RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme of
POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Machine Design

(Effective from academic session: 2020-21)

Rajasthan Technical University, Kota
Akelgarh, Rawatbhata Road, Kota-324010

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

M. Tech. Machine Design

Scheme and Syllabus

Semester - I

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MMD1-01	Advanced Solid Mechanics	3	0	0	3	30	70	100	3
2	PCC	1MMD1-02	Computer Aided Geometric Design	3	0	0	3	30	70	100	3
3	PCC	1MMD1-03	Advanced Vibrations	3	0	0	3	30	70	100	3
4	PEC	1MMD2-11	Numerical Methods in Engineering	3	0	0	3	30	70	100	3
		1MMD2-12	Analysis and Synthesis of Mechanism								
		1MMD2-13	Optimization Techniques								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MMD1-06	Geometric Modeling Lab	0	0	4	4	60	40	100	2
7	PCC	1MMD1-07	Computing Lab for Design Applications	0	0	4	4	60	40	100	2
8	SODECA	1MMD5-00	Social Outreach discipline & Extra Curriculum activities							100	2
			Total					270	430	800	20

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Semester - II

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	2MMD1-01	Finite Element Analysis	3	0	0	3	30	70	100	3
2	PCC	2MMD1-02	Product Design and Lifecycle Management	3	0	0	3	30	70	100	3
3	PEC	2MMD2-11	Experimental Modal Analysis	3	0	0	3	30	70	100	3
		2MMD2-12	Smart Materials and Structures								
		2MMD2-13	Soft Computing								
4	PEC	2MMD2-14	Mechanics of Composite Materials	3	0	0	3	30	70	100	3
		2MMD2-15	Biomaterials Science and Engineering								
		2MMD2-16	Tribology in Design								
5	MCC	2MCC3-XX	Audit Course-I	2	0	0					
6	PCC	2MMD1-06	FEA Lab	0	0	4	4	60	40	100	2
7	PCC	2MMD1-07	Product Design Lab	0	0	4	4	60	40	100	2
8	REW	2MMD4-50	Mini Project	0	0	4	4	60	40	100	2
9	SODECA	2MMD5-00	Social Outreach discipline & Extra Curriculum activities							100	2
			Total					300	400	800	20

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Semester - III

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exm Hrs	IA	ETE	Total	
1		3MMD2-11	Fracture Mechanics	3	0	0	3	30	70	100	3
2	PEC	3MMD2-12	Mechatronic Systems Design and Applications								
3		3MMD2-13	Innovation and Entrepreneurship for Engineers								
4	MCC	3MMD3-XX	Open Elective	3	0	0	3	30	70	100	3
5	MCC	3MMD3-XX	Audit Course-II	2	0	0					
6	REW	3MMD4-60	Dissertation-I / Industrial Project	0	0	20		240	160	400	10
			Total					300	300	600	16

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Semester - IV

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	REW	4MMD4-70	Dissertation-II	0	0	32		360	240	600	16
			Total					**360**	**240**	**600**	**16**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SEMESTER-I

1MMD1-01: Advanced Solids Mechanics

Credit: 3　　　　　　　　　　　　　　　**Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P　　　　　　　　　　　　　　　**End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Stress:** Definition and Notation for forces and stresses. Components of stresses, Stress tensor, Equations of Equilibrium, Specification of stress at a point, Cauchy's formula. Principal stresses and shear stresses. Stress transformation, Stress components on an arbitrary plane, Stress invariants, Octahedral stresses. decomposition of state of stress, deviator and spherical stress tensors.	6
3	**Introduction to Strain :** Deformation, Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation. **Generalized Stress -Strain Relations:** Generalized Hooke's; law in terms of engineering constants. Existence and uniqueness of solution, Saint-Venant's principle, Principle of super position and reciprocal theorem. Formulation of elasticity Problems.	8
4	**Energy Methods:** Work done by forces and elastic strain energy stored, First theorem of Castigliano, Theorem of virtual work.	4
5	**Bending of Beams:** Symmetric and Asymmetric straight beams, effect of shear stresses, Shear center and shear flow, shear stresses in thin walled sections, Curved beams, Deflection of thick curved bars.	6
6	**Torsion of Prismatic Bars:** Torsion of Circular and elliptical cross section bars, Membrane analogy, Torsion of thin walled closed tubes.	6
7	**Axisymmetric problems:** General equations, Thick walled cylinder, Composite tube-shrink fit, Rotating disk of uniform thickness.	5
8	**Thermal stresses:** General equations, Thermal stresses in thin circular discs.	4
	Total	40

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

TEXT BOOK	
1	L S Srinath, Advanced Mechanics of Solids, Tata Mcgraw Hill.

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1.	Timoshenko and Goodier, Theory of Elasticity, McGraw Hill.
2.	Arther P Boresi and Richard J Schmidt, Advanced Mechanics of Materials, Wiley.
3.	G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press.
4.	Budynas, R. G. Advance strength and Applied Stress Analysis, Second Edition, WCB/ McGraw Hill 1999
5.	Sadhu Singh **,** Theory of Elasticity, Khanna publisher
6.	Sadd, Martin H., Elasticity: Theory, applications and Numeric, Academic Press
	Dally and Riley, Experimental Stress Analysis, McGraw Hill.

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1MMD1-02: Computer Aided Geometric Design

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	Overview of Transformation and Projection of geometric models	4
3.	**Curves:** Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems. Parametric Space of a Curve, Reparametrization, Space Curves: Spline Curves, Bezier Curves, B-Spline Curve, Rational curves, NURBS. Blending of curves. Curve manipulations.	10
4.	**Surfaces** Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen point form, Four Curve Form, Plane, Cylindrical and Ruled Surfaces, Surfaces of Revolutions, Hermite bicubic surface, Bezier Surface, B-Spline Surface, Coons Surface. Surface manipulations	10
5.	**Solids** Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSF), sweep representation, Analytic Solid Modeling (ASM), Solid manipulations. Applications: CG, mass and geometric properties calculations.	13
6.	CAD Hardware and Software, CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. Role of CADG in areas like CAM, RPT, CFD etc	2
	Total	40

TEXT BOOK		
	1	I. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill
	2	M. E. Mortenson, Geometric Modeling, John Wiley & Sons

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1.	I.D. Faux and M.J. Pratt, Computation Geometry for Design and Manufacture, John Wiley (Ellis Horwood Ltd.).
2.	Farin, Gerald, Curves and Surfaces for Computer Aided Geometric Design – A Practical Guide, Academic Press Inc.
3.	D. L. Ryan, Computer-Aided Graphics and Design, Marcel Dekker Inc.
4.	K. Lee, Principles of CAD/CAM/CAE systems, Addison Wesley.
5.	Choi, B.K, Surface Modeling for CAD/CAM, Elsevier.
6.	P N Rao, CAD/CAM: Principles and Applications, McGraw Hill.
7.	Yamaguchi, Curves and Surfaces in Computer Aided Geometric Design, Springer.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

1MMD1-03: Advanced Vibrations

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Vibration of continuous systems: Hamilton's principle, Lagrange's equations.	2
3	Longitudinal vibration of bars, Equation of motion, Initial and Boundary conditions, Wave motion in continuous systems. Solution of wave equation using method of separation of variables.	4
4	Lateral vibration beams, Equation of motion and solution, Orthogonality of beam functions.	4
5	Vibration of membranes and plates. Derivation of governing equation using Newton's second law and Hamiltion's principle. Solution of governing equation, Commensurate modes.	6
6	Nonlinear vibrations, introduction, characteristics and examples.	2
7	Nonlinear vibration of simple system, Duffing's equation, Perturbation method, appearance of secular term. Lindstedt – Poincare method.	5
8	Periodic solution of damped system, Van der Pol's equation, Limit cycle.	3
9	Stability Considerations: Phase Plane method, Singular points, Type of singularity, Trajectory construction in Phase Plane, Routh-Hurwitz criteria, Direct stability method, Floquet's theory of stability, Mathieu's equation.	8
10	Forced oscillations of nonlinear system, Harmonic oscillations of Duffing's equation, Jump phenomenon, Stability of Duffing solution.	5
	Total	**40**

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TEXT BOOK	
1	Advanced Theory of Vibration by JS Rao, New Age International Publishers.
2	Mechanical Vibrations by S S Rao, Pearson Education, New Delhi.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Nonlinear Mechanical Vibration by P. Srinivasan, New Age International Publishers, New Delhi.

1MMD2-11: Numerical Methods in Engineering

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Approximations: Accuracy and precision, definitions of round off and truncation errors, error propagation.	4
3	System of Linear Equations: Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (Gauss - Siedel); convergence of iteration methods.	8
4	Computations of Eigen-values of a Matrix: Power method for dominant, sub-dominant and smallest eigen-values.	3
5	Interpolation methods: Newton's divided difference, interpolation polynomials.	4
6	Numerical Solution of Ordinary Differential Equations: Initial-value problems: linear multistep methods, Runge-Kutta methods, predictor-corrector Adam- Bashforth, Milne's method. Boundary-value problems: the shooting method, finite difference methods.	10
7	Finite differences: Review of finite difference operators. Finite Difference Methods: Solution of Elliptic PDE usingfive point formulae for Laplacian, replacement for Dirichlet and Neumann's boundary conditions; Solution of Parabolic PDE using Crank-Nicholson, du-Fort and Frankel scheme; Solution of Hyperbolic PDE using finite differences (FD). Problems on application to design, thermal and production engineering will be discussed in different topics of the course.	10
	Total	**40**

TEXT BOOK	
1	S.S. Sastry, *"Introductory Methods of Numerical Analysis"*, PHI publication.

REFERENCE BOOKS	
SN	Name of Authors /Books /Publisher
1	John H. Mathews, *"Numerical Methods Using Matlab, 4/e"*, Pearson Education, India.
2	M.K. Jain, S.R.K. Iyengar, and R.K. Jain, "*Numerical Methods for Scientific and Engineering Computation*", New Age Pvt. Pub, New Delhi.
3	B.S. Grewal, "*Numerical Methods in Engineering & Science (with Programs in C,C++ &MATLAB)*", Khanna Publisher, India.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

1MMD2-12: Analysis and Synthesis of Mechanism

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**ADVANCED KINEMATICS OF PLANE MOTION- I:** Introduction to plane motion. The Inflection circle, Euler – Savary Equation, Analytical and graphical determination of di , Bobillier's Construction , Collineation axis , Hartmann's Construction ,Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis.	7
3	**ADVANCED KINEMATICS OF PLANE MOTION – II:** Polode curvature, Hall's Equation, Polode curvature in the four bar mechanism, coupler motion, relative motion of the output and input links	5
4	Determination of the output angular acceleration and its Rate of change, Freudenstein's collineation –axis theorem, Carter –Hall circle, The circling – point curve for the Coupler of a four bar mechanism.	4
5	**INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS – I:** The Four bar linkage ,Guiding a body through Two distinct positions, Guiding a body through Three distinct positions, The Roto center triangle , Guiding a body through Four distinct positions, Burmester's curve.	6
6	**INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS – II:** Function generation- General discussion, Function generation: Relative – Roto center method, Overlay's method	5
7	Function generation- Velocity – pole method, Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.	4
8	**INTRODUCTION TO SYNTHESIS – ANALYTICAL METHODS:** Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation, Path Generation	3
9	Synthesis of Four-bar Mechanisms for specified instantaneous condition, Method of components, Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link, Method of components.	5
	Total	**40**

TEXT BOOK

1	Mallik, Asok Kumar, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.
2	Design of machinery / Robert L Norton third edition/ McGraw-Hill 2004

REFERENCE BOOKS

SN	Name of Authors /Books /Publisher
1	Kinematics and Dynamics of plane mechanisms/ Jeremy Hirschhorn/McGraw-Hill, 1962.
2	Theory of Machines and Mechanisms/ J. E Shigley and J.J . Uicker Jr./ McGraw-Hill, 1995
3	Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition
4	Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E. W. P. Publishers.
5	Kinematic Linkage Design/ Allen S.Hall Jr./ PHI,1964

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1MMD2-13: Optimization Techniques

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Optimal Problem Formulation:** Design Variables, Constraints, Objective Function, Variable Bounds. Engineering Optimization Problems. Classification.	3
3	**Single Variable Optimization Problems:** Optimality Criterion, Bracketing Methods, Region Elimination Methods, Successive Quadratic Estimation Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method. Application to Root finding.	10
4	**Multivariable Optimization Algorithms:** Optimality Criteria, Unidirectional Search, Direct Search Methods: Hooke-Jeeves pattern search method, Powell's Conjugate Direction Method. Gradient Based Methods: Cauchy's Steepest Descent Method, Newton's method, Marquardt's Method.	12
5	**Constrained Optimization Algorithms:** Kuhn Tucker conditions, Transformation Methods: Penalty Function Method, Method of Multipliers. Sensitivity analysis.	10
6	**Specialized Algorithms:** Integer Programming: Penalty Function Method, Branch and Bound Method. Problems on application to design, thermal and production engineering will be discussed in different topics of the course.	4
	Total	40

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

TEXT BOOK	
1	Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	S. S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons.
2	Jasbir Arora, Introduction to Optimum Design, McGraw Hill.
3	Ranjan Ganguli, Engineering Optimization: A Modern Approach, Universities Press.
4	G.V. Reklaites, A. Ravindran and K.M. Rogsdeth, Optimization, Wiley.
5	D E Goldberg, Genetic Algorithm in Search, Optimization and Machine Learning , Addison Wesley.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

1MMD1-06: Geometric Modeling Lab

Credit: 2   **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P   **End Term Exam: 4 Hours**

SN	List of Experiments
A: by using CAD packages such as SOLIDWORKS/CATIA/PTC Creo/ NX, etc	
1.	Introduction of GUI of the software. Bottom-up and Top-down approaches.
2.	Solid models of the complex shaped objects.
3.	Assembly modeling of simple mechanical systems (Consisting of few parts), with GD&T
4.	Dimensioning and tolerancing
5.	Apply the features of animation.
6.	Orthographic views from solid models and assembly.
7.	Surface modelling of real life products
8.	Creation of a surface from reverse engineering data
B: Project work	
Each student will undertake a project in which part modelling and assembly of a mechanical system (consisting of many parts) are to be carried out. The animation of the system is to be demonstrated. The weightage of the project shall be 30% of IA component.	

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

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1MMD1-07: Computing Lab for Design Applications

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P **End Term Exam: 4 Hours**

SN	List of Experiments
	Laboratory work includes Python or C++ or MATLAB programming.
A: Application of numerical methods	
	Introduction to programming syntax.
1.	Root finding using Newton-Raphson method.
2.	Solution of simultaneous equations.
3.	Solution of ODEs and PDEs etc.
B: Design of Machine Components	
4.	Programs to find designed sizes of few machine components like shafts, gears, bolts, springs, clutch, bearings etc
C: Design Optimization	
	Introduction to the concept of optimization and its application in engineering. The students are required to formulate the optimization problem and solve it using classical or GA or NIAs using software or source code or own code.
5.	Problems on shape optimization, weight minimization and topology optimization.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

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SEMESTER -II

2MMD1-01: Finite Element Analysis

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Concept of FEM, Applications and advantages, Steps in finite element method, Discretization, types of elements and shape functions. Review: Matrix algebra and solution of simultaneous equations. Finite element analysis of 1-D problems: formulation by different approaches (direct method and potential energy); Derivation of elemental equations and their assembly, solution and its postprocessing.	6
3	Finite element formulation: Ritz method and Galerkin method, Derivation of elemental equations from Governing equation, completeness and compatibility requirements. C_0 and C_1 Continuity Elements.	6
4	1-D and 2-D problems from Structural Mechanics: Bar, Plane stress and plane strain problems, Axisymmetric problems. Bending of beams, analysis of truss and frame.	10
5	Higher order elements, Isoparametric formulation, Serendipity and Lagrange family elements, Numerical integration, convergence of solution: h and p methods of refinement.	8
6	1-D steady state heat conduction and fluid flow: Derivation of elemental equations, Application of boundary conditions.	5
8	Eigen-value problems, Natural vibration of bars and beams, Methods to find eigen-values and eigen-vectors. Brief introduction to application of FEM to Time dependent problems, non-linear problems, plate problem etc	4
	Total	40

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

TEXT BOOK	
1	U S Dixit, Finite Element Methods for Engineers, Cengage Learning.
2	Chandrupatla and Belegundu, Introduction to finite elements in Engineering", Prentice Hall of India.

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	P Seshu, Text Book of Finite Element Analysis, PHI.
2	Logan Deryl L., A First Course in Finite Element Method", Thomson Brook/Cole.
3	Cook R.D. Concepts and applications of finite element analysis, Wiley.
4	Reddy J N, Finite element Method, Tata McGraw Hill.
5	Bathe K.J., Cliffs, N.J. , Finite Element Procedures in Engineering Analysis, Englewood. Prentice Hall.

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2MMD1-02: Product Design and Lifecycle Management

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Development processes and organizations, Product Planning.	5
3	Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing.	7
4	Design for manufacture, assembly, maintenance, casting, forging.	7
5	Design for Reliability, Design for sustainability, Robust design.	6
6	Industrial design: Design for Emotion and experience, Ergonomics and Aesthetics in design.	6
7	PLM overview • PLM constitutes (CAD, PDM, etc) • PLM lifecycle processes and workflows o Process modelling using use cases, IDEF0 etc. • Information configuration and product structures o Modelling using UML • PLM strategy and implementation	8
	Total	40

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TEXT BOOK	
1	Karl T. Ulrich and Steven Eppinger, Product Design and Development, McGraw Hill.
2	George E Dieter, Engineering Design, McGraw Hill.
3	Antti Saaksvuori and Anselmi Immonen, Product Lifecycle Management (PLM), Springer.

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1.	Prashant Kumar, Product Design, Creativity, Concepts and Usability, Eastern Economy.
2.	T.T. Woodson, Introduction to Engineering Design, McGraw Hill.
3.	J.C. John, Design Methods, Wiley Inter science.
4.	Averill M. Law and W. David Kelton, Simulation, modelling and analysis, McGraw Hill.
5.	Pahl, G.and W.Beitz, *Engineering Design–A Systematic Approach,* Springer.
6.	John Stark , Product Lifecycle Management: 21st Century Paradigm for Product Realisation, Springer.

2MMD2-11: Experimental Modal Analysis

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction to modal testing, Application and Philosophy of Modal Testing, Summary of theory, measurement methods and analysis.	4
3	Presentation and properties of FRF data for SDOF system, undamped multi degree of freedom system (MDOF), proportional damping, hysteretic damping, viscous damping, characteristics and presentation of MDOF FRF data.	8
4	Mobility measurement techniques: Basic measurement system, structure preparation, excitation of the structure, transducers and amplifiers, analyzers, digital signal processing, use of different excitation types, calibration, mass cancellation.	6
5	Modal parameter extraction methods: Preliminary checks of FRF data, SDOF modal analysis- Peak amplitude, circle-fit method, inverse method, residuals, introduction to MDOF curve-fitting procedure - extension of SDOF method.	8
6	Derivation of mathematical models: Modal models, display of modal model, response models, spatial models, mobility skeletons and system models.	7
7	Application: Comparison of experiment and predication, correction or adjustment of models, structural modification, response predication and force determination.	6
	Total	**40**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

TEXT BOOK	
1	Modal Testing: Theory and Practice by DJ Ewins, John Wiley & Sons Inc. England 1986.
2	Modal Testing: A Practitioner's Guide by Peter Avitabile, John Wiley & Sons, 2017.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Vibration and Acoustics: Measurement and Signal Analysis by C Sujatha, Mc Graw Hill Education (P) Ltd, India 2010.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

2MMD2-12: Smart Materials and Structures

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Smart Structures**: Types of smart structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures.	3
3	Piezoelectric materials, properties, piezoelectric constitutive relations, depoling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor.	5
4	Beam modeling with induced strain rate effects, inchworm linear motor beam modeling with induced strain actuation- single actuators, dual actuators, pure extension, pure bending harmonic excitation, Bernoulli-Euler beam model, problems, piezo-electrical applications.	6
5	**Shape memory Alloy**: Experimental phenomenology, shape memory effect, phase transformation. Applications of SMA and problems. ER and MR fluids: Mechanisms and properties, fluid composition and behavior, the Bingham plastic and related models	6
6	**Vibration absorbers**: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications.	5
7	Control of structures: Modeling, control strategies and limitations, active structures in practice..	3
8	**MEMS**: Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.	6
9	**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.	5
	Total	**40**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

TEXT BOOK	
1	Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2	Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

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

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

2MMD2-13: Soft Computing

Credit: 3   Max. Marks: 100(IA:30, ETE:70)
3L+0T+0P   End Term Exam: 3 Hours

SN	CONTENTS	Hours
1	**INTRODUCTION TO SOFT COMPUTING:** Aims of Soft Computing-Foundations of Fuzzy Sets Theory-Basic Concepts and Properties of Fuzzy Sets- Elements of Fuzzy Mathematics-Fuzzy Relations-Fuzzy Logic	6
2	**APPLICATION OF FUZZY SETS:** Applications of Fuzzy Sets-Fuzzy Modeling – Fuzzy Decision Making-Pattern Analysis and Classification-Fuzzy Control Systems-Fuzzy Information Processing- Fuzzy Robotics.	8
3	**ARTIFICIAL NEURAL NETWORKS:** Artificial Neural Networks-Models of Neuron-Architecture of Feed Forward Neural Networks, Recurrent Neural Networks-Learning methods-supervised and unsupervised learning-Time Delay Neural Networks-Radial Basis Function Neural Networks-Adaptive Resonance Theory (ART) Neural Networks- Associative Neural Memory Models-Application of ANN.	8
4	**GENETIC ALGORITHMS:** Main Operators- Genetic Algorithm Based Optimization-Principle of Genetic Algorithm- Genetic Algorithm with Directed Mutation-Comparison of Conventional and Genetic Search Algorithms-Issues of GA in practical implementation. Introduction to Particle swarm optimization-PSO operators-GA and PSO in engineering applications.	6
5	**NEURO-FUZZY TECHNOLOGY:** Fuzzy Neural Networks and their learning-Architecture of Neuro- Fuzzy Systems- Generation of Fuzzy Rules and membership functions - Fuzzification and Defuzzyfication in Neuro-Fuzzy Systems- Neuro-Fuzzy Identification - Neuro Fuzzy Control- Combination of Genetic Algorithm with Neural Networks-Combination of Genetic Algorithms and Fuzzy Logic-Neuro-Fuzzy and Genetic Approach in engineering applications.	6
6	**PROGRAMMING USING MATLAB:** Using Neural Network toolbox – Using Fuzzy Logic toolbox-Using Genetic Algorithm & directed search toolbox.	6
	TOTAL	

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TEXT BOOK	
1	Sivanandam. S.N, Deepa. S.N, Principles of soft computing, Wiley India.
2	Juh Shing Roger Jang, Cheun Tsai Sun, Eiji Mizutani, Neuro fuzzy and soft computing, Prentice Hall.

REFERENCE BOOKS	
SN	Name of Authors /Books /Publisher
1	Aliev,R.A, Aliev,R.R, Soft Computing and its Application, World Scientific Publishing Co.
2	Mehrotra.K, Mohan.C.K, Ranka.S, Elements of Artificial Neural Networks, The MIT Press.
3	Juh Shing Roger Jang,Cheun Tsai Sun,Eiji Mizutani, Neuro fuzzy and soft computing, Prentice Hall.
4	Ronald R.Yager, Lofti Zadeh, An Introduction to fuzzy logic applications in intelligent Systems, Kluwer Academic.
5	Cordón.O, Herrera.F, Hoffman.F, Magdalena.L, Genetic Fuzzy systems, World Scientific Publishing Co.

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2MMD2-14: Mechanics of Composite Materials

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Definition, Characteristics, Classification, Particulate composites, Fibre reinforced composites, Applications of composite materials, Matrix materials and reinforcing fibres, Fabrication of FRP composites. Cutting, Machining, joining and repair of composites.	6
3	**Micromechanical Behavior of Lamina**: Rule of mixture, Prediction of elastic properties, Strength, Thermal and moisture expansion. Mechanics of materials approach, Halpin-Tsai equations. Micromechanics of failure; failure mechanisms under different loading.	6
4	**Macromechanical Behavior of Lamina**: Stress-strain relations for anisotropic materials, Stiffness, Compliances and engineering constants for orthotropic materials, Restriction on elastic constants, Stress-strain relations of orthotropic lamina along principal and arbitrary material direction, Transformation of elastic constants. **Failure Criteria of Lamina**: Strengths of an orthotropic lamina, Maximum Stress and Strain Theory, Tsai-Hill theory, Tsai-Wu tensor theory.	8
5	**Macromechanical Behavior of Laminate**: Classification of laminates, Classical lamination theory, Resultant laminate forces and moments, General Load-Deformation Relations: Laminate stiffness (A, B & D matrics), Determination of Lamina stresses within Laminates, Analysis of special cases of laminates. Laminate engineering properties.	8
6	**Hygrothermal Effects:** Hygrothermal effects on mechanical behavior, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.	5
7	**Failure Analysis of Laminates:** Types of failures, Stress analysis and first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials.	5
	Total	40

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TEXT BOOK	
1	Isaac M. Daniels, OriIshai, "Engineering Mechanics of Composite Materials", Oxford University Press.
2.	Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc.

REFERENCE BOOKS	
SN	Name of Authors /Books /Publisher
1	Auter K. Kaw, Mechanics of Composite Materials, CRC Press.
2	Krishan K. Chawla, Composite Material Science and Engineering, Springer.
3	Robert M Jones, Mechanics of Composite Materials, CRC Press.
4	Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press.
5	P.C. Mallik, Fibre Reinforced Composites, Marcel Decker.

2MMD2-15: Biomaterials Science and Engineering

Credit: 3

3L+0T+0P

Max. Marks: 100(IA:30 ETE:70)

End Term Exam: 3 Hours

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction: Requirements of biomaterials, Biocompatibility, Classification of biomaterials, Mechanical properties of biomaterials, Effects of processing on properties of biomaterials	5
3	Biological Materials: Structure of proteins, collagen, elastic proteins, polysaccharides, chitin and chitosan, structure properties relationships	5
4	Metallic Implant Materials: Some common examples and properties of metals used as implants: stainless steel, titanium and titanium alloy, cobalt chrome alloys. Problem of corrosion, corrosion behavior and the importance of passive films for tissue adhesion, wear, fatigue, stress shielding, stress-corrosion cracking. Host tissue reaction with metals.	6
5	Polymeric Implant Materials: Some common examples and properties of polymers used as implants: PE, PMMA, Silicon Rubber, Polyester, Acetals, Biodegradable Polymers. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: Tg, creep-recovery, stress relaxation, strain-rate sensitivity. Host tissue reaction: importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking.	6
6	Ceramics Implant Materials: Definition of bioceramics. Common types of bioceramics (inert and bioactive types) and their properties (importance of wear resistance and low fracture toughness). Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).	6
7	Composite Implant Materials: Mechanics of improvement of properties by incorporating different elements. Composites theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g hydroxyapatite). Textile composites. Host tissue reactions.	6

8	Testing of Biomaterials: In-vitro testing. Mechanical test: wear, fatigue, tensile, corrosion studies and fracture toughness. Effect of physiological fluid on the properties of biomaterials. In-vivo testing (animals). Ex-vivo testing. Contact allergy to biomaterials. Standards.	5
	Total	**40**

TEXT BOOK	
1	Hoffman, Schoen, Lemons, Biomaterials Science-Ratner, Elsevier; 2nd Edition (2004).
2	Temenoff and Mikos , Biomaterials:The intersection of Biology and Materials Science, Pearson, 2009.
REFERENCE BOOKS	
SN	**Name of Autho rs /Books /Publisher**
1	Ashby, M. F. and Jones, D. R. H., Engineering Materials: an Introduction to their Properties and Applications, 1st Edn., Pergamon Press, 1980.
2	SH Teoh , Engineering Materials for Biomedical Applications, World Scientific, 2004.
3	JB Park and RS Lakes (Eds), Biomaterials - An Introduction, Springer-Verlag, 3rd Edition, 2007.
4	BD Ratner, AS Hoffman, FJ Schoen, JE Lemons (Eds), Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2nd Edition, 2004.

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2MMD2-16: Tribology in Design

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

S N	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction: Introduction to tribology, Interdisciplinary approach, Economic aspects, Surface properties and characterization, Elements of contact mechanics.	3
3	Friction: Definition, Role of friction, laws of static friction, causes of friction; Adhesion. Adhesion theory, laws of rolling friction, friction of metals and non-metals, friction measurement.	4
4	Wear: Wear definitions, types of wear, mechanism of wear, factors affecting wear behaviour, measurement of wear a brief introduction of wear test equipments.	5
5	Fluid-Film Lubrication: Fluid mechanics concepts, equations of continuity and motion; Generalized Reynold's equation with incompressible and compressible lubricants.	4
6	Dynamically loaded journal bearings: Solution of the generalized Reynold's equation for infinite and short bearing, load carrying capacity, Sommerfield numbers. Hydrostatic lubrication-- basic concepts, applications, compensated thrust and journal bearings.	7
7	Infinitely long, short (narrow) and finite journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution),	4
8	Design of hydrodynamic journal and slider-shoe bearings, Air lubricated bearings. Gas Lubrication: Types of gas bearings and their characteristics.	6
9	Measurement and control of friction and wear. Tribological properties and testing of lubricants. Nanotribology: Introduction to nanotribology and nanomechanics, Measurement and application of friction and wear at nanoscale.	6
	Total	**40**

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	TEXT BOOK
1	Majumdar B. C "Introduction to Tribology of Bearing", S. Chand Publishing, New Delhi, 2010.
2	"Fundamentals of Friction and wear of Materials" American Society of Metals.

	REFERENCE BOOKS
SN	**Name of Authors /Books /Publisher**
1	Bhushan, B., Principles and Applications of Tribology, Second edition, John Wiley & Sons, UK, 2013.
2	D. D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
3	Sahoo P., Engineering Tribology, PHI, New Delhi, 2005.
4	Arnell R. D., Davies P. B., Halling J. and Whomes T. L. , Tribology: Principles and Design Applications, First edition, Springer-verlag, New York, 1991.
5	Stolarski, T.A., Tribology in Machine Design, Butterworth-Heinemann, Oxford, Boston, 2000.

2MMD1-06: FEA Lab

Credit: 2   **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P   **End Term Exam: 4 Hours**

SN	List of Experiments
	Laboratory work for the solution of solid mechanics problems, heat transfer problems, and free vibration problems
A: by using FE packages such as COMSOL multiphysics/ ANSYS/ SIMULIA/ ABAQUS/ Siemens NX CAE, etc	
1.	Introduction of GUI of the software in the above mentioned areas' realistic problems.
2.	To solve boundary value problems in solid mechanics: Plane, axisymmetric and 3D problems.
3.	Modal analysis of beams and plates under different load conditions and its parametric studies.
4.	Heat transfer analysis of realistic problem.
5.	Analysis of a fluid flow problem.
6.	Analysis of multiphysics problem: Thermomechanical.
7.	Problem on Contact stress analysis.
8.	Bending of beam with material nonlinearity.
9.	Hygrothermal analysis of composite laminates.
10.	Stress analysis of a structure having V-notch, crack, etc.
B: Project work	
Each student will undertake a project in which structural/thermal/fluid flow FE analysis of a realistic problem (e.g. 3D machine member) is to be carried out. It will be required to demonstrate the convergence and validation of the solution. The weightage of the project shall be 30% of IA component.	

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

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2MMD1-07: Product Design Lab

Credit: 2   **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P   **End Term Exam: 4 Hours**

SN	List of Experiments
	Laboratory work covers implementation of various design aspects through small projects/case studies on real life examples.
1.	Design for Manufacturing: To analyse the part-designs on the basis of design for manufacturing using the FMS facility and find out the better design.
2.	Design for Assembly: Using solid modelling and additive manufacturing, compare and analyse two designs on the basis of principles of design for assembly.
3.	Case study on design for ergonomics/design for sustainability/design for aesthetic/design for emotion/user experience designs/design for reliability etc.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

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SEMESTER-III

3MMD2-11: Fracture Mechanics

Credit: 3   **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Historical aspects, Brittle and ductile fracture, Modes of fracture failure. Energy release rate: crack resistance, stable and unstable crack growth.	6
3	**Linear elastic fracture mechanics:** Stress intensity factor: Stress and displacement fields, SIF for general cases, Fracture Toughness, Approach of Westergaard for different modes of the fracture and its analysis.	10
4	**Elastic plastic fracture mechanics**: Crack tip plasticity - Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement.	9
5	**Test methods** for determining critical energy release rate, critical stress intensity factor, J-Integral, CTOD. Fracture Control Plans for various materials, stress levels and crack sizes. Finite element analysis of cracks.	6
6	**Fatigue failure:** Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load. Environment-assisted cracking. Dynamic mode crack initiation and growth, various crack detection techniques.	8
	Total	40

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TEXT BOOK	
1	Prashant Kumar, Elements of Fracture mechanics, .McGraw-Hill.
2	David Broek, Elementary Engineering Fracture Mechanics, Springer.

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	K Ramesh, Engineering Fracture Mechanics (e-book), IIT Madras.
2	E E Gdoutos, Fracture Mechanics: An Introduction, Springer
3	Maiti, Surjya Kumar, Fracture Mechanics: Fundamentals and Applications, Cambridge University Press.
4	T.L.Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press.
5	J.F.Knott, Fundamentals of Fracture Mechanics, Butterworths.
6	Karen Hellan, Introduction to fracture mechanics, McGraw Hill.

3MMD2-12: Mechatronic Systems Design and Applications

Credit: 3	Max. Marks: 100(IA:30 ETE:70)
3L+0T+0P	End Term Exam: 3 Hours

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Overview of Mechatronics: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Design process, systems, measurement systems, control systems, programmable logic controller, examples of mechatronic systems. Sensors and Transducers: Performance terminology, Displacement, Position, and Proximity Sensors, velocity and motion, Force and torque sensors, fluid Pressure, liquid Flow, liquid level, Temperature, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors.	10
2	Signal conditioning, Operational amplifier, protection, filtering, wheatstone bridge, pulse modulation. Digital Signals, Analogue and digital signals, digital-to-analogue and analogue-to-digital converters, multiplexers, data acquisition, digital signal processing. Digital Logic, logic gates, applications of logic gates, sequential logic Data presentation systems: displays, data presentation elements, magnetic recording, optical recording, displays, data acquisition systems, measurement systems, testing and calibration.	8
3	Pneumatic and hydraulic actuation systems: actuation systems, pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, servo and proportional control valves, process control valves, rotary actuators. Mechanical actuation systems: mechanical systems, types of motion, kinematic chains, cams, gears, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection. Electrical actuation systems: electric systems, mechanical switches, solid-state switches, solenoids, DC motors, AC motors, and stepper motors.	8
4	Basic System Models: mathematical models, mechanical system building blocks, electrical systems building blocks, fluid system building blocks, and Thermal system building blocks. System Models: Engineering systems, rotational – translational systems, electromechanical systems, linearity, and hydraulic-mechanical systems. Dynamic responses of systems: modeling dynamic systems, terminology, first-order systems, second order systems, performance measures of second order system and system identification System Transfer Functions: Transfer function, first –order systems, second order systems, systems in series, systems with feedback loops, effect of pole location on transient response. Frequency response: sinusoidal input, phasors, frequency response, bode plots, performance specifications, and stability.	8

5	Closed-loop controllers: continuous and discreet control processes, terminology, two-step mode, proportional mode, derivative control, integral control, PID controller, digital controllers, control system performance, controller tuning, velocity control and adaptive control. Microprocessors: control, microprocessor systems, microcontrollers, and applications. Programmable logic controllers: Basic PLC structure, Input/output processing. Mechatronic systems: mechatronic designs, case studies.	6
	Total	**40**

TEXT BOOK	
1	W. Bolton, Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education, 5/e, 2011.

REFERENCE BOOKS

SN	Name of Authors /Books /Publisher
1	David G. Alcaiatore and Michel B. Histand, Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill Int. Edition, 3/e,
2	James J Allen, Micro Electro Mechanical Systems Design, CRC Press.
3	Craig K. C. and Stolfi, F. R., Introduction to Mechatronic System Design with Applications, IEEE Educational Activities Department,.
4	Robert H. Bishop. The Mechatronics Handbook, CRC Press, 2/e
5	K P Ramachandran, G K Vijayraghavan and M S Balasundaram, "Integrated mechanical electronic systems" Wiley India Edition, 2008

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3MMD2-13: Innovation and Entrepreneurship for Engineers

Credit: 3   **Max. Marks: 100(IA:30, ETE:70)**
3L+0T+0P   **End Term Exam: 3 Hours**

SN	Contents	Hours
1.	**Introduction:** Objective, scope and outcomes of the course.	1
2.	**Entrepreneurship:** Concept and Definitions; Entrepreneurship and Economic Development; Types of Entrepreneurs; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, types of entrepreneurships, Entrepreneurial myths.	5
3.	**Opportunity Identification and Product Selection:** Entrepreneurial Opportunity Search and Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Project Planning and Scheduling. Sources of finance for entrepreneurs. Procedure for Export and Import. Handicraft business opportunities in India.	8
4.	**Support Institutions and Management of Small Business:** MSME- Definition and significance in Indian economy, Registration, NOC from Pollution Board; Major problems faced by MSME; MSME Schemes, Challenges and Difficulties in availing MSME Schemes, Development Commissioner (MSME); Department of Industrial Policy and Promotion (DIPP); Director of Industries (DIC); KVIC, Coir Board; SIDBI; RIICO, SIDCO; NSIC, RSIC; Entrepreneurship development institutes: NIESBUD, IIE, NIMSME, EDI etc; State Financial Corporation SFC; Venture Capital: Concept, venture capital financing schemes offered by various financial institutions in India, Legal issues related to forming business entity, Requirements for formation of a Private/Public Limited Company. Steps in registration of firms and partnership.	10
5.	**Introduction to IPR and patents:** Basic concept of intellectual property Rights: Patents, design, trademark, GI, Copyright. Indian patent system and salient features of patent Act 1970. WTO-TRIPS agreement: Development of TRIPS Complied Regime in India. Patent Databases & Patent Information System: WIPO, IPINDIA, USPTO, Google Patents etc. Novelty searches. Subject matters of patentable and non-patentable in India. Procedure of patent filing, PCT application, provisional application, date of priority.	8
6.	**Startup:** Stages in transforming idea to a startup, Idea – Create, develop and validation. Prototype testing, Developing the product, developing the team, creating traction for the product, pitching the startup, Sources for funding of a startup, Pre Seed funding – Business angles, accelerators, Seed Funding - Angles, venture capitalists, crowd funding, syndicate investing, SME lending, grants, Accelerator funding. Mergers and acquisition.	8
	TOTAL	**40**

TEXT BOOK	
1	Entrepreneurship development small business enterprises, Poornima M Charantimath, Pearson.
2	Understanding Patent Law, Vishnu S. Warrier, LexisNexis.

REFERENCE BOOKS	
SN	Name of Authors /Books /Publisher
1.	Entrepreneurship, Roy Rajiv, Oxford University Press.
2.	Innovation and Entrepreneurship, Drucker. F, Peter, Harper Business.
3.	Entrepreneurship, Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, Tata Mc-Graw Hill Publishing Co. Ltd.
4.	Enterpreneurship Development, S.S.Khanka, S.Chand & Co.
5.	Small-Scale Industries and Entrepreneurship, Vasant Desai, Himalaya Publishing House.
6.	Entrepreneurship Management, Cynthia, Kaulgud, Aruna, Vikas Publ
7.	Entrepreneurship: Ideas in Action, Cynthia L. Greene, Thomson Asia Pvt.
8.	Patent Law in India, M. B. Rao , Manjula Guru, Kluwer Law International
9.	Intellectual Property Law, P Narayan, Eastern Law House
10.	Intellectual Property Rights: Drafting,Interpretation of Patent Specifications and Claims, N.S. Rathore, New India Publishing Agency
11.	Handbook on Patent Law - The Patents Act, 1970, LexCampus
12.	The Law of Intellectual Property Rights : Introductory, WTO, Patent Laws, Shiv Sahai Singh, Eastern book Company.
13.	Patents Act, 1970, SCC Editorial, Eastern book Company.