M.Tech. (Machine Design)
PROGRAMME CODE: EPRMD200802
REGULATIONS
(w.e.f. 2012-2013 admitted batch)

1.0 ADMISSIONS

1.1 Admissions into M.Tech. (Machine Design) programme of GITAM University are governed by GITAM University admission regulations.

2.0 ELIGIBILTY CRITERIA

2.1 A pass in B. E. / B. Tech. / AMIE or equivalent in Mechanical / Production / Marine / Metallurgy / Automobile / Aeronautical Engineering

2.2 Admissions into M.Tech will be based on the following:

(i) Score obtained in GAT (PG), if conducted.
(ii) Performance in qualifying examination / Interview.

The actual weightage to be given to the above items will be decided by the authorities before the commencement of the academic year. Candidates with valid GATE score shall be exempted from appearing for GAT (PG).

3.0 STRUCTURE OF THE M.Tech. PROGRAMME

3.1 The Programme of instruction consists of:

(i) A core programme imparting to the student specialization of engineering branch concerned.
(ii) An elective programme enabling the students to take up a group of departmental courses of interest to him/her.
(iii) Carry out a technical project approved by the Department and submit a report.

3.2 Each academic year consists of two semesters. Every branch of the M.Tech. programme has a curriculum and course content (syllabi) for the subjects recommended by the Board of Studies concerned and approved by Academic Council.

3.3 Project Dissertation has to be submitted by each student individually.

4.0 CREDIT BASED SYSTEM

4.1 The course content of individual subjects - theory as well as practicals – is expressed in terms of a specified number of credits. The number of credits assigned to a subject depends on the number of contact hours (lectures & tutorials) per week.

4.2 In general, credits are assigned to the subjects based on the following contact hours per week per semester.

One credit for each Lecture hour.
One credit for two hours of Practicals.
Two credits for three (or more) hours of Practicals.

4.3 The curriculum of M.Tech. programme is designed to have a total of 70 -85 credits for the award of M.Tech. degree. A student is deemed to have successfully completed a particular semester's programme of study when he / she earns all the credits of that semester i.e., he / she has no 'F' grade in any subject of that semester.

5.0 MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6.0 REGISTRATION

Every student has to register himself/herself for each semester individually at the time specified by the College / University.

7.0 CONTINUOUS ASSESSMENT AND EXAMINATIONS

7.1 The assessment of the student's performance in each course shall be based on continuous evaluation and semester-end examination. The marks for each component of assessment are as shown in the Table 1.

Table 1: Assessment Procedure

S. No.	Component of Assessment	Marks Allotted	Type of Assessment	Scheme of Examination/Evaluation
1	Theory	40	Continuous Evaluation	i) Thirty (30) marks for mid Semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations.
		60	Semester-end Examination	Sixty (60) marks for Semester-end examinations
	Total	100		
2	Practicals	100	Continuous Evaluation	i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the Semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the Semester) conducted by the concerned lab Teacher.
3	Project work (Interim evaluation – III semester)	100	Continuous Evaluation	i) Forty (40) marks for periodic evaluation on originality, innovation, sincerity and progress of the work, assessed by the Project Supervisor. ii) Thirty (30) marks for mid-term evaluation for defending the Project, before a panel of examiners*. iii) Thirty (30) marks for final Report presentation and Viva-voce, by a panel of examiners*
4	Project work (Final evaluation – IV semester)	50	Continuous Evaluation	i) Twenty (20) for periodic evaluation on originality, innovation, sincerity and progress of the work, assessed by the Project Supervisor. ii) Fifteen (15) marks for mid-term evaluation for defending the Project, before a panel of examiners*. iii) Fifteen (15) marks for interim Report presentation and Viva-voce.
		50	Semester-end Examination	Fifty (50) marks for final Report presentation and Viva-voce assessed by external examiners.
5	Comprehensive Viva	100	Continuous Evaluation	Through five periodic Viva-voce exams for 20 marks each, conducted by a panel of examiners*. The course content for Viva exams shall be announced at the beginning of the Semester.

**Panel of Examiners shall be appointed by the concerned Head of the Department.*

8.0 REAPPEARANCE

8.1 A Student who has secured 'F' Grade in any theory course / Practicals of any semester shall have to reappear for the semester end examination of that course / Practicals along with his / her juniors.

8.2 A student who has secured 'F' Grade in Project work shall have to improve his report and reappear for viva – voce Examination of project work at the time of special examination to be conducted in the summer vacation after the last academic year.

9.0 SPECIAL EXAMINATION

9.1 A student who has completed the stipulated period of study for the degree programme concerned and still having failure grade ('F') in not more than 5 courses (Theory / Practicals), may be permitted to appear for the special examination, which shall be conducted in the summer vacation at the end of the last academic year.

9.2 A student having 'F' Grade in more than 5 courses (Theory/practicals) shall not be permitted to appear for the special examination.

10.0 ATTENDANCE REQUIREMENTS

10.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He /She has to repeat the semester along with his / her juniors.

10.2 However, the Vice Chancellor on the recommendation of the Principal / Director of the University college / Institute may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine medical grounds and on payment of prescribed fee.

11.0 GRADING SYSTEM

11.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 3.

Table 3: Grades & Grade Points

Grade	Grade points	Absolute Marks
O	10	90 and above
A+	9	80 – 89
A	8	70 – 79
B+	7	60 – 69
B	6	50 – 59
C	5	40 – 49
F	Failed, 0	Less than 40

11.2 A student who earns a minimum of 5 grade points (C grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course. However, a minimum of 24 marks is to be secured at the semester end examination of theory courses in order to pass in the theory course

12.0 GRADE POINT AVERAGE

12.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

Where

C = number of credits for the course,

G = grade points obtained by the student in the course.

12.2 Semester Grade Point Average (SGPA) is awarded to those candidates who pass in all the subjects of the semester.

12.3 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken in all the semesters completed up to the particular point of time.

12.4 The requirement of CGPA for a student to be declared to have passed on successful completion of the M.Tech programme and for the declaration of the class is as shown in Table 4.

Table 4: CGPA required for award of Degree

Distinction	**≥ 8.0***
First Class	**≥ 7.0**
Second Class	**≥ 6.0**
Pass	**≥ 5.0**

* In addition to the required CGPA of 8.0, the student must have necessarily passed all the courses of every semester in first attempt.

13.0 ELIGIBILITY FOR AWARD OF THE M.TECH DEGREE

13.1 **Duration of the programme**:
A student is ordinarily expected to complete the M Tech. programme in four semesters of two years. However a student may complete the programme in not more than four years including study period.

13.2 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

13.3 Project dissertation shall the submitted on or before the last day of the course. However, it can be extended up to a period of 6 months maximum, with the written permission of the Head of the Department concerned.

