536

3. **Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker**, "Product design for manufacture and assembly", Inc. CRC Press,Third Edition, 2011. ISBN- 978-1420089271

Reference Books:

1. **ASM Hand book,** "Material selection and Design", Vol. 20, 2016, ISBN- 978-087170386

2. **C.M. Creveling,** "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 2016, ISBN- 978-0201634730

3. **James G. Bralla,** "Handbook of Product Design for Manufacturing", McGraw Hill, 2011, ISBN- 978-0070071391

4. **Kevien Otto and Kristin Wood,** "Product Design", Pearson Publication, 2010, ISBN- 978-0130212719

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

ADVANCED MATERIALS TECHNOLOGY

Course Code : 20MMD154
L:T:P : 3:0:0
Exam Hours : 03

Credits : 03
CIE Marks: 50
SEE Marks : 50

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD154.1	**Understand** the concept of Atomic bonds and atomic structure.
20MMD154.2	**Evaluate** the concept of Newer materials.
20MMD154.3	**Apply** the situ process concept in MMC's.
20MMD154.4	**Analyze** the different types of failure analysis in composites.
20MMD154.5	**Create** the suitable materials for surface treatment process.
20MMD154.6	**Understand** the different powder method techniques used in powder metallurgy.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD154.1	3	3	2	2	1	1	1	1	1	2	2	1
20MMD154.2	3	3	3	3	2	1	1	1	2	3	3	2
20MMD154.3	3	3	3	3	3	1	1	1	3	1	1	1
20MMD154.4	3	3	2	3	1	1	1	1	1	3	3	2
20MMD154.5	3	3	3	2	2	1	1	1	2	2	2	2
20MMD154.6	3	3	2	2	2	1	1	1	2	2	2	2

Course Syllabus

Module No.	Contents of the Module	Hours	COs
1	**STRUCTURE-PROPERTY RELATIONS** Introduction, Atomic structure, atomic bonds, secondary bonds, crystal structure, Miller indices, packing efficiency, crystal defects, grain structure, elastic and plastic deformation in single crystals, dislocation theory, strain /work hardening, plastic deformation in polycrystalline metals, fracture of metals, cold working, re crystallization and hot working, grain growth. **NEWER MATERIALS**: Introduction, plastics, molecular structure,	**9**	20MMD154.1 20MMD154.2

	isomers, polymerization, thermosetting and thermoplastic materials, properties and applications of plastics. Ceramics, nature and structure, fine ceramics, properties and applications of ceramics.		
2	**PROCESSING OF COMPOSITES**: Liquid-state process, solid state process and in situ processes of MMC's. Slurry infiltration process, combined hot pressing and reaction bonding method, melt infiltration process, direct oxidation, isothermal chemical impregnation process and Sol-Gel and polymer pyrolysis of CMC's. Hand layup process, filament winding process, pultrusion process, pressure bag molding, vacuum bag molding, autoclave molding, injection molding process and thermoforming process of PMC's.	**9**	20MMD154.3
3	**FAILURE ANALYSIS AND DESIGN OF COMPOSITES:** Failure criterion for particulate and laminate composites. Design of laminated and particulate composites. Other mechanical design issues-Long term environmental effects, inter laminar stresses, impact resistance, fracture resistance and fatigue resistance.	**9**	20MMD154.4
4	**SURFACE TREATMENT**: Introduction, Surface Engineering, Surface quality & integrity concepts, Mechanical treatment, Thermal spraying processes and applications, Vapour depositions processes and applications, Ion-treatment..	**9**	20MMD154.5
5	**POWDER METALLURGY:** Introduction, Steps in powder metallurgy, Production of Powder, Characterization & Testing of Powders, Powder Conditioning, Powder Compaction, Sintering, Finishing operations, Applications of PM components.	**8**	20MMD154.6

TEXT BOOKS:

1. **E.Paul Degarmo, J.T.Black, Ronald A Kohser**. , Materials and Processing in Manufacturing 9th Edition, 2012 – Prentice Hall India. ISBN- 978-0471033066
2. **K.K.Chawla,** Composite materials – Science & Engineering,. Springer, 3rd Edition, 2013 ISBN- 978-0387743646
3. **AUTAR K.KAW** , Mechanics of composite materials,Taylor and Francis grou **Autar K. Kaw,** "Mechanics of Composite Materials" Second Edition (Mechanical Engineering), Publisher**:** CRC, 2015, ISBN- 978-0849313431.

REFERENCE BOOKS:

1. **Composite Materials**, Science & Engg - Krishan K. Chawla, 4th edition, Springer publication, ISBN- 978-1906574321
2. **ASM Handbook on Metal Casting** - Vol .15, 9th edition, ASM publication, ISBN- 978-08717002163. ASM Handbook on Powder Metallurgy - Vol 17, ASM publications, 2015, ISBN- 978-1627080873
3. **Mick Wilson, Kamali Kannangara**, Nanotechnology – Basic Science and Emerging Technologies, -, Overseas Press India Private Limited, 2013, ISBN-13: 978-1584883395.

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks)

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

RESEARCH METHODOLOGY

Course Code : 20MMD16 **Credits : 03**
L:T:P : 3:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks : 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD16.1	Understand the significance and suitability of research for various engineering applications.
20MMD16.2	Analyze the various processing techniques of research.
20MMD16.3	Understand the research in the development of engineering materials/process.
20MMD16.4	Analyze the properties/process of research through various techniques. Understanding that when IPR would take such important place in growth of individuals & nation.
20MMD16.5	Evaluate the influence of design, analysis and testing of research.
20MMD16.6	Knowledge of Report writing.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD16.1	3	2	2	2	1	1	1	1	1	1	1	2
20MMD16.2	3	2	2	2	1	1	1	1	1	1	1	2
20MMD16.3	2	2	2	2	3	1	1	1	1	1	1	2
20MMD16.4	2	2	2	2	3	1	1	1	1	1	1	2
20MMD16.5	2	2	3	2	1	3	1	1	1	1	1	2
20MMD16.6	3	3	2	2	2	1	1	1	1	1	1	1

Ratings: 3 for high, 2 for substantial, 1 for low.

Module No	Contents of Module	Hrs	Cos
1	**Meaning of Research:** problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	**7**	**20MMD16.1 20MMD16.2**
2	**Research Design**: Concept and Importance in Research – Features of a good research design, Exploratory Research Design, concept, types and uses, Descriptive Research Designs, concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. **Qualitative and Quantitative Research**: Qualitative research, Quantitative research, Concept of measurement, causality,	**7**	**20MMD16.2**

	generalization, and replication. Merging the two approaches.		
3	**Measurement**: Concept of measurement, Problems in measurement in research, Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. **Sampling**: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.	**7**	**20MMD16.3**
4	**Interpretation of Data and Paper Writing** – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. **Nature of Intellectual Property**: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**7**	**20MMD16.4**
5	**References**: Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. **Use of tools / techniques for Research**: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**7**	**20MMD16.5** **20MMD16.6**

Reference Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. 2016, w AgeInternational. Fourth edition, ISBN-13: 978-9386649225
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, 2009, Wiley EasternPvt., Ltd., New Delhi, Wiley; Third edition, BN-13: 978-8126524488
4. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta Academic; 2nd ed edition, 2001, ISBN-13: 978-0702156601
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, 2016, " Intellectual Property in New Technological Age", Clause 8 Publishing , ISBN-13: 978-1945555015

CIE- Continuous Internal Evaluation for theory (50 Marks)

Bloom's Category	Tests	Assignments	External participation
Marks (out of 50)	30	10	10

Remember	10		
Understand	5		
Apply	5	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE – Semester End Examination (50 Marks - Theory)

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

ADVANCED FEM LAB

Course Code	**:20MMD17**	**Credits**	**: 02**
L: T: P	**: 0:0:2**	**CIE Marks**	**: 25**
Exam Hours	**: 03**	**SEE Marks**	**: 25**

Hours/Week: 03

1. Numerical Calculation and MATLAB Simulation

a. Invariants, Principal stresses and strains with directions

b. Maximum shear stresses and strains and planes, Von-Mises stress

2. Stress analysis in Curved beam in 2D

3. Mode frequency analysis of Beam

4. Stress analysis of rectangular "L" Bracket under various loading condition.

4. Stress analysis in Curved beam in 2**D, (**Modeling and Numerical Analysis)

5. Conductive heat transfer analysis of 2-D component.

6. Convective heat transfer analysis of 2-D component.
7. Determination of heat flux and temperature distribution of given composite wall
8. Contact Stress Analysis of Circular Disc under diametrical compression

3-D Modeling of Circular Discs with valid literature background, supported with experimental results on contact stress

CIE for Lab

Bloom's Category	**Tests**	**Assignments**	**Viva**
Marks (Out of 25)	**10**	**10**	**5**
Remember	2		1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	2	1
Create		2	1

SEE (25 Marks) Lab

Bloom's Category	**Questions**
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	--

SECOND SEMESTER

MECHANICS OF COMPOSITE MATERIALS

Course Code : 20MMD21 **Credits: 04**
L: T :P : 4:0:0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD21.1	**Understand** the basics of composite materials.
20MMD21.2	**Evaluate** the concepts of micromechanics of composites.
20MMD21.3	**Know** about Elastic behaviour of unidirectional composites.
20MMD21.4	**Remember** the unidirectional lamina in composites.
20MMD21.5	**Understand** about co-ordinate transformation & Hooke's law.
20MMD21.6	**Learn** about Analysis, design, optimization and test simulation of advanced composite structures and Components.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD21.1	3	2	2	3	3	1	1	1	1	1	1	2
20MMD21.2	3	2	2	2	3	2	1	2	1	2	2	2
20MMD21.3	3	2	2	2	2	2	1	2	2	2	2	2
20MMD21.4	3	3	2	3	3	1	1	3	1	1	3	2
20MMD21.5	2	3	2	2	2	1	1	2	2	1	3	2
20MMD21.6	2	3	2	2	2	1	1	2	2	1	3	2

SYLLABUS			
Module No	**Content of the Module**	**Hours**	**COs**
1	**BASIC CONCEPTS AND CHARACTERISTICS:** Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. **Reinforcements:** Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosets, Metal matrix and ceramic composites.	9	20MMD21.1, 20MMD21.2

2	**MICROMECHANICS:** Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties Manufacturing methods: Autoclave, tape production, molding methods, filament winding, man layup, pultrusion, RTM.	9	20MMD21.3
3	**CO-ORDINATE TRANSFORMATION:** Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations Off – axis, stiffness modulus, off – axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.	9	20MMD21.4
4	**STRENGTH OF UNIDIRECTIONAL LAMINA:** Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects Micros mechanical predictions of elastic constants	9	20MMD21.5
5	**ANALYSIS OF LAMINATED COMPOSITE PLATES**: Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.	8	20MMD21.6

Text Books:

1. **R. M. Jones, "**Mechanics of Composite Materials" Mc Graw Hill Company, New York, 2015.ISBN-978-0521126908

2. **Isaac and M Daniel**, "Engineering Mechanics of Composite Materials" Oxford University Press, 2014, ISBN- 978-0195150971

3. **B. D. Agarwal and L. J. Broutman** , "Analysis and performance of fibre Composites," Wiley-Interscience, New York, 2016, ISBN- 978-0471268918.

4. **Autar K. Kaw,** "Mechanics of Composite Materials" Second Edition (Mechanical Engineering), Publisher**:** CRC, 2015, ISBN- 978-0849313431.

Reference Books:

1. **L. R. Calcote/ Van Nostrand Rainfold, "**Analysis of Laminated Composite Structures" New York, 2012, ISBN- 978-0442156282
2. **Vasiliev &Morozov**, "Advanced Mechanics of Composite Materials" Elsevier/Second Edition, 2014, ISBN- 978-0080974330.

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

DYNAMICS AND MECHANISIM DESIGN

Course Code	**: 20MMD22**	**Credits**	**: 04**
L: T: P:	**: 4:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD22.1	**Understand** the basics of geometry of motion, Grashoff's law in Dynamics & mechanism design.
20MMD22.2	**Knowledge** of Generalized Principles of Dynamics.
20MMD22.3	**Remember** the synthesis of mechanism by analytical method.
20MMD22.4	**Know** about synthesis of mechanism by graphical method.
20MMD22.5	**Understand** about spatial mechanism & Eulerian angles.
20MMD22.6	**Know** about System Dynamics with respect to DMD.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD22.1	3	3	3	1	1	3	3	1	1	1	1	2
20MMD22.2	3	3	3	1	1	3	3	1	1	1	1	2
20MMD22.3	3	3	3	1	1	3	3	1	1	1	1	2
20MMD22.4	3	3	3	1	1	3	3	1	1	1	1	2
20MMD22.5	3	3	3	1	1	3	3	1	1	1	1	2
20MMD22.6	3	3	3	1	1	3	3	1	1	1	1	2

SYLLABUS			
Module No	**Content of the Module**	**Hours**	**COs**
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.	9	20MMD22.1, 20MMD22.2

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.	9	20MMD22.3
3	System Dynamics: Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. 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.	9	20MMD22.4
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. Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis.	9	20MMD22.5
5	Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.	8	20MMD22.6

Text Books:

1. **K.J.Waldron&G.L.Kinzel,** "Kinematics, Dynamics and Design of Machinery", Wiley India, 2013, ISBN- 978-0471583998.
2. **Greenwood,** "Classical Dynamics", Prentice Hall of India, 2013, ISBN- 978-0486696904

References Books:

1. **J E Shigley,** "Theory of Machines and Mechanism" -McGraw-Hill, 2016, ISBN- 978-0199454167
2. **A.G.Ambekar,** "Mechanism and Machine Theory", PHI, 2016, ISBN- 978-8120331341
3. **Ghosh and Mallick,** "Theory of Mechanism and Mechanism", East West press 2014,ISBN- 978-8185938936
4. **David H. Myszka,** "Machines and Mechanisms", Pearson Education, 2014, ISBN- 978-0132157803

ASSEMENT METHOD:

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

ADVANCED MACHINE DESIGN

Course Code : 20MMD23 **Credits : 04**
L: T:P : 4:0:0 **CIE Marks : 50**
Exam Hour : 03 **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD23.1	**Understand** the different failure analysis & fatigue mechanism
20MMD23.2	**Evaluate** the Stress-Life & Strain- Life approach.
20MMD23.3	**Illustrate** the LEFM approach & Crack tip plastic zone & crack growth
20MMD23.4	**Apply** the concepts of Journal bearings & Hydrostatic bearings
20MMD23.5	**Know** the different types of Fatigue from variable amplitude
20MMD23.6	**Characterize** the Surface failure & Different types of wear

Mapping of CO v/s PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD23.1	1	2	1	1	3	2	1	3	2	1	1	2
20MMD23.2	3	3	2	3	2	2	1	1	2	1	3	2
20MMD23.3	3	2	3	2	1	2	2	1	3	2	2	1
20MMD23.4	2	3	2	2	1	3	1	2	2	1	2	1
20MMD23.5	2	2	3	3	2	2	3	2	2	1	2	2
20MMD23.6	1	3	2	2	3	3	2	1	3	2	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**Cos**
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 testing, Test methods and standard test specimens.	**9**	20MMD23.1, 20MMD23.2
2	**Stress-Life (S-N) Approach**: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN 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, Life estimation by ε-N approach	**9**	20MMD23.2
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, Notch strain analysis and the strain – life approach	**9**	20MMD23.3, 20MMD23.4
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.	**9**	20MMD23.5, 20MMD23.6
5	**Surface Failure**: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength	**8**	20MMD23.6

Text Books:

1. **Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs,** "Metal Fatigue in engineering", John wileyNewyork, Second edition. 2012, ISBN- 978-8126539215
2. **Jack. A. Collins,** "Failure of Materials in Mechanical Design," John Wiley, Newyork,2014, ISBN- 978-0471558910
3. **Robert L. Norton**, **"**Machine Design an Integrated Approach", Pearson Education India, 2015,

ISBN- 978-8131705339

Reference Books:

1. **S.Suresh,** "Fatigue of Materials", Cambridge University Press, -2014, ISBN- 978-0521578479
2. **Julie.A.Benantine,** "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 2013, ISBN- 978-0133401912
3. "Fatigue and Fracture," ASM Hand Book, Vol 19, 2012, ISBN- 978-0871703859

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

AUTOMATION ENGINEERING

Course Code : 20MMD24 | **Credits : 04**
L: T:P : 4:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

20MMD24.1	Understand the concepts through necessary Programming of Automation, Internet of Things and Machine learning in Manufacturing.
20MMD24.2	Identify and Apply different types of automated flow lines, storage and retrieval systems in Manufacturing
20MMD24.3	Apply the concepts of embedded systems for software development in Industries
20MMD24.4	Understand the statistical and mathematical basics of Machine Learning algorithms.
20MMD24.5	Apply the knowledge of Automation, Machine learning and Internet of Things in real time projects.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD24.1	3	1	1	1	1	1	1	-	-	-	1	2
20MMD24.2	3	1	2	1	1	2	1	-	-	-	1	2
20MMD24.3	3	2	3	2	2	2	1	-	1	-	1	2
20MMD24.4	3	3	2	3	2	1	1	-	-	-	1	2
20MMD24.5	3	3	3	3	3	3	2	-	2	2	2	3

Ratings: 3 for high, 2 for substantial, 1 for low

Module No	Contents of Module	Hrs	Cos
1	Introduction to automation-Definition, types, merits and Criticism, Manufacturing plants and operations-automation strategies, Production concepts, MLT, Mathematical Models & Costs of Manufacturing Operations, Working syntax such as G-Codes and M-Codes for CNC Programming Introduction to concepts of IoT, Overview of IoT-Enabled Manufacturing System What is Machine Learning, Importance of Machine learning in Automation, machine learning algorithms Lab: CNC (Absolute Programming) and Python Programming	**9**	**20MMD24.1**
2	Automated Flow lines, Analysis of Automated Flow Lines, Automated Guided Vehicle, Automated	**9**	**20MMD24.2**

	Storage/Retrieval Systems, Product identification system, Automated Assembly Systems, Automated Inspection Principles and Methods, Building Blocks of Automation System Lab: CNC Programming for Turning, Milling and Drilling		
3	IoT-Enabled Smart Assembly station: RFID-Based Applications in Assembly line, Assistant services for Assembly Line, Architecture of IoT-Enabled Smart Assembly station , Real-Time status monitoring, Real-Time Production guiding, Real-Time Production data sharing, Real-Time Production Requeuing. Data Acquisition and Control Unit: Hardware: Introduction, Basic Modules, Functional Modules, DACU Capacity Expansion, System Cables, Integrated Assemblies, DACU Construction, Data Exchange on Bus, Summary Data Acquisition and Control Unit: Software: Introduction, Software Structure, Application Programming, Summary Lab: The Raspberry Pi platform and Python Programming for Raspberry Pi.	**9**	**20MMD24.3**
4	Describe or summarise a set of data. Measure of central tendency and measure of dispersion. The mean, median, mode, kurtosis and skewness Standard deviation and Variance. Types of distribution. Hypothesis Testing, Basics of Hypothesis Testing, Supervised Learning-Linear Regression, Logistics Regression, Decision Tree. Lab: Regression Model Building using Python Programming.	**9**	**20MMD24.4**
5	IoT and Programming enabled case studies: Smart irrigation using IoT, Weather Monitoring, System using Raspberry Pi, Weather update system with IoT, Home Automation using IoT, Automated Street light using IoT, Smart water monitoring, Facial recognition door Lab: Model Building and Prototype development using Arduino and Programming.	**8**	**20MMD24.5**

Reference Books:

1. Machine Learning, Tom M Mitchel, McGraw Hill Education, July 2017, ISBN: 978-1-25-9096952.
2. Business Analytics, U DinesH Kumar, Wiley India Pvt Ltd, 2017, ISNB:978-81-265-6877-2.

3. Optimization of Manufacturing systems using Internet of Things, Yingfeng Zhang, Fei Tao, First Edition, 2016, Elsevier, ISBN: 9780128099100
4. Overview of Industrial Process Automation, KLS Sharma, 2016, Elsevier, ISBN: 9780128053546
5. Machine Learning, An Algorithmic Perspective, Stephen Marsland, Chapman and Hall, Nov 2014, ISBN: 978-1466583283.
6. Data Science and Analytics, V. K. Jain, Khanna Publishing, 2018, ISBN-10: 9789386173676
7. "Automation, Production Systems and Computer Integrated Manufacturing"- M.P.Grover, Pearson Education, 4th Edition, 2016, ISBN: 978-9332572492
8. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI, 2nd edition, 2011, ISBN: 978-8120339880
9. Principles and Applications of PLC – Webb John, Mcmillan, 2006, ISBN- 9780024249708
10. Sensor Technology Handbook , Jon S. Wilson, Newnes, 2004

CIE- Continuous Internal Evaluation for theory (50 Marks)

Bloom's Taxonomy	Test 30	Assignment 10	External Participation(10)
Remember	5		
Understand	10	5	
Apply	5	5	5
Analyze	5		
Evaluate	5		5
Create			

SEE – Semester End Examination for theory (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

CORE ELECTIVES-2

MECHATRONICS SYSTEM DESIGN

Course Code	**: 20MMD251**	**Credits**	**: 03**
L: T:P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD251.1	**Understand** the basics of Mechatronics system design.
20MMD251.2	**Know** about actuation system.
20MMD251.3	**Learn** advanced applications of Mechatronics.
20MMD251.4	**Know** about signal conditioning and data presentation.
20MMD251.5	**Understand** basic system model.
20MMD251.6	**Know** about actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD251.1	1	1	2	1	1	1	1	1	1	1	1	2
20MMD251.2	1	2	2	2	1	2	1	2	1	2	2	2
20MMD251.3	2	2	2	2	2	2	1	2	2	2	2	2
20MMD251.4	2	3	2	3	1	1	1	3	1	1	3	2
20MMD251.5	2	3	2	2	2	1	1	2	2	1	3	2
20MMD251.6	2	3	2	2	2	1	1	2	2	1	3	2

SYLLABUS			
Module No	**Contents of the Module**	**Hours**	**COs**
1	Introduction: Definition and Introduction to Mechatronics Systems. Modeling &Simulation of Physical systems Overview of Mechatronics Products and their functioning, measurement systems Control Systems, simple Controllers Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	9	20MMD251.1
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, electromechanical systems, hydro- mechanical systems, pneumatic systems.	9	20MMD251.2
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 Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process.	9	20MMD251.3, 20MMD251.4
4	Micro System Fabrication Process: Photolithography, Ion implantation, Diffusion, CVD, PVD, Epitaxy, Etching. Overview of Micro Manufacturing: Bulk Micro manufacturing surface, Micromachining, The LIGA Process.	9	20MMD251.5
5	Advanced Applications in Mechatronics: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design	8	20MMD251.6

Text Books:

1. **W. Bolton,** "Mechatronics" - Addison Wesley Longman Publication, 6th Edition, 2016, ISBN- 978-1292076683
2. **Tai-Ran Hsu** "MEMS and Microsystems design and manufacture"- Wiley; 2 edition , 2014, ISBN-978-0470083017

Reference Books:

1. **Kamm,** "Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"- IEEE Press, 1 edition, 2012, ISBN- 978-0780310315
2. **Shetty and Kolk** "Mechatronics System Design"- Cengage Learning, 2014, ISBN- 978-1439061985
3. **HMT** "Mechatronics"- Tata McGraw-Hill Education, 2013, ISBN- 978-0074636435
4. **Michel .B. Histand& David. Alciatore**, "Introduction to Mechatronics & Measurement Systems"–. Mc Grew Hill, 2014, ISBN- 978-0073380230

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

ADVANCED MANUFACTURING PLANNING AND CONTROL

Course Code	**: 20MMD252**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks:**	**50**
Exam Hours	**: 03**	**SEE Marks:**	**50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD252.1	**Understand** broad array of topics that falls under the umbrella of manufacturing planning and control.
20MMD252.2	**Apply** the terminology, concepts, principles of manufacturing in AMPC
20MMD252.3	**Develop** a basic understanding of traditional planning techniques used by practical and operational managers in real world organizations.
20MMD252.4	**Learn** the new approaches for planning and control.
20MMD252.5	**Know** about the MRP and MRP-II.
20MMD252.6	**Understand** about Just in Time and Quality Control, Frequency response & random vibrations.

Mapping of CO v/s PO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
20MMD252.1	3	3	1	1	3	2	1	3	2	1	1	2
20MMD252.2	3	3	2	3	2	2	1	1	2	1	3	2
20MMD252.3	2	2	3	2	1	2	2	1	3	2	2	1
20MMD252.4	3	3	2	2	1	3	1	2	2	1	2	1
20MMD252.5	2	2	3	3	2	2	3	2	2	1	2	2
20MMD252.6	3	3	2	2	3	3	2	1	3	2	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**Cos**
1	Introduction to Manufacturing Systems Engineering: Process Planning, Logical design of process planning, Computer Aided Process Planning (CAPP), Computerization of file management; Variant (Retrieval), Generative and degenerative approaches, General remarks on CAPP developments and trends.	8	20MMD 252.1, 20MMD 252.2
2	Resource Planning & Production Control: Overview of	9	20MMD

	production control, Forecasting, Master production schedule, Materials requirements planning, Evolution from MRP to MRP II, Evaluation of MRP approach, Order release, Shop floor control.		252.3
3	Just in Time (JST) Production: Introduction- The spread of JIT movement, Some definitions of JIT, Core Japanese practices of JIT, Profit through cost reduction, Elimination of over production, Quality control, Quality assurance, Respect for humanity, Flexible work force, JIT production adapting to changing production quantities, Process layout for shortened lead times, Standardization of operation, automation.	9	20MMD 252.4
4	Toyota Production System (TPS): Philosophy of TPS, Basic frame work, Kanbans, Determining number of Kanbans in TPS, Kanban number under constant quantity withdrawal system, Constant cycle, Non-constant quantity withdrawal system, Constant withdrawal cycle system for the supplier Kanban, Supplier Kanban and the sequence schedule for use by suppliers, Later replenishment system by Kanban, Sequence withdrawal system	9	20MMD 252.5
5	Production smoothing in TPS, Production planning, Production smoothing, Adaptability to demand fluctuations, Sequencing method for the mixed model assembly line to realize smoothed production of goal	9	20MMD 252.6

Text Books:

1. **Halevi, G, Weill, R.D**., "Principles of Process Planning", Chapman and Hall, 2015, ISBN-978-7109289341

2. **Yasuhiro Monden,** "Toyota production System-An IntegratedApproach to Just in Time", CRC Press, 2014, ISBN- 978-1439820971

References:

1. **Chary,S,N.**, "Production and Operations Management", Tata McGraw Hill, 2012, ISBN- 978-0074518892
2. **Monks, J,G**., "Operations Management", McGraw Hill, 2016, ISBN- 978-0070427648
3. **Francis, R,L**., **Leon Franklin McGinnis., John A. White**., "Facility Layout and Location", Prentice Hall, 2012, ISBN- 978-8120314603
4. **Cheng, T,C., Podolsky, S., "** Just in Time Manufacturing", Springer, 2016, ISBN- 978-0915299485
5. **James P. Womack., Daniel T. Jones**., "Lean Thinking", Simon & Schuster, 2013, ISBN- 978-0743249270

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

DESIGN OPTIMIZATION

Course Code	**: 20MMD253**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD253.1	**Understand** fundamentals of Engineering Design Practice.
20MMD253.2	**Knowledge** of Optimum Design Problem Formulation
20MMD253.3	**Remember** the skills of Manufacturability in Optimization Problems**.**
20MMD253.4	**Learn** about conceptual design optimization.
20MMD253.5	**Know** about the Dynamic Programming.
20MMD253.6	**Understand** Classical Optimization Techniques, Non - linear Programming.

Mapping of CO v/s PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD253.1	3	3	1	1	3	2	1	1	1	1	1	2
20MMD253.2	3	3	2	3	2	2	1	1	1	1	1	2
20MMD253.3	2	2	3	2	1	2	1	1	1	1	1	1
20MMD253.4	3	3	2	2	1	3	1	1	1	1	1	1
20MMD253.5	2	2	3	3	2	2	1	1	1	1	1	2
20MMD253.6	3	3	2	2	3	3	1	1	1	1	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**Cos**
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.	9	20MMD253.1, 20MMD253.2
2	**Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization,	9	20MMD253.3

	Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non Linear Optimization.		
3	**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.	9	20MMD2 53.4
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 .	9	20MMD2 53.5
5	**Dynamic Programming**: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. 8 Hours.	8	20MMD2 53.6

Text Books:

1. **S.S.Rao, "**Engineering Optimization: Theory and Practice," John Wiley, 2016, ISBN- 978-0470183526
2. **JasbirArora,** "Introduction to Optimum Design, "McGraw Hill, 2011. ISBN- 978-0128008065

Reference Books:

1. **Ram, "Optimisation** and Probability in System Engg "- Van Nostrand, 2012, ISBN-978-710928934
2. **K. V. Mital and C. Mohan, "**Optimization methods" - New age International Publishers, 2014, ISBN-978-8122408737
3. **R.L Fox,** Addison "Optimization methods for Engg. Design" Wesley, 2015, ISBN- 978-8120346789

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

FATIGUE, CREEP & FRACTURE MECHANICS

Course Code : 20MMD254 **Credits : 03**
L: T: P : 3:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks : 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD254.1	**Understand** the basics of fatigue, creep and fracture mechanics
20MMD254.2	**Know** about stress intensity factor in fracture mechanics.
20MMD254.3	**Understand** about elastic/plastic fracture mechanics.
20MMD254.4	**Know** about fatigue of welded structures.
20MMD254.5	**Evaluate** the Crack like defects on the performance of aerospace, civil, and Mechanical engineering structures.
20MMD254.6	**Create** appropriate materials for engineering structures to insure damage tolerance.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD254.1	3	3	2	2	1	2	1	2	3	2	2	2
20MMD254.2	2	2	2	3	2	2	1	2	1	2	2	1
20MMD254.3	2	2	3	2	1	1	2	3	2	3	1	1
20MMD254.4	3	3	3	2	3	1	2	2	1	3	1	1
20MMD254.5	3	3	2	3	1	2	3	1	1	2	2	2
20MMD254.6	3	3	2	3	3	1	2	1	2	2	1	1

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**COs**
1	**INTRODUCTION**: Fracture behavior of metals and alloys. The ductile/brittle transition temperatures for notched and un-notched components, Ductile rupture as a failure mechanism Fracture at elevated temperature. Definitions of types of fracture and failure **Basic stress analysis and mechanical properties**: Elasticity, General 3-D relations, Plane stress and plane strain, Mohr's circle-principal stresses, Yield in materials, Tresca and Von Mises criteria, Ideal and actual strength of materials. Typical stress/strain curves for different classes of Materials	**9**	20MMD254.1, 20MMD254.2
2	**STRESS INTENSITY FACTOR AND ITS USE IN** **FRACTURE MECHANICS**: Early concepts of stress concentrators and flaws, Ingles solution to stress round elliptical hole-implications of results. Stress intensity factor for a crack. Westergaard's solution for crack tip stresses. Linear Elastic Fracture Mechanics Typical values of fracture toughness, Different modes of crack opening. Superposition of crack tip stress fields, Direction of crack growth under mixed mode loadings. Crack tip plasticity, Early estimates of plastics zone, Irwin plastic zone correction and Dugdale approach, Plastic zone shape in three dimensions and shape under plane stress and plane strain conditions,	**9**	20MMD254.3
3	Elastic/plastic fracture mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, RAD, Fail sage and safe life design approaches Practical applications. Advanced topics in EOFM	**8**	20MMD254.4

4	**FATIGUE**: Importance of fatigue in engineering, Low cycle fatigue, cyclic work hardening and softening. Micro structural models of crack initiation Stage I, II and III crack growth. **Analysis of Fatigue**: The empirical laws of fatigue failure. High cycle-low strain fatigue, asquin's law, Goodman, Soderberg and Gerber mean stress corrections, Low cycle fatigue, Crack growth and application of fracture mechanics to fatigue, Paris-Ergodan law, Threshold stress intensity range. Crack closure and its theories Cycle counting methods, Developments in using rain-flow counting methods to recreate fatigue standard spectra. Standard spectra suitable for different applications	**9**	20MMD254.5
5	**FATIGUE OF WELDED STRUCTURES**: Factors affecting the fatigue lives of welded joints, the codes and standards available to the designer, the use of fracture mechanics to supplement design rules. Practical examples **Creep**: Phenomenology, Creep curves, Creep properties, Multi-axial creep, Creep-fatigue interaction, Creep integrals.	**9**	20MMD254.6

Text Books:

1. **Dieter,** "Mechanical Metallurgy," McGraw Hill,3rd Edition, 2013, ISBN- 978-1259064791
2. **Anderson T.L & Boca Raton,** "Fracture Mechanics: Fundamental and Applications" CRC Press, Florida, 4th Edition, 2017, ISBN- 978-1498728133
3. **Richard W Hertz,** "Deformation and Fracture mechanics of Engineering Materials" Wiley, 5th Edition ,2014, ISBN- 978-0470527801
4. **D.R.J. Owen and A.J. Fawkes,** "Engineering Fracture Mechanics" Pincridge press, Swansea, U.K. 2012, ISBN- 978-0906674260

Reference Books:

1. **S.T. Rolfe and J.M. Barsom,** "Fracture and fatigue control in structures" Pearson College Div; Revised, Subsequent edition, 2013, ISBN- 978-0133298635
2. **B.R. Lawn and T.R. Wilshaw, "**Fracture of brittle solids" Cambridge university press, 2012, ASIN: B01DRXAO7U
3. **R.W.K. Honeycombe,** "Plastic deformation of Metals" 2nd edition, Edward Arnold, 2012, ISBN-978-0713121810

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

ADVANCED THEORY OF VIBRATIONS

Course Code	**: 20MMD255**	**Credits**	**: 03**
L: T:P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD255.1	**Understand** the basics of mechanical vibrations.
20MMD255.2	**Learn** about Vibration isolation theory.
20MMD255.3	**Acquire** skills of Dynamic Testing of machines and Structures**.**
20MMD255.4	**Remember** the different types of Random Vibrations.
20MMD255.5	**Know** about Euler's equation in Vibrations.
20MMD255.6	**Understand** about Frequency response & random vibrations.

Mapping of CO v/s PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD255.1	3	3	1	1	3	2	1	3	2	1	1	2
20MMD255.2	3	3	2	3	2	2	1	1	2	1	3	2
20MMD255.3	3	2	3	2	1	2	2	1	3	2	2	1
20MMD255.4	2	3	2	2	1	3	1	2	2	1	2	1
20MMD255.5	2	2	3	3	2	2	3	2	2	1	2	2
20MMD255.6	3	3	2	2	3	3	2	1	3	2	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**Cos**
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. Transient Vibration of single Degree-of freedom systems: Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.	9	20MMD255.1
2	Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, and Vibration dampers. Vibration Measurement and applications	9	20MMD255.2
3	Modal analysis & Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis. Non Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines	9	20MMD255.3
4	Random Vibrations : Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.	8	20MMD255.4, 20MMD255.5
5	Continuous Systems: Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	9	20MMD255.6

Text Books :

1. **William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan**, "Theory of Vibration with Application," - 5th edition Pearson Education, 2015, ISBN- 978-0136510680
2. **S. Graham Kelly,** "Fundamentals of Mechanical Vibration" - McGraw-Hill, 2013, ISBN- 978-0071163255
3. **S. S. Rao,** "Mechanical Vibrations", Pearson Education, 4th edition, 2015, ISBN- 978-0201526868

Reference Books:

1. **S. Graham Kelly,** "Mechanical Vibrations", Schaum's Outlines, Tata McGraw Hill, 2016, ISBN- 978-1439062128.
2. **C Sujatha,** "Vibraitons and Acoustics – Measurements and signal analysis", Tata McGraw Hill, 2012, ISBN-978-3212609341.

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

DYNAMICS AND MECHANISIM DESIGN LAB

Course Code	**: 20MMD27**	**Credits**	**: 02**
L: T:P	**: 0:0:2**	**CIE Marks**	**: 25**
Exam Hours	**: 03**	**SEE Marks**	**: 25**

1. Structural Analysis

a. FE Modeling of a stiffened Panel using a commercial preprocessor.

b. Buckling, Bending and Modal analysis of stiffened Panels.

2. Design Optimization

a. Shape Optimization of a rotating annular disk.

b. Weight Minimization of a Rail Car Suspension Spring.

3. Thermal analysis

a. Square Plate with Temperature Prescribed on one edge and opposite edge insulated.

b. A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

4. Thermal Stress Analysis

a. A Thick Walled Cylinder with specified Temperature at inner and outer Surfaces.

b. A Thick Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

5. Welded Joints.--FE Modeling and Failure Analysis. .

6. Bolted Joints. -- FE Modeling and Failure Analysis.

CIE for Lab

Bloom's Category	**Tests**	**Assignments**	**Viva**
Marks (Out of 25)	**10**	**10**	**5**
Remember	2	2	1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	2	1
Create			1

SEE (25 Marks) Lab

Bloom's Category	**Questions**
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	--

THIRD SEMESTER

TRIBOLOGY AND BEARING DESIGN

Course Code	**: 20MMD31**	**Credits**	**: 04**
L:T:P	**: 4:0:0**	**CIE Marks**	**: 50**
Exams Hours	**: 03**	**SEE Marks**	**: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD31.1	**Understand** basics of Tribology, Wear mechanism & Friction
20MMD31.2	**Evaluate** Hagen's Poiseuille's theory & Petroff's Equation
20MMD31.3	**Apply** the Hydrodynamic lubrication & Reynolds's equation in Tribology
20MMD31.4	**Remember** the concepts of Journal bearings & Hydrostatic bearings
20MMD31.5	**Know** the different types of Antifriction bearings & its applications
20MMD31.6	**Understand** the different types of Magnetic bearings

Mapping of Course outcomes to Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD31.1	1	2	1	1	3	2	1	3	2	1	1	2
20MMD31.2	3	3	2	3	2	2	1	1	2	1	3	2
20MMD31.3	3	2	3	2	1	2	2	1	3	2	2	1
20MMD31.4	2	3	2	2	1	3	1	2	2	1	2	1
20MMD31.5	2	2	3	3	2	2	3	2	2	1	2	2
20MMD31.6	1	3	2	2	3	3	2	1	3	2	1	2

Module No	Contents of Module	Hrs	COs
1	**Introduction to Tribology-**Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Viscometers, Hagen's poiseuille's theory, Numerical problems, Petroff's equation, Numerical problems **Types of wear -** Wear Mechanism of sliding wear of metals-Abrasive wear-Materials for Adhesive and Abrasive wear situations - Corrosive wear – Surface Fatigue wears situations.	**9**	20MMD31.1, 20MMD31.2
2	**Hydrodynamic Lubrications -**Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions Introduction to idealized slide bearing with fixed shoe. Expression for load carrying capacity, Numerical problems **Journal Bearings -** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Numerical problems.	**9**	20MMD31.3

3	**Hydrostatic Bearings:** Hydrostatic thrust bearings, rectangular pad bearings, types of flow restricters, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.	**9**	20MMD31.4
4	**Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings. Porous Bearings: Introduction to porous and gas lubricated bearings.	**9**	20MMD31.5
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	**8**	20MMD31.6

TEXT BOOKS:

1. **Mujamdar.B.C** "Introduction to Tribology of Bearing", S Chand Publisher, New Delhi 2016, ISBN: 978-8121929875
2. **Krzysztof Czolczynski, "** Rotordynamics of Gas-Lubricated Journal Bearing Systems", Springer,2012, ISBN- 978-1461271765
3. **Andras Z Szeri**, "Fluid Film Lubrication" Cambridge Publication, 2nd Edition-1998, ISBN: 978-0521481007

REFERENCE BOOKS:

1. **Dudley D.Fulier** "Theory and practice of Lubrication for Engineers", New YorkCompany.2013 , ISBN: 978-0471047032
2. **Moore** "Principles and applications of Tribology" Pergamon press, 2013, ISBN: 978-1483124865
3. **Bharat Bhushan** "Introduction to Tribology" A John Wiley & Sons Ltd, Publications, 2nd Edn -2013, ISBN: 978-0471158936
4. **G W Stachowiak**, A W Batchelor , "Engineering Tribology", Elsevier publication 3rd Edition, 2012, ISBN: 978-0123970473
5. **Lingaiah K**, Machine Design Data Handbook Vol 2, Suma Publishers, 2006, ISBN-5551234001940

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

CORE ELECTIVE- 3

APPLICATIONS OF SMART MATERIALS

Course Code	**: 20MMD321**	**Credits**	**: 03**
L:T:P	**: 3:0:0**	**CIE Marks**	**: 50**
Exams Hours	**: 03**	**SEE Marks**	**: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD321.1	**Understand** basics of Behavior and applicability of various smart materials
20MMD321.2	**Identify** the concepts of Shape memory alloys
20MMD321.3	**Know** about ER & MR Fluids
20MMD321.4	**Remember** the concepts of Different types of vibration absorbers & its applications
20MMD321.5	**Evaluate** the different Mechanical properties of MEMS
20MMD321.6	**Analyze** the conductivity of semiconductors, stress & strain relations

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD321.1	2	3	2	2	1	2	1	2	3	1	2	2
20MMD321.2	3	2	2	3	2	2	1	2	1	2	2	1
20MMD321.3	2	2	3	2	1	1	2	3	2	2	1	1
20MMD321.4	3	3	3	2	3	1	2	2	1	2	1	1
20MMD321.5	2	3	2	3	1	2	3	1	1	1	2	2
20MMD321.6	3	3	2	3	3	1	2	1	2	2	1	1

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**COs**
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 Coercive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.	**9**	20MMD321.1
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	**9**	20MMD321.1, 20MMD321.3
3	Vibration Absorbers: series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications	**9**	20MMD321.4
4	MEMS – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration	**8**	20MMD321.5
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	**9**	20MMD321.6

TEXT BOOKS:

1. **M. V. Gandhi and B.So Thompson**, "Smart Materials and Structures," Chapman and Hall, London; New York, 2013 (ISBN: 0412370107).
2. **B. Culshaw**, "Smart Structures and Materials," Artech House, Boston, 2013 ISBN: 978-0750302227
3. **A. V. Srinivasan,** "Smart Structures: Analysis and Design," Cambridge University Press, Cambridge; New York, 2012 (ISBN: 0521650267).

REFERENCE BOOKS:

1. **A. J. Moulson and J. M. Herbert**, "Electroceramics: Materials, Properties and Applications," John Wiley & Sons, 2013 ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2015
3. Piezoelectric Ceramics – Principles & applications by APC International Ltd.,-2013
4. **G. Engdahl,** "Handbook of Giant Magnetostrictive Materials," Academic Press, San Diego, Calif.; London, 2014 (ISBN: 012238640X).
5. **K. Otsuka and C. M. Wayman,** Shape Memory Materials - Cambridge University Press, Cambridge; New York, 2nd Edn 2014 (ISBN: 052144487X).

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

MACHINE LEARNING

Course Code : 20MMD322 **Credits: 03**
L: T:P : 3:0:0 **CIE Marks:50**
Exam Hours : 3 **SEE Marks:50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD322.1	Understand the basics of Excel, Rattle and R programming platform
20MMD322.2	Analyse the basic algorithms in machine learning
20MMD322.3	Apply various tests on data to develop linear regression and logistic regression model
20MMD322.4	Develop decision tree and clustering models using unsupervised learning
20MMD322.5	Understand reinforcement learning using Markov Chain Models

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD322.1	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**3**	**2**	**2**
20MMD322.2	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**3**	**2**	**2**
20MMD322.3	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**2**	**2**
20MMD322.4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**2**	**2**
20MMD322.5	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**2**	**2**

Ratings: 3 for high, 2 for substantial, 1 for low

Module No	Contents of Module	Hrs	Cos
1	**<u>Introduction to Machine Learning</u>**: What is Machine Learning? The origin of machine learning, Its importance in our daily lives. Descriptive, Predictive and Prescriptive analysis techniques, machine learning algorithms, Fundamental concepts of probability, Bayes Theorem, Types of distribution, **Hypothesis testing:** one-tailed and two-tailed test, Z-test, t-test, Chi-Square test, ANOVA	**9**	**20MMD322.1** **20MMD322.2**

2	**Suprvised learning using linear regression:** SLR Model Building, Estimation of parameters using OLS, Interpretation of SLR coefficients, Validation of SLR model, confidence interval, multiple linear regression, MLR Model Building, Standardized regression co-efficient, Qualitative variables, Validation **Case study on testing techniques based on linear regression**	**9**	**20MMD322.2** **20MMD322.3**
3	**Suprvised learning using logistic regression:** Introduction to Classification problems and binary logistic regression, Estimation of parameters, classification table, Sensitivity, Specificity, ROC curve, Optimal Cut-off probability, Gain chart and Lift chart **Case study on testing techniques based on logistic regression**	**9**	**20MMD322.2** **20MMD322.3**
4	**Unsupervised learning:** Decision Trees, CHAID, Generating business rules using CHAID, CART, Entropy, Information Gain, Clustering, k means clustering, distance and dissimilarity measures, Hierarchical clustering, **Case study on clustering and decision tree**	**9**	**20MMD322.2** **20MMD322.4**
5	**Reinforcement learning :** Introduction to Stochastic process, Markov chains, states in Markov Chain, One step Transition Probabilities of Markov Chains, Stationary Distribution, Markov Chain with absorbing states, Duration calculation, Markov decision process **Case study on Markov Chain Models**	**8**	**20MMD322.2** **20MMD322.5**

Text Books:

1. Machine Learning, Tom M Mitchel, McGraw Hill Education, July 2017, ISBN: 978-1-25-9096952.
2. Business Analytics, U DinesH Kumar, Wiley India Pvt Ltd, 2017, ISNB:978-81-265-6877-2.

Reference Books:

1. Machine Learning, An Algorithmic Perspective, Stephen Marsland, Chapman and Hall, Nov 2014, ISBN: 978-1466583283.
2. THE ART OF R PROGRAMMING, Norman Matloff, 2011, No Starch Press,ISNB-10 1593273842

CIE- Continuous Internal Evaluation for theory (50 Marks)

Bloom's Taxonomy	Test(30)	Assignment(10)	External Participation
Remember	2		
Understand	5		
Apply	8	5	
Analyze	10	5	
Evaluate	3		5
Create	2		5

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

SIMULATION PROCESS FOR MANUFACTURING

Course Code	**:20MMD323**	**Credits**	**: 03**
L: T: P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD323.1	**Understand** the nature of discrete-event simulation and the types of simulation models
20MMD323.2	**Evaluate** the essential steps of the simulation methodology
20MMD323.3	**Understand** the broad applicability of discrete-event simulation to solve complex manufacturing systems problems
20MMD323.4	**Understand** the system behavior by measuring the performance characteristics proposed new manufacturing
20MMD323.5	**Knowledge** of simulation modeling to an industrial problem, utilizing experimental design techniques.
20MMD323.6	**Evaluate** and interpret alternative system in designs

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD323.1	3	3	2	2	1	2	1	2	3	2	2	2
20MMD323.2	2	2	2	3	2	2	1	2	1	2	2	1
20MMD323.3	2	2	3	2	1	1	2	3	2	3	1	1
20MMD323.4	3	3	3	2	3	1	2	2	1	3	1	1
20MMD323.5	3	3	2	3	1	2	3	1	1	2	2	2
20MMD323.6	3	3	2	3	3	1	2	1	2	2	1	1

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**COs**
1	MANUFACTURING SYSTEMS AND MODELS: Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.	**8**	20MMD 323.1

2	FLOW SHOP SYSTEMS: Assembly lines - reliable serial systems - approaches to line balancing – COMSOAL, ranked positional weight heuristic, branch and bound technique (optimal solution) – Sequencing mixed models – unplaced lines. transfer lines and general serial systems – paced lines without buffers, two stage paced lines with buffers, introduction to unplaced lines	**9**	20MMD323.2, 20MMD323.3
3	FLEXIBLE MANUFACTURING SYSTEMS: System components – planning and control hierarchy – system design, system setup, scheduling and control – flexible assembly systems. CELLULAR SYSTEMS: Group technology – coding schemes – assigning machines to groups – production flow analysis, binary ordering algorithm, single pass heuristic, similarity coefficients, graph partition - assigning parts to machines. JOB SHOP SYSTEMS: Facility layout- systematic layout planning, quadratic assignments problem approach – VNZ heuristic, branch and bound method – graph theoretical approach – decomposition of large facilities – net aisle and department layout	**9**	20MMD323.4
4	SUPPORTING COMPONENTS: Machine setup and operation sequencing – task assignment, task sequencing, integrated assignment and sequencing. Material handling systems – conveyor analysis, AGV systems. Warehousing – storage and retrieval systems, order picking	**9**	20MMD323.5
5	GENERIC MODELING APPROACHES: Queuing models – notations, performance measures, m/m/1 queue, m/m/m queue, batch arrival queuing systems, queues with breakdowns – queuing networks – open and closed networks, central server model. MODELING THROUGH PETRI NET: Basic Definitions – classical Petri nets – transformation firing and reach ability, reach ability graphs – representation schemes – timed Petri nets - modeling of manufacturing systems.	**9**	20MMD323.6

References Book:

1. **Ronald G Askin**, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc, 2013, ISBN- 978-0471514183
2. **Viswanatham N and Narahari Y** "Performance Modeling of Automated Manufacturing Systems", Prentice Hall Inc., 2012, ISBN- 978-8120308701
3. **Mengchu Zhou**, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach", World Scientific Publishing Company Pvt Ltd., 2014, ISBN- 978-9810230296
4. **Jean Marie Proth and Xiaolan Xie**, "Petri Nets: A Tool for Design and Management of Manufacturing Systems", John Wiley and Sons, New York, 2016, ISBN- 978-0471967705.

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

CORE ELECTIVES-4

ADVANCED MECHANICS OF SOLIDS

Course Code : 20MMD331
L:T:P : 3:0:0
Exam Hours : 03

Credits : 03
CIE Marks : 50
SEE Marks : 50

Course Outcomes: At the end of the Course, the Student will be able to do the following:

20MMD331.1	**Remember** the concept of bending and deflection of beams.
20MMD331.2	**Understand** the concept of torsion and curved beam theory.
20MMD331.3	**Understand** the concept of Deflection of bodies in point contact
20MMD331.4	**Evaluate** two dimensional elasticity problems in plane stress & plain strain.
20MMD331.5	**Evaluate** two dimensional elasticity problems in polar co-ordinates.
20MMD331.6	**Analyze** the three dimensional problems in bending of plates and circular shafts.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD331.1	3	3	2	2	1	2	2	1	1	2	1	1
20MMD331.2	3	3	3	3	2	3	3	1	2	3	1	2
20MMD331.3	3	3	3	3	3	3	1	1	3	1	1	1
20MMD331.4	3	3	2	3	1	3	3	1	1	3	1	2
20MMD331.5	3	3	3	2	2	2	2	1	2	2	1	2
20MMD331.6	3	3	2	2	2	2	2	1	2	2	1	2

Course Syllabus			
Module No.	**Contents of the Module**	**Hrs**	**COs**
1	**Shear center**: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections **Unsymmetrical bending:** Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.	**9**	20MMD331.1
2	**Curved beam theory**: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links. **Torsion** : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.	**9**	20MMD331.2 20MMD331.3
3	**Contact stresses:** Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.	**9**	20MMD331.4
4	**Two Dimensional Elasticity Problems:** Plane stress & Plain strain-Problems in Rectangular Co-ordinates, bending of cantilever loaded at the end, bending of a beam by uniform load. **Two Dimensional Elasticity Problems**: in polar co-ordinates, general equations in polar coordinates, stress distribution symmetrical about an axis, pure bending of curved bars, displacements for symmetrical stress distributions, rotating discs.	**9**	20MMD331.5
5	**Introduction to Three Dimensional Problems**: Uniform stress stretching of a prismatic bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates	**8**	20MMD331.6

TEXTBOOKS:

1. **Boresi & Sidebottom**, Advanced Mechanics of materials , -6th Edition, Wiely International, 2013, ISBN-978-8126522163.

2. **Timoshenko and Goodier**, "Theory of Elasticity"-'McGraw Hill Book Company, 2014. ASIN: B019TM4WQ2

REFERENCES:

1. **John Case,** Strength of Materials and Structures, Butterworth-Heinemann; 4 edition,2012, ISBN-978-0340719206
2. **Sadhu singh**, Strength of materials, , Khanna Publishers, 2014, ISBN- 978-9381068809

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**External Participation**
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks)

Bloom's Category	**Questions**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

BIO AND NANOMATERIALS

Course Code	**: 20MMD332**	**Credits**	**: 03**
L: T:P	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**:50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD332.1	**Understand** the basics knowledge of Nano composites
20MMD332.2	**Remember** about polymer Nano composites
20MMD332.3	**Analyze** the synthesis of Nano materials.
20MMD332.4	**Understand** about Mechanics of polymer Nano composites.
20MMD332.5	**Learn** the computer control of agile manufacturing
20MMD332.6	**Knowledge** of design of super hard materials by using nanocomposites.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MMD332.1	3	3	2	2	1	2	1	2	2	2	2	2
20MMD332.2	2	2	2	3	2	2	1	2	2	2	2	1
20MMD332.3	2	2	3	2	1	1	2	3	3	3	1	1
20MMD332.4	3	3	3	2	3	1	2	2	3	3	1	1
20MMD332.5	3	3	2	3	1	2	3	1	2	2	2	2
20MMD332.6	3	3	2	3	3	1	2	1	2	2	1	1

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**COs**
1	**Metal based nano composites**- Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties	**9**	20MMD332.1
2	**Design of Super hard materials**- Super hard nanocomposites, its designing and improvements of mechanical properties	**8**	20MMD332.2, 20MMD332.3
3	**Nanofiller synthesis**, applications, Polymer nanocomposites, particulate and fibre modified nanocomposites, matrices and fibres, polymer- filler interphase, pull- out strength, effect of various treatments.	**9**	20MMD332.4
4	**Mechanics of polymer nanocomposites**, Interfacial adhesion and characterization, factors influencing the performance of nanocomposites, physical and functional properties. Nano composite fabrication, matrices, methods, additives, molding processes	**9**	20MMD332.5
5	**Polymer-carbon nanotubes based composites**, processing methods and characterization using SEM, XRD, TEM **Characterization of Polymer nanotubes based composites** for Mechanical, Electrical and Thermal Properties and their applications - Polymer / Nanofiller (metallic nanopowders) systems, Rheological measurements, processing characteristics Testing of nanocomposites, Thermal analysis such as TGA, TMA, DSC, DMTA	**9**	20MMD332.5, 20MMD332.6

REFERENCE BOOKS:

1. **Fred W. Billimeyer, Jr – Wiley,** "Text Book of Polymer Science" Interscience Publication - third edition, 2014, ISBN- 978-1566765596
2. **Joel R. Fried,** "New Developments and Technology -Hand book of Elastomers" (Eds. A. K. Bhowmic and H. C. Stephense), Marcel - Dekker Inc., New York – 2015, ISBN- 978-0133155716
3. **M. J. Folkes ,** "Short Fibre Reinforced Thermoplastics" John Wiley, New York – 2012, ISBN- 78-0471102090.
4. **P. M. Ajayan, L.S.Schadler, P. V. Braun, R. Saito,** "Nanocomposites Science and Technology Physical Properties of Carbon Nanotubes - Carbon Nanotubes" (Carbon, Vol 33) - M. Endo, S. Iijima, M.S. Dresselhau , ISBN- 978-0387332024

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--

ADVANCED NON-TRADITIONAL MACHINING

Course Code	**: 20MMD333**	**Credits**	**: 03**
L:T:P	**: 3:0:0**	**CIE Marks**	**: 50**
Exams Hours	**: 03**	**SEE Marks**	**: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

20MMD333.1	**Understand** the need for development of newer non-traditional machining processes
20MMD333.2	**Remember** the different types of advanced non-traditional machining process.
20MMD333.3	**Analyze** the benefits of non-traditional machining processes over Traditional machining processes.
20MMD333.4	**Understand** the process of hybrid electro chemical and thermal processes.
20MMD333.5	**Analyze** the types of high velocity forming methods
20MMD333.6	**Apply** the principles of Non Traditional Machining towards the development of modern techniques towards material testing.

Mapping of Course outcomes to Program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
20MMD333.1	3	1	1	1	2	2	1	1	1	1	1	2
20MMD333.2	3	2	1	1	3	2	2	1	2	1	1	2
20MMD333.3	3	2	1	1	3	2	2	1	2	1	1	2
20MMD333.4	3	2	1	1	3	2	2	1	2	1	1	2
20MMD333.5	3	2	1	1	3	2	2	1	2	1	1	2
20MMD333.6	3	2	1	1	3	2	2	1	2	1	1	2

SYLLABUS			
Module No	**Contents of Module**	**Hrs**	**COs**
1	**Metal removal Process:** Introduction, history of machining, traditional machining, machine by cutting, machining by abrasion, non-traditional machining, single action non-traditional machining, hybrid machining	**8**	20MMD333.1
2	**Mechanical Processes**- Ultrasonic machining: Introduction, machining system, metal removal process, factors affecting metal removing process, dimensional accuracy and surface quality, applications. **Water Jet Machining**: Introduction, machining system, process parameters, applications, advantages and dis-advantages. **Ice-Jet Machining**: Introduction, process description. **Magnetic Abrasive finishing**: Introduction, machining system, metal removal process, applications.	**9**	20MMD333.2, 20MMD333.3
3	**Hybrid Electro Chemical machining**: Introduction, electro-chemical grinding. Introduction, metal removal rate, accuracy and surface quality, applications, advantages and disadvantages. **Electro Chemical Honing**: Introduction, Process characteristics, applications. **Electro Chemical Super finishing**: Introduction, metal removal process, process accuracy **Electro Chemical buffing:** Introduction, metal removal process. **Ultrasonic assisted Electro Chemical Machining**: Introduction, metal removing process, Laser Assisted Electro Chemical Machining,	**9**	20MMD333.4
4	**Hybrid Thermal Process**: Introduction, electro erosion dissolution machining, electric discharge grinding, abrasive electric discharge machining, electric discharge with ultra sonic assistance. **Electro Discharge Grinding:** Brush erosion, dissolution, mechanical machining	**9**	20MMD333.5
5	**High Velocity forming processes:** Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods. Types of high velocity forming methods, explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations	**9**	20MMD333.6

TEXT BOOKS

1. Hassan El-Hofy, "Advanced Machining Process", Tata Mc Graw Hill, 2015, Reprint, ISBN-978-0071453349

2. P.C Pandy & H.S Shan, "Modern Machining Process"-Tata Mc Graw Hill. 2013 ISBN: 9780070965539.

3. **Angelos P. Markopoulos**, "Advanced Machining Processes", CRC Press; 1 edition, 2017, ISBN- 978-1138033627

REFERENCE BOOKS:

1. **HMT,** "Production technology"-Tata Mc Graw Hill. 2012, ISBN- 978-0070964433

2. **J Paulo,** "Traditional Machining Process" Springer-2016, ISBN- 978-3662523810

3. **Adithan, A G Gupta** "Modern Manufacturing Methods" New Age International Publisher 2014, ISBN- 978-8174092250

ASSESEMENT METHOD

CIE (50 Marks Theory)

Bloom's Category	Tests	Assignments	External Participation
Marks (Out of 50)	**30**	**10**	**10**
Remember	5		
Understand	5		
Apply	10	5	5
Analyze	5	5	5
Evaluate	5		
Create			

SEE (50 Marks) Theory

Bloom's Category	Questions
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	--