Rajasthan Technical University (RTU)
Mechanical
(Machine Design)

M. Tech Program in Mechanical Engineering with specialization in
Machine Design

Courses

The theory subjects will be of maximum 125 Marks each having 25 Marks as course work and 100 Marks for University examination.

First Semester

S. No.	Code No.	***Subject***	L	T	P	Marks	Ex. Hrs.
1.	1MEMD1	Advanced Solid Mechanics	3	1	0	125	3
2.	1MEMD2	Advanced Vibrations	3	1	0	125	3
3.	1MEMD3	Numerical Methods	3	1	0	125	3
4.	1MEMD4	Computer Aided Graphics and Design	3	1	0	125	3
5.	1MEMD5	CAD Lab	0	0	3	100	3
Total			12	4	3	600	

Second Semester

S. No.	Code No.	***Subject***	L	T	P	Marks	Ex. Hrs.
6.	2MEMD6	Finite Element Analysis	3	1	0	125	3
7.	2MEMD7	Rotor Dynamics	3	1	0	125	3
8.	2MEMD8	Experimental Modal Analysis	3	1	0	125	3
9.	2MEMD9	Advanced Mechanisms and Manipulators	3	1	0	125	3
10.	2MEMD10	FEA lab	0	0	3	100	3
Total			12	4	3	600	

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Third Semester

S. No.	Code No.	***Subject***	L	T	Marks	Ex. Hrs.
11.	3MEMD11	Elective 1	3	1	125	3
12.	3MEMD12	Elective 2	3	1	125	3
13.	3MEMD13	Seminar			150	
14.	3MEMD14	Dissertation –I			100	
Total			6	2	500	

Fourth Semester

S. No.	Code No.	***Subject***	L	T	Marks	Ex. Hrs.
15.	4MEMD15	Dissertation -II			500	
Total					500	

List of Electives: (For 3MEMD11 & 3MEMD12)

Choose any two out of six given below.

Tribology

Fracture Mechanics

Composite Materials

Pipe and Pressure Vessel Design

Selection of Engineering Materials

Micro-Electrical and Mechanical Systems (MEMS)

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1MEMD1: ADVANCED SOLID MECHANICS

3L+1T **MM:125** **Ex.Hrs. 3**

Continuum concepts- Stress field (stress tensor, Cauchy's principle, equilibrium equation), Deformation (strain tensor, compatibility), Constitutive equations. Uniqueness and superposition- Boundary value problems in plane stress and plain strain. Torsion of non circular cross section (St. Venant's theory), Timoshenko beam theory and Kirchoff's plate theory. Failure theories, introduction to concepts of fracture mechanics. Numerical and Experimental methods, Introduction to Photo-elasticity and strain gauge techniques. Principle of virtual work, Energy theorems.

1MEMD2: ADVANCED VIBRATIONS

3L+1T **MM:125** **Ex.Hrs. 3**

Vibration of continuous systems: Hamilton's principle, Lagrange's equations. Longitudinal vibration of bars, lateral vibration beams, vibration of membranes and plates. Wave motion in continuous systems.

Nonlinear vibrations: Phase space, singular points, limit cycle; Analytical methods, perturbation techniques, equivalent linearization; Duffing's equation, jump phenomenon, Van der Pol's equation. Stability criterion; Floquet's theory, Hill's and Mathieu's equations, Bifurcation and chaos.

1MEMD3: NUMERICAL METHODS

3L+1T **MM:125** **Ex.Hrs. 3**

Approximations: Accuracy and precision, definitions of round off and truncation errors, error propagation Algebraic equations : Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (Gauss - Siedel), convergence of iteration methods, eigen values and eigen vectors. Interpolation methods: Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials. Differentiation and Integration: High accuracy differentiation formulae, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration. Introduction to optimization methods: Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function.

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1MEMD4: COMPUTER AIDED GRAPHICS AND DESIGN

3L+1T **MM:125** **Ex.Hrs. 3**

Brief introduction to solid modeling: Fundamentals of Solid Modeling, Half -spaces, Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Sweep Representation, Analytical Solid Modeling. Solid Manipulations

Methodology of interactive, graphical, engineering design; Discretization, optimization, simulation in CAED. Design of curves and surfaces. Design of volumes. Intersection of surface and interference of volumes.

1MEMD5: CAD LAB

3P **MM:100** **Ex.Hrs. 3**

Computer aided drafting. Solid modeling: part creation, surface generation and assembly of parts. Exercise problems using software.

2MEMD6: FINITE ELEMENT ANALYSIS

3L+1T **Ex. Hrs: 3**

Method of weighted residuals and variational approach for solving differential equations. Galerkin and Rayleigh-Ritz methods. Finite element method and implementation. Convergence criterion. Finite element formulation for linear elastic continuum. Substructuring. C_0-elements including isoparametric elements. Plate bending and C_1 elements. Introduction to dynamic and non-linear problems.

2MEMD7: ROTOR DYNAMICS

3L+1T **Ex. Hrs: 3**

Torsional Vibration. Analysis of Rotating Machines including branched systems. Response to steady state and transient excitation. Bending critical speeds of simple shafts, Unbalance response, Orbital Analysis and Cascade Plots. Disc gyroscopics, synchronous and non-synchronous whirl, Review of fluid film bearings and seals, Analysis of rotors mounted on hydrodynamic bearings, Application to two spool and multispool rotors. Introduction to asymmetric shafts. Parametric excitation and instabilities.

2MEMD8: EXPERIMENTAL MODAL ANALYSIS

3L+1T **Ex. Hrs: 3**

Introduction to modal testing: 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.
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.
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.
Derivation of mathematical models: Modal models, display of modal model, response models, spatial models, mobility skeletons and system models.
Application: Comparison of experiment and predication, correction or adjustment of models, structural modification, response predication and force determination.

2MEMD9: ADVANCED MECHANISMS AND MANIPULATORS

3L+1T **Ex. Hrs: 3**

Classification of closed- and open-loop kinematic systems, Definition of mechanisms and manipulators, Kinematic constraints, Degree of freedom (DOF) and Mobility; DH parameters, Coordinate transformations, Matrix methods; Structural analysis and synthesis of mechanisms; Forward kinematics of robot manipulators with examples; Inverse kinematics; Jacobian and singularity; Alternative design solutions of mechanisms and manipulators; Evaluation and selection of optimum mechanism; Type and number synthesis, Design of mechanisms; Indexes of merit; Graphical, Algebraic and Optimization techniques.

2MEMD10: FEA LAB

3P **MM:100** **Ex.Hrs. 3**

Laboratory work for the solution of solid mechanics problems and free vibration problems using FE packages.