13.4 A student shall be eligible for award of the M.Tech degree if he / she fulfils all the following conditions.

a) Registered and successfully completed all the courses and projects.
b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.
c) Has no dues to the Institute, hostels, Libraries, NCC / NSS etc, and
d) No disciplinary action is pending against him / her.

13.5 The degree shall be awarded after approval by the Academic Council.

RULES

1. With regard to the conduct of the end-semester examination in any of the practical courses of the programme, the Head of the Department concerned shall appoint one examiner from the department not connected with the conduct of regular laboratory work, in addition to the teacher who handled the laboratory work during the semester.

2. In respect of all theory examinations, the paper setting shall be done by an external paper setter having a minimum of three years of teaching experience. The panel of paper setters for each course is to be prepared by the Board of Studies of the department concerned and approved by the Academic Council. The paper setters are to be appointed by the Vice Chancellor on the basis of recommendation of Director of Evaluation / Controller of Examinations.

3. The theory papers of end-semester examination will be evaluated by two examiners. The examiners may be internal or external. The average of the two evaluations shall be considered for the award of grade in that course.

4. If the difference of marks awarded by the two examiners of theory course exceeds 12 marks, the paper will have to be referred to third examiner for evaluation. The average of the two nearest evaluations of the three shall be considered for the award of the grade in that course.

5. Panel of examiners of evaluation for each course is to be prepared by the Board of Studies of the department concerned and approved by the Academic Council.

6. The examiner for evaluation should possess post graduate qualification and a minimum of three years teaching experience.

7. The appointment of examiners for evaluation of theory papers will be done by the Vice Chancellor on the basis of recommendation of Director of Evaluation / Controller of Examinations from a panel of examiners approved by the Academic Council.

8. Project work shall be evaluated by two examiners at the semester end examination. One examiner shall be internal and the other be external. The Vice Chancellor can permit appointment of second examiner to be internal when an external examiner is not available.

M.Tech. (Machine Design)

(Four-Semester Course)

FIRST SEMESTER

Scheme of Instruction and Examination

Course Code	Name of the course	Periods per week			Duration of exam (hours)	Max. marks			Credits
		Lec.	Lab	Total		Exam	Sess.	Total	
EPRMD101/ EPRCC101	Computational Methods in Engineering	4	—	4	3	60	40	100	4
EPRMD 102	Advanced Mechanics of Solids	4	—	4	3	60	40	100	4
EPRMD 103	Mechanics of Machinery	4	—	4	3	60	40	100	4
EPRMD 104	Mechanical Vibrations	4	—	4	3	60	40	100	4
EPRMD 105	Computer Aided Design	4	—	4	3	60	40	100	4

Practical / Drawing

EPRMD111/ EPRCC111	Computer Aided Design Lab	—	3	3	3	—	100	100	2
EPRMD 112	Mechanical Vibrations Lab	—	3	3	3	—	100	100	2
Total		20	6	26	—	300	400	700	24

SECOND SEMESTER

Course Code	Name of the course	Periods per week			Duration of exam (hours)	Max. marks			Credits
		Lec	Lab	Total		Exam	Ses	Total	
EPRMD201	Finite Element Analysis	4	—	4	3	60	40	100	4
EPRMD202	Failure Analysis and Design	4	—	4	3	60	40	100	4
EPRMD203	Experimental Stress Analysis	4		4	3	60	40	100	4
EPRMD 221-224	Elective – I	4	—	4	3	60	40	100	4
EPRMD 231-234	Elective – II	4		4	3	60	40	100	4

Practical / Drawing

EPRMD211	Experimental Methods Lab	—	3	3	3	—	100	100	2
EPRMD212/ EPRCC211	Computer Aided Engg. Lab	—	3	3	3	—	100	100	2
Total		20	6	26	—	300	400	700	24

THIRD SEMESTER

Course Code	Name of the Course	Periods per week			Duration of exam (hours)	Max. marks			Credits
		Lec	Lab	Total		Exam	Sess	Total	
EPRMD301/ EPRIE102/ EPRCC221	Optimization Methods in Engineering	4	—	4	3	60	40	100	4
EPRMD 321-324	Elective- III	4	—	4	3	60	40	100	4
Practical / Drawing									
EPRMD311	Seminar	-	3	3	-	-	100	100	2
EPRMD312	Comprehensive Viva-voce	-	3	3	-	-	100	100	2
EPRMD313	Project - I	-	9	9	-	50	50	100	6
Total		8	15	23		50	50	100	18

FOURTH SEMESTER

Course Code	**Name of the Course**	**Periods per week**			**Duration of exam (hours)**	**Max. marks**			**Credits**
		Lec	**Lab**	**Total**		**Exam**	**Sess.**	**Total**	
EPRMD 411	Project - II	-	21	21	-	50	50	100	14
Total		-	21	21	-	50	50	100	14

Total Credits: 80

Elective – I

Sl. No	Course code	Course
1	EPRMD 221	Robotics
2	EPRMD 222	Nonlinear Solid Mechanics
3	EPRMD 223	Mechatronics
4	EPRMD 224	Tribology

Elective – II

Sl. No	Course Code	Course
1	EPRMD 231	Mechanics of Composite Materials
2	EPRMD 232	Product Design
3	EPRMD 233	Vehicle Dynamics
4	EPRMD 234	Computational Fluid Dynamics

Elective – III

Sl. No	Course Code	Course
1	EPRMD 321	Fracture Mechanics
2	EPRMD 322	Theory of Plasticity
3	EPRMD 323	Signal Analysis and Condition Monitoring
4	EPRMD 324	Advanced Finite Element Analysis

M.Tech (Machine Design)
FIRST SEMESTER
EPRMD 101/ EPRCC101: COMPUTATIONAL METHODS IN ENGINEERING

Periods per week: 4 | End Examination: 60 Marks
Credits: 4 | Sessionals: 40 Marks

UNIT I

Modeling, Computers, and Error Analysis: Mathematical Modeling and Engineering Problem Solving, Approximations and Round-Off Errors, Truncation Errors and the Taylor Series.

Roots of Equations: Bracketing Methods – Bisection Method, False Position Method, Incremental searches and Determining Initial Guesses; Open Methods – Fixed Point Iteration, Newton-Raphson Method, Secant Method; Roots of Polynomials – Muller's Method, Bairstow's method; Application to practical problems – Ideal and Nonideal gas laws, Vibration Analysis.

UNIT II

Linear Algebraic Equations: Gauss Elimination – Solving Small Numbers of Equations, Naïve Gauss Elimination, Pitfalls, Techniques for improving Solutions, Nonlinear Systems of Equations, Gauss-Jordan; LU Decomposition and Matrix Inversion, Special Matrices and Gauss-Seidel, Application to practical problems – Analysis of a Statically Determinate Truss, Spring Mass Systems.

UNIT III

Numerical Differentiation and Integration: Newton-Cotes Integration Formulas – Trapezoidal Rule, Simpson's Rules, Integration with Unequal Segments, Open Integration Formulas, Multiple Integrals; Integration of Equations - Newton-Cotes Algorithms for Equations, Romberg Integration, Gauss Quadrature, Improper Integrals; Numerical Differentiation – High Accuracy Differentiation Formulas, Richardson Extrapolation, Derivatives of Unequally spaced Data; Application to practical problems – Integration to Determine the Total Quantity of Heat, Computation of Work.

UNIT IV

Ordinary Differential Equations: Runge-Kutta Methods – Euler's Method, Improvement of Euler's Method, Runge-Kutta Methods, Systems of Equations, Adaptive Runge-Kutta Methods; Stiffness and Multistep Methods, Boundary-Value and Eigenvalue Problems, Application to practical problems – The Swinging Pendulum.

UNIT V

Partial Differential Equations: Finite Difference: Elliptic Equations – The Laplace Equation, Solution Techniques, Boundary Conditions, The Control Volume Approach; Finite Difference: Parabolic Equations – The Heat Conduction Equation, ExplicitMethods, A Simple Implicit Method, The Crank-Nicolson Method; Application to practical problems - Finite-Element Solution of a Series of Springs.

Text Book:

1. Numerical Methods for Engineers by S. C. Chapra and R. P. Canale, Tata McGraw-Hill Company Ltd.

References:

1. Applied Numerical Methods with MATLAB for Engineers and Scientists by S. C. Chapra, McGraw-Hill Company Ltd.
2. Applied Numerical Methods for Digital Computation by M. L. James, G. M. Smith, J. C. Wolford, Harper & Row Publishers

EPRMD 102: ADVANCED MECHANICS OF SOLIDS

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT-I

Analysis of Stress: Introduction, Body Force, Surface Force and Stress Vector, The State of Stress at a Point, Normal and Shear Stress Components, Rectangular Stress Component, Stress Components on an Arbitrary Plane, Digression on Ideal Fluid, Equality of Cross Shears, A More General Theorem, Principal Stresses, Stress Invariants, Principal Planes are Orthogonal, Cubic Equation has Three Real Roots, Particular Cases, Recapitulation, The State of Stress Referred to Principal Axes, Mohr's Circles for the Three-dimensional State of Stress, Mohr's Stress Plane, Planes of Maximum Shear, Octahedral Stresses, The State of Pure Shear, Decomposition into Hydrostatic and Pure Shear States, Cauchy's Stress Quadric, Lame's Ellipsoid, The Plane State of Stress, Differential Equations of Equilibrium, Equilibrium Equations for Plane Stress State, Boundary Conditions, Equations of Equilibrium in Cylindrical Coordinates, Axisymmetric Case and Plane Stress Case.

UNIT-II

Analysis of Strain: Introduction, Deformations, Deformation in the Neighborhood of a Point, Change in Length of a Linear Element, Change in Length of a Linear Element—Linear Components, Rectangular Strain Components, The State of Strain at a Point, Interpretation of γ_{xy}, γ_{yz}, γ_{xz} as Shear Strain Components, Change in Direction of a Linear Element, Cubical Dilatation, Change in the Angle between Two Line Elements, Principal Axes of Strain and Principal Strains, Plane State of Strain, The Principal Axes of Strain Remain Orthogonal after Strain, Plane Strains in Polar Coordinates, Compatibility Conditions, Strain Deviator and its Invariants.

Stress–Strain Relations for Linearly Elastic Solids: Introduction, Generalized Statement of Hooke's Law, Stress–Strain Relations for Isotropic Materials, Modulus of Rigidity, Bulk Modulus, Young's Modulus and Poisson's Ratio, Relations between the Elastic Constants, Displacement Equations of Equilibrium.

UNIT-III

Energy Methods: Introduction, Hooke's Law and the Principle of Superposition, Corresponding Force and Displacement or Work-absorbing Component of Displacement, Work Done by Forces and Elastic Strain Energy Stored, Reciprocal Relation, Maxwell–Betti–Rayleigh Reciprocal Theorem, Generalized Forces and Displacements, Begg's Deformeter, First Theorem of Castigliano, Expressions for Strain Energy, Fictitious Load Method, Superposition of Elastic Energies, Statically Indeterminate Structures, Theorem of Virtual Work, Kirchhoff's Theorem, Second Theorem of Castigliano or Menabrea's Theorem, Generalization of Castigliano's Theorem or Engesser's Theorem, Maxwell–Mohr Integrals.

Bending of Beams: Introduction, Straight Beams and Asymmetrical Bending, Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure, Shear Stresses in Thin-walled Open Sections: Shear Centre, Shear Centers for a Few Other Sections, Bending of Curved Beam (Winkler-Bach Formula), Deflections of Thick Curved Bars.

UNIT-IV

Torsion: Introduction, Torsion of General Prismatic Bars–Solid Sections, Alternative Approach, Torsion of Circular and Elliptical Bars, Torsion of Equilateral Triangular Bar, Torsion of Rectangular Bars, Membrane Analogy, Torsion of Thin-walled Tubes, Torsion of Thin-walled Multiple-Cell Closed Sections, Torsion of Bars with Thin Rectangular Sections, Torsion of Rolled Sections, Multiply-Connected Sections, Centre of Twist and Flexural Centre.

UNIT-V

Axisymmetric Problems: Introduction, Thick-walled Cylinder subjected to Internal and External Pressures-Lame's Problem, Stresses in Composite Tubes-Shrink Fits, Sphere with Purely Radial Displacements, Stresses Due to Gravitation, Rotating Disks of Uniform Thickness, Disks of Variable Thickness, Rotating Shafts and Cylinders, Summary of Results for Use in Problems.

Thermal Stresses: Introduction, Thermoelastic Stress–Strain Relations, Equations of Equilibrium, Strain-Displacement Relations, Some General Results, Thin Circular Disk: Temperature Symmetrical about Centre, Long Circular Cylinder, The Problem of a Sphere, Normal Stresses in Straight Beams due to Thermal Loading, Stresses in Curved Beams due to Thermal Loading.

Text Book:

1. Advanced Mechanics of Solids by L.S. Srinath, Tata-McGraw-Hill Publishing Co. Ltd.

References:

1. Advanced Mechanics of Materials by Boresi, A.P. and Sidebottm, O.M., Wiley India Pvt. Ltd.
2. Advanced Mechanics of Materials by Seely and Smith, Wiley India Pvt. Ltd.
3. Advanced Strength of Materials by Den Hartog., Dover Publications.
4. Advanced Strength of Materials by Timoshenko S.P., D Van Nostrand Company Inc.

EPRMD 103: MECHANICS OF MACHINERY

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT I

Kinematics of complex mechanisms: Complex mechanisms, Low and high degree of complexity, Goodman's indirect acceleration analysis, Method of normal accelerations, Hall and Ault's auxiliary point method, Carter's method and comparison of methods.

UNIT II

Advanced kinematics of plane motion: The inflexion circle - Euler-Savary equation, Analytical and graphical determination of diameter of inflection circle - Bobbileier's construction, Collineation axis - Hartman's construction, Application of inflection circle to kinematic analysis - Polode curvature - General case and special case, Polode curvature in the four-bar mechanism - Coupler motion, Relative motion of the output and input links, Freudenstein's collineation axis theorem - Carter Hall circle, Circling-point curve (general case).

UNIT III

Introduction to synthesis (graphical methods): guiding a point through two, three and four distinct positions - Burmaster's curve, Function generation - Overlay's method, Path generation - Robert's theorem.

UNIT IV

Introduction to synthesis (analytical methods): Freudenstein's equation - Precision point approximation - Precision derivative approximation - Method of components - Block synthesis and Reven's method.

Forces in mechanisms - Free body diagrams - Friction in link connections - Forces in linkages.

UNIT V

Cam dynamics: Forces in rigid systems, Mathematical models, Response of a uniform - Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis.

Text Book:

1. Kinematics and Dynamics of Plane Mechanisms by J. Hirschhorn, McGraw-Hill Education.

Reference:

1. Theory of Machines by J.E. Shigley, McGraw-Hill Education (for Cam Dynamics).

EPRMD104: MECHANICAL VIBRATIONS

Periods per week: 4 | End Examination: 60 Marks
Credits: 4 | Sessionals: 40 Marks

UNIT-I:

Fundamentals of Vibration: Brief history of vibration, Importance of the study of vibration, basic concepts of vibration, classification of vibrations, vibration analysis procedure, spring elements, mass or inertia elements, damping elements, harmonic analysis.

Free Vibration of Single Degree of Freedom Systems: Introduction, Free vibration of an undamped translational system, free vibration of an undamped torsional system, stability conditions, Raleigh's energy method, free vibration with viscous damping, free vibration with coulomb damping, free vibration with hysteretic damping.

UNIT-II:

Harmonically Exited Vibrations: Introduction, Equation of motion, response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base, Response of a damped system under rotating unbalance, forced vibration with coulomb damping, forced vibration with hysteresis damping.

UNIT-III:

Vibration Under General Forcing Conditions: Introduction, Response under a general periodic force, Response under a periodic force of irregular form, Response under a non periodic force, convolution integral.

Two Degree of Freedom Systems: Introduction, Equation of motion for forced vibration, free vibration analysis of an undamped system, Torsional system, Coordinate coupling and principal coordinates, forced vibration analysis.

UNIT-IV:

Multidegree of Freedom Systems: Introduction, Modeling of Continuous systems as multi degree of freedom systems, Using Newton's second law to derive equations of motion, Influence coefficients, Free and Forced vibration of undamped systems, Forced vibration of viscously damped systems.

Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's method, Holzers' method, Matrix iteration method, Jacobi's method.

UNIT-V:

Continuous Systems: Transverse vibration of a spring or a cable, longitudinal vibration of bar or rod, Torsional vibration of a bar or rod, Lateral vibration of beams, Critical speeds of rotors.

Vibration Control: Introduction, Control of vibration, Control of natural frequencies, Vibration isolation, Vibration absorbers.

Text Book:

1. Mechanical Vibrations by S.S.Rao, Pearson publications.

References:

1. Mechanical Vibrations by G.K. Grover, S. Chand & Co.
2. Mechanical Vibrations by W.T. Thomson, Prentice Hill India.
3. Fundamentals of mechanical vibrations by S.Graham Kelly, McGraw-Hill.

EPRMD 105: COMPUTER AIDED DESIGN

Periods per week: 4 | End Examination: 60 Marks
Credits : 4 | Sessionals: 40 Marks

UNIT I

Fundamentals of CAD: Introduction, Design process, Application of computer for design, Benefits of CAD, CAD tools, CAD hardware, CAD software, Mechanical applications of CAD.

Geometric modeling - Types and Mathematical Representations of Curves: Wireframe models, wireframe entities, curve representation, parametric representation of analytic curves and synthetic curves, simple problems.

UNIT II

Geometric modeling - Types and Mathematical Representations of Surfaces: Surface models, surface entities, surface representation, parametric representation of analytic surfaces and synthetic surfaces, simple problems.

UNIT III

Geometric modeling - Types and Mathematical Representations of Solids: Solid models, solid entities, solid representation, fundamentals of solid modeling, half spaces, boundary representation (B-rep), Constructive solid geometry (CSG), sweep representation, analytic solid modeling (ASM).

UNIT IV

Graphics Concepts - Geometric Transformations: Transformation of geometric models, mappings of geometric models, inverse transformations and mappings, projections of geometric models.

Graphics Concepts - Visual realism: Model clean-up, hidden line removal, hidden surface removal, hidden solid removal, Shading, Coloring.

UNIT V

Mechanical assembly: Assembly modeling, representation schemes, generation of assembly sequence, assembly analysis.

Mass property calculations: Geometrical property formulation, mass property formulation, property evaluation, properties of composite objects.

Text Book:

1. CAD/CAM Theory and Practice by I. Zeid, Tata McGraw-Hill.

References:

1. CAD/CAM Principles and Applications by P. N. Rao, Tata McGraw Hill Publishing Company Ltd.
2. CAD/CAM Computer Aided Design and Manufacturing by M. P. Groover and E. W. Zimmer, Jr., Pearson Education.
3. Computer Integrated Design and Manufacturing by D. D. Bedworth, M. R. Henderson, P. M. Wolfe, McGraw-Hill.

EPRMD 111/ EPRCC111: COMPUTER AIDED DESIGN LAB

Hours per week: 3 Continuous Evaluation: 100 Marks
Credits: 2

1. **Introduction to Modeling Packages** - ProEngineer / I-DEAS / CATIA / Unigraphics / SolidWorks.
2. **2D drawings**
3. **3D drawings**
4. **Assembly** – flange coupling, Knuckle joint, connecting rod.
5. **Drafting**
6. **Introduction to pre-processing tool for Finite Element Analysis –** Hypermesh
7. **2D meshing**
8. **3D meshing**

EPRMD 112: MECHANICAL VIBRATIONS LAB

Hours per week: 3 Continuous Evaluation: 60 Marks
Credits: 2

1. To determine the radius of gyration of given bar by using bifilar suspension.
2. Find the CG of a connecting rod using free vibration techniques.
3. To determine natural frequency of free torsional vibrations of single rotor system.
   (a) Horizontal rotor (b) Vertical rotor
4. Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.
5. Finding the damping presence in the structure using logarithmic decrement method.
6. Finding the damping presence in the structure using half power band width method.
7. Finding the natural frequencies and mode shapes of cantilever beam.
8. Finding the natural frequencies and mode shapes of plate at different boundary conditions
9. Study the beat phenomenon.
10. Study of vibration measuring instruments.

EPRMD 201: FINITE ELEMENT ANALYSIS

Periods per week: 4 | End Examination: 60 Marks
Credits: 4 | Sessionals: 40 Marks

UNIT-I

Overview of finite element method (FEM): Basic concept, historical background, engineering applications of FEM, general description of the FEM, comparison of FEM and other methods.

Discretization of the domain: Basic element shapes, discretization process, node numbering scheme, automatic mesh generation.

UNIT-II

Interpolation models: Interpolation polynomial in terms of nodal degree of freedom, selection of the order of the interpolation polynomial, interpolation polynomial for vector quantities, linear interpolation polynomials in terms of global coordinates and local coordinates.

Higher order and Isoparametric elements: Higher order elements in terms of natural coordinates, higher order elements in terms of classical interpolation polynomials, one-dimensional elements using classical interpolation polynomials, two-dimensional (rectangular) elements using classical interpolation polynomials.

UNIT-III

Derivation of Element Matrices and Vectors: solution of equilibrium and eigenvalue problems using variational (Rayleigh-Ritz) approach and weighted residual (Galerkin and Least squares) approach.

Assembly of Element Matrices and Vectors and Derivation of System Equations: Coordinate Transformation, Assemblage of Element Equations, Incorporation of Boundary Conditions.

Numerical Solution of Finite Element Equations of Equilibrium and Eigenvalue Problems

UNIT-IV

Application to Solid Mechanics Problems - Static Analysis:

Basic Equations and Solution Procedure: Basic equations of solid mechanics, formulations of solid and structural mechanics, formulation of finite element equations.

Analysis of Trusses, Beams and Frames: Space truss element, beam element, space frame element, planar frame element.

Analysis of Plates: Triangular membrane element, numerical results with membrane element, bending behavior of plates, finite element analysis of plate bending, triangular plate bending element, numerical results with bending elements, analysis of three dimensional structures using plate elements.

UNIT- V

Application to Solid Mechanics Problems - Dynamic Analysis: Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis, dynamic response using finite element method.

Application to Heat Transfer Problems: Basic equations of heat transfer, governing equation for three-dimensional bodies, statement of the problem, derivation of finite element equations, straight uniform fin analysis, tapered fin analysis, analysis of uniform fins using quadratic elements, unsteady state problems, heat transfer problems with radiation.

Text Book:

1. The finite element method in Engineering by SS Rao, Butterworth-Heinemann, Elsevier, India.

References:

1. An introduction to the finite element method by J. N. Reddy, McGraw-Hill Education.
2. Concepts and Applications of Finite Element Analysis by R.D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, John-Wiley & Sons, Inc.
3. Applied Finite Element Analysis by L.J. Segerlind, John-Wiley & Sons, Inc.

EPRMD 202: FAILURE ANALYSIS AND DESIGN

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT I

Role of Failure Prevention Analysis in Mechanical Design: Introduction, a definition of design, a challenge, some design objectives.

Modes of Mechanical Failure: Definition of failure mode, failure modes observed in practice, a glossary of mechanical failure modes.

Introduction to Fracture Mechanics: An introduction to linear elastic fracture mechanics, use of fracture mechanics design, elastic-plastic fracture mechanics.

UNIT II

High-Cycle Fatigue: Introduction, historical remarks, nature of fatigue, fatigue loading, laboratory fatigue testing, the S-N-P curves, factors that affect S-N-P curves, using the factors in design, the influence of nonzero mean stress, multiaxial fatigue stresses, using multiaxial fatigue failure theories.

UNIT III

Cumulative Damage, Life Prediction and Fracture Control: Introduction, the Linear damage theory, cumulative damage theories, life prediction based on local stress-strain and fracture mechanics concepts, service loading simulation and full scale fatigue testing, damage tolerance and fracture control.

UNIT IV

Low-Cycle Fatigue: Introduction, the strain cycling concept, the strain life curve and low-cycle fatigue relationships, the influence of nonzero mean strain and nonzero mean stress, cumulative damage rule in low-cycle fatigue.

Creep, Stress Rupture and Fatigue: Introduction, prediction of long-term creep behavior, theories for predicting creep behavior, creep under uniaxial state of stress and multi axial state of stress, cumulative creep concept, combined creep and fatigue.

UNIT V

Fretting, Fretting Fatigue and Fretting Wear: Introduction, variables of importance in the fretting process, fretting fatigue, fretting wear, fretting corrosion, minimizing or preventing fretting damage.

Wear and Corrosion: Introduction, wear – Adhesive, abrasive, corrosion, surface fatigue, deformation, fretting, impact, empirical model of zero wear, corrosion, stress corrosion cracking.

Text book:

1. Failure of Materials in Mechanical Design: Analysis, Prediction, Prevention, J. A. Collins, John Wiley & Sons, Inc.

References:

1. Fatigue of Materials, S. Suresh, Cambridge University Press.
2. Fracture Mechanics: Fundamentals and Applications, T. L. Anderson, CRC Press.

EPRMD 203: EXPERIMENTAL STRESS ANALYSIS

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT-I

Light and Optics as Related to Photo Elasticity: Behavior of light, polarized light, plane polarizers, wave plates, conditioning of light by a series combination of a linear polarizer and a wave plate, arrangement of the optical elements in polariscope, construction details of diffused light and lens type polariscopes, lens formulas.

Theory of Photo elasticity: The stress optic law in two dimensions at normal incidence, effects of stress model in plane polariscope, effects of a stressed model in a circular polariscope – Dark field and light field, photoelastic photography, fringe multiplication by photographic methods, fringe sharpening with partial mirrors, fringe multiplication with partial mirrors.

UNIT-II

Photo elastic Model Materials for Two Dimensional Applications: Criteria for selection of model materials, properties of commonly employed photoelastic materials, calibration methods.

Analysis Techniques: Isochromatic fringe patterns, Isoclinic fringe patterns, compensation techniques, separation techniques, scaling model to prototype stresses.

UNIT-III

Three Dimensional Photoelasticity: Locking in model deformations, materials for three dimensional photoelasticity, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions.

Application of Photoelastic Methods: Stresses about a circular hole near the edge of uniformly loaded half plane, photoelastic analysis of a reactor closure head, dynamic stress distribution on the boundary of a circular hole in a half plane.

UNIT-IV

Introduction to Strain Measurements: Definition of strain and its relation to experimental determinations, basic characteristics of a strain gage, types of strain gage, Moire method of strain analysis, grid method of strain analysis.

Electrical resistance strain gages: Factors producing strain sensitivity in metallic alloys, Gage construction, Temperature compensation, factors influencing gage selection, Gage sensitivity and gage factors, corrections for transverse strain effects, Semi conductor strain gages.
Parameters influencing the behavior of bonded-wire and Foil strain gage: Strain gage adhesives, Influence of strain cycling, Frequency response of strain gage, Gage current, Effect of moisture and humidity, Time effects, Influence of hydrostatic pressure, Influence of magnetic field.

UNIT-V
Rosette Analysis: Three element rectangular rosette, Delta rosette, Four element rectangular rosette, Four element tee-delta rosette, Stress gage
Strain Gage Circuits: The potentiometer and its applications to strain measurement, range and sensitivity of the potentiometer circuit, temperature compensation and signal addition in the potentiometer circuit, potentiometer output, load effects on the potentiometer circuit, the Wheatstone bridge, Wheatstone bridge sensitivity, null balance bridges, commercial strain indicators, criteria for circuit selection.
Recording Instruments: The galvanometer and oscillograph, transient response of galvanometers, response of galvanometer to a sinusoidal signal, the wheatstone bridge and the galvanometer, frequency response of the wheatstone bridge and galvanometer system, wheatstone bridge and galvanometer circuits, the cathode ray oscilloscope, potentiometer recorder.

Text Book:

1. Experimental Stress Analysis by Dally, J.W., and Riley, W.F., McGraw-Hill Inc.

References:

1. Experimental Stress Analysis by Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., Tata McGraw-Hill.
2. Hand book of Experimental Stress Analysis by Hetyenyi, M., John Wiley and Sons Inc.

EPRMD 211: EXPERIMENTAL METHODS LAB

Hours per week: 3 Continuous Evaluation: 60 Marks
Credits: 2

List of Experiments:

1. Measurement of strain by using strain gauges.
2. Calibration of Rotameter.
3. Calibration of Thermocouples.
4. Experiment with constant voltage/current Hot-wire Anemometer.
5. Experiments with piezo-electric pick-up, Inductive pick-ups. Determination of characteristics - Displacement, Velocity and Acceleration.
6. Experimental determination of undamped and damped frequencies of spring-mass system.
7. Ultrasonic flaw detector.
8. Experiment on photoelastic bench (Plain polariscope, Circular polariscope).
9. Photoelastic analysis of disc under diametric compression.
10. Photo elastic analysis of Ring under diametric compression.

EPRMD 212/ EPRCC211: COMPUTER AIDED ENGINEERING LAB

Hours per week: 3 Continuous Evaluation: 60 Marks
Credits: 2

1. Introduction to Finite Element Analysis software – ANSYS / NISA / Nastran
2. Static Structural Analysis of 1D problems – bars, trusses, beams and frames
3. Static Structural Analysis of 2D problems – plane stress, plane strain, axisymmetric
4. Static Structural Analysis of 3D problems – various brackets
5. Dynamic Structural Analysis of 1D problems – beams and frames
6. Steady State Thermal Analysis of 1D and 2D models
7. Transient Thermal Analysis of 1D and 2D models
8. Couple Field (Thermal/Structural) Analysis

EPRMD 221: ROBOTICS
(Elective - I)

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT-I

Introduction and Robot Kinematics: Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT-II

Robot Drives and Control: Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT-III

Robot sensors: Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

UNIT-IV

Robot Cell Design and Application: Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT-V

Robot Programming, Artificial Intelligence and Expert Systems: Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – Problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

Text Book:

1. Robotics Control, Sensing, Vision and Intelligence by K.S.Fu, R.C. Gonzalez and C.S.G. Lee Mc Graw Hill.

References:

1. Robotics for Engineers by Yoram Koren Mc Graw-Hill.
2. Industrial Robots by Kozyrey, Yu MIR Publishers.
3. Robotics Engineering-An Integrated Approach by Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin Prentice-Hall of India Pvt. Ltd.
4. Robotics Technology and Flexible Automation by Deb, S.R, Tata Mc Graw-Hill.
5. Industrial Robotics Technology, Programming and Applications by Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Mc Graw-Hill.

EPRMD 222: NONLINEAR SOLID MECHANICS
(Elective - I)

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT I

Introduction to Vectors and Tensors: Algebra of Vectors, Algebra of Tensors, Higher-order Tensors, Eigenvalues, Eigenvectors of Tensors, Transformation Laws for Basis Vectors and Components, General Bases, Scalar, Vector, Tensor Functions, Gradients and Related Operators, Integral Theorems.

UNIT II

Kinematics: Configurations and Motions of Continuum Bodies, Displacement, Velocity, Acceleration Fields, Material, Spatial Derivatives, Deformation Gradient, Strain Tensors, Rotation Tensor, Stretch Tensors, Rates of Deformation Tensors, Lie Time Derivatives.

The Concept of Stress: Traction Vectors, and Stress Tensors, Extremal Stress Values, Examples of States of Stress, Alternative Stress Tensors.

UNIT III

Balance Principles: Conservation of Mass, Reynolds' Transport Theorem, Momentum Balance Principles, Balance of Mechanical Energy, Balance of Energy in Continuum Thermodynamics, Entropy Inequality Principle, Master Balance Principle.

Some Aspects of Objectivity: Change of Observer, and Objective Tensor Fields, Superimposed Rigid-body Motions, Objective Rates, Invariance of Elastic Material Response.

UNIT IV

Hyperelastic Materials: General Remarks on Constitutive Equations, Isotropic Hyperelastic Materials, Incompressible Hyperelastic Materials, Compressible Hyperelastic Materials, Some Forms of Strain-energy Functions, Elasticity Tensors, Transversely Isotropic Materials, Composite Materials with Two Families of Fibers, Constitutive Models with Internal Variables, Viscoelastic Materials at Large Strains, Hyperelastic Materials with Isotropic Damage.

UNIT V

Thermodynamics of Materials: Physical Preliminaries, Thermoelasticity of Macroscopic Networks, Thermodynamic Potentials, Calorimetry, Isothermal, Isentropic Elasticity Tensors, Entropic Elastic Materials, Thermodynamic Extension of Ogden's Material Model, Simple Tension of Entropic Elastic Materials, Thermodynamics with Internal Variables.

Variational Principles: Virtual Displacements, Variations, Principle of Virtual Work, Principle of Stationary Potential Energy, Linearization of the Principle of Virtual Work, Two-field Variational Principles, Three-field Variational Principles.

Text Book:

1. Nonlinear Solid Mechanics: A Continuum Approach for Engineering by G. A. Holzapfel, John-Wiley & Sons.

Reference:

1. Nonlinear Solid Mechanics: Theoretical formulations and finite element solutions by A. Ibrahimbegovic**,** Springer publications.

EPRMD 223: MECHATRONICS
(Elective - I)

Periods per week: 4 — End Examination: 60 Marks
Credits: 4 — Sessionals: 40 Marks

UNIT I

Mechatronics system design: Introduction to Mechatronics: What is mechatronics, Integrated design issues in mechatronics, Mechatronics key elements, The mechatronics design process, Advanced approaches in mechatronics.

UNIT II

Modelling and simulation of physical systems: Simulation and block diagrams, Analogies and impedance diagrams, Electrical systems, Mechanical translational systems, Mechanical rotational systems, Electromechanical coupling, Fluid systems.

UNIT III

Sensors and transducers: An introduction to sensors and transducers, Sensors for motion and position measurement, Force, torque and tactile sensors, Flow sensors, Temperature-sensing devices. Actuating devices: Direct current motor, Permanent magnet stepper motor, Fluid power actuation.

UNIT IV

Signals, systems and controls: Introduction to signals, systems and controls, System representation, Linearization of nonlinear systems, Time delays.
Real time interfacing: Introduction, Elements of a data acquisition and control system, Overview of the I/O process, Installation of the I/O card and software.

UNIT V

Advanced applications in mechatronics: Sensors for condition monitoring, Mechatronic control in automated manufacturing, Artificial intelligence in mechatronics, Microsensors in mechatronics.

Text Book:

1. Mechatronics System Design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing Company.

Reference:

1. Mechatronics by W. Bolton, Pearson Education.

EPRMD 224: TRIBOLOGY
(Elective - I)

Periods per week: 4 | End Examination: 60 Marks
Credits : 4 | Sessionals: 40 Marks

UNIT I

Historical background - Viscosity - Viscometry - Effect of temperature on viscosity - Effect of pressure in viscosity - Other physical properties of mineral oils - The generalized Reynolds equation - Flow and shear stress - The energy equation - The equation of state - Mechanism of pressure development.

UNIT II

Circumferential flow - Oil flow through a bearing having a circumferential oil groove - Heat generation and lubricant temperature - Heat balance and effective temperature - Bearing design: Practical considerations - Design of journal bearings - Parallel surface bearing - Step bearing - Some situations under squeeze film lubrication - The mechanism of hydrodynamic instability - Stiffness and damping coefficients - Stability.

UNIT III

Elastohydrodynamic lubrication: Theoretical consideration - Grubin type solution - Accurate solution - Point contact - Dimensionless parameters - Film thickness equations - Different regimes in EHL contact - Deep-groove radial bearings - Angular contact bearings - Thrust ball bearings - Geometry - Kinematics - Stress and deformations - Load capacity.

UNIT IV

Surface topography - Surface characterization - Apparent and real area of contact - Derivation of average Reynolds equation for partially lubricated surface - Effect of surface roughness on journal bearings

UNIT V

Laws of friction - Friction theories - Surface contaminants - Frictional heating - Effect of sliding speed on friction - Classification of wear - Mechanisms of wear - Quantitative laws of wear - Wear resistance materials.

Text Book:

1. Introduction to Tribology of Bearings by Majumdar, B.C., S Chand &Company Ltd., 2012

References:

1. Basic Lubrication Theory by Alistair Cameron, Edition 3, John Wiley & Sons, 1981
2. Engineering Tribology by Gwidon W. Stachowiak, Andrew W. Batchelor, Elsevier.
3. Fundementals of Fluid Film Lubrication: Bernard J. Hamrock, Steven R. Schmid and Bo O. Jacobson, Marcel Dekker.
4. Friction and Wear of Materials: Earnest Rabinowicz, John Wieley & Sons.

EPRMD 231: MECHANICS OF COMPOSITE MATERIALS
(Elective - II)

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT-I

Introduction to composite materials: Classification and characteristics of composite materials, Mechanical behavior of composites, Basic terminology of laminated fiber reinforced composite materials, Advantages, Applications, Different types of fibers and matrix materials, Manufacture of laminated fiber reinforced composite materials - Hand layup, bag molding, Resin transfer molding, filament winding and pultrusion.

UNIT-II

Macromechanical behavior of a lamina: Introduction, Stress-strain relations for anisotropic materials - generalized hooks law, Stiffnesses, compliances and engineering constants for orthotropic materials, Restrictions on engineering constants, Stress-strain relations for plane stress in orthotropic materials, Stress-strain relations for a lamina of arbitrary orientation, Invariant properties of an orthotropic lamina, strengths of an orthotropic lamina, Biaxial criteria for an orthotropic lamina.

UNIT-III

Micromechanical behavior of lamina: Introduction, Mechanics of materials approach to stiffness, Elasticity approach to stiffness, comparison of approaches to stiffness, Mechanics of materials approach to strength.

UNIT-IV

Macro mechanical behavior of laminate: Introduction, Classical lamination theory, Special cases of laminate stiffnesses, Theoritical versus measured laminate stiffnesses, Strength of laminates, Inter laminar stresses.

Bending of laminated plates: Introduction, Governing equation for bending of laminated plates, Deflection of simply supported laminated plates under distributed transverse load.

UNIT-V

Introduction to design of composite structures: Introduction, Structural design, Materials selection, Laminate joints, Design requirements and design failure criteria, Optimization concepts, Design analysis philosophy for composite structures.

Text Book:

1. Mechanics of composite materials by R. M. Jones, Taylor and Francis.

References:

1. Analysis and performances of Fiber composites by B. D. Agarwal, L. J. Broutman and K. Chandrasekhara, John Wiley & Sons, Inc.
2. Primer on composite materials by J. C. Halpin, Technomic Publishing Company, Inc.

EPRMD 232: PRODUCT DESIGN
(Elective-II)

Periods per week: 4 — End Examination: 60 Marks
Credits: 4 — Sessionals: 40 Marks

UNIT-I

Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability

UNIT-II

Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory. Fatigue failure theories, Fatigue mechanisms, Fatigue failure models, Fatigue failure criteria, Methods to reduce fatigue, Design for fatigue, Modified Goodman Diagram, Gerber method, Soderberg line, Surface failure models. Lubrication, friction and wear.

UNIT-III

Product Design: Product strategies, Product value, Product planning, Product specifications, Concept generation, Concept selection, Concept testing.

UNIT-IV

Design for manufacturing: Forging design, Casting design, Design process for non metallic parts-Plastics, Rubber, Ceramic, Wood and Glass.

UNIT-V

Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.

Text Book:

1. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall.

References:

1. Mechanical Engineering Design by Joseph Shigley and Mischke. Sixth edition, Tata McGraw Hill.
2. Machine Design - An Integrated Approach by R.L. Norton, Prentice Hall.
3. Product design and development by Karl T. Ulrich and Steven D. Eppinger. Third edition, Tata McGraw Hill.

EPRMD 233: VEHICLE DYNAMICS
(Elective - II)

Periods per week: 4 | End Examination: 60 Marks
Credits: 4 | Sessionals: 40 Marks

UNIT I

Introduction to Vehicle Dynamics: Various kinds of vehicles, Motions, Mathematical modelling methods, Multibody system approach, Lagrangian formulations, Methods of investigations, Stability concepts.

UNIT II

Mechanics of pneumatic tyres: Tyre construction, SAE recommended practice, Tyre forces and moments, Rolling resistance of tyres, Tractive effort and longitudinal slip, Cornering properties of tyres, Performance of tyre traction on dry and wet surfaces, Ride properties of tyres.

UNIT III

Performance characteristics of road vehicle: Equation of motion and maximum tractive effort, Aerodynamic forces and moments, Vehicle power plant and transmission characteristics, Prediction of vehicle performance, Operating fuel economy, Braking performance.

UNIT IV

Handling and stability characteristics of road vehicles: Steering geometry, Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Directional stability, Effects of tyre factors, Mass distribution and engine location on stability of handling.

UNIT V

Vehicle ride characteristics: Human response to vibration, Vehicle ride models, Introduction to random vibration – Road surface profile as a random function, Frequency response function, Evaluation of vehicle vertical vibration in relation to ride comfort criteria, Active and semi active systems, Optimum design for ride comfort and road holding.

Text Book:

1. Theory of Ground Vehicles by Wong, J.Y., John Wiley and Sons.

References:

1. Fundamentals of Vehicle Dynamics by Gillespie, T.D., SAE Publication.
2. Tyres, Suspension and Handling by Dixon, J.C., SAE Publication, Warrendal, USA and Arnold Publication.

M.Tech (Machine Design)
THIRD SEMESTER
EPRMD301 EPRIE102/EPRCC221:
OPTIMIZATION METHODS IN ENGINEERING

Periods per week: 4 — End Examination: 60 Marks
Credits: 4 — Sessionals: 40 Marks

UNIT I

Geometric programming (G.P): Unconstrained minimization problem, Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming, constrained minimization.

UNIT II

Dynamic programming (D.P): Multistage decision processes. Concepts of sub optimisation, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and Continuous D.P.

UNIT III

Integer programming (I.P): Integer linear programming, Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Integer non linear programming, Branch-and-bound method. Sequential linear discrete programming, Generalized penalty function method

UNIT IV

Stochastic Programming (S.P): Basic concepts of Probability Theory, Stochastic linear programming, Stochastic non-linear programming.

UNIT V

Unconventional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated Annealing, Neural Networks based Optimization.

Text Book:

1. Engineering Optimization - Theory and Practice by Rao, S.S., New Age International (P) Ltd. Publishers.

References:

1. Operations Research - Principles and Practice, Ravindran, Phillips and Solberg, John Wiely.
2. Introduction to Operations Research, Hiller and Lieberman, Mc Graw Hill.
3. Goal Programming and Extensions by James P. Ignizio, Lexigton Books.
4. Genetic Algorithms - In Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.

EPRMD 321 FRACTURE MECHANICS
(Elective - III)

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT-I

Fundamental Concepts: Introduction, Historical perspective, Linear Elastic Fracture Mechanics, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, The Energy Release Rate, Instability and the R Curve, Stress Analysis of Cracks, Relationship between K and G, Crack-Tip Plasticity, K-Controlled Fracture, Plane Strain Fracture, Mixed-Mode Fracture, Interaction of Multiple Cracks.

UNIT-II

Elastic-Plastic Fracture Mechanics: Crack-Tip-Opening Displacement, The J Contour Integral, Relationships Between J and CTOD, Crack-Growth Resistance Curves, Controlled Fracture, Crack-Tip Constraint Under Large-Scale Yielding.

Dynamic and Time-Dependent Fracture: Dynamic Fracture and Crack Arrest, Creep Crack Growth, Viscoelastic Fracture Mechanics.

UNIT-III

Fracture Mechanisms in Metals: Ductile Fracture, Cleavage, The Ductile-Brittle Transition, Intergranular Fracture.

Fracture Mechanisms in Nonmetals: Engineering Plastics, Ceramics and Ceramic Composites, Microcrack Toughening, Concrete and Rock.

UNIT-IV

Fracture Toughness Testing of Metals: General Considerations, KIc Testing, K-R Curve Testing, J Testing of Metals, CTOD Testing, Dynamic and Crack-Arrest Toughness, Fracture Testing of Weldments, Testing and Analysis of Steels in the Ductile-Brittle Transition Region, Qualitative Toughness Tests.

Fracture Testing of Nonmetals: Fracture Toughness Measurements in Engineering Plastics, Precracking and Other Practical Matters, Interlaminar Toughness of Composites, Ceramics.

UNIT-V

Application to Structures: Linear Elastic Fracture Mechanics, The CTOD Design Curve, Elastic-Plastic J-Integral Analysis, Failure Assessment Diagrams, Probabilistic Fracture Mechanics.

Fatigue Crack Propagation: Similitude in Fatigue, Empirical Fatigue Crack Growth Equations, Crack Closure, The Fatigue Threshold, Variable Amplitude Loading and Retardation, Growth of Short Cracks, Micromechanisms of Fatigue, Fatigue Crack Growth Experiments, Damage Tolerance Methodology

Text Book:

1. Fracture Mechanics: Fundamentals and Applications by T.L. Anderson, CRC Press, Florida.

References:

1. Elementary Engineering Fracture Mechanics by D. Broek, Martinus Nijhoff.
2. The Practical Use of Fracture Mechanics by D. Broek, Kluwer Academic Publishers.
3. Deformation and Fracture Mechanics of Engineering Materials by R. W. Hertzberg, John-Wiley & Sons.
4. Fracture and Fatigue Control in Structures: Applications of fracture mechanics by J.M. Barsom and S.T. Rolfe, ASTM International.
5. Mechanics and Mechanisms of Fracture: An Introduction by A. F. Liu, ASTM International.

EPRMD 322 THEORY OF PLASTICITY
(Elective - III)

Periods per week: 4 | End Examination: 60 Marks
Credits: 4 | Sessionals: 40 Marks

UNIT-I

Stresses and Strains: Stress-strain behavior, Analysis of stress and strain rate, Mohr's representation of stress, strain hardening postulates, role of plastic flow, stress-strain relations, total strain theory.

UNIT-II

Elastoplastic bending and torsion: Plane strain compression and bending, cylindrical bars under torsion and tension, thin-walled tubes under combined loading, pure bending of prismatic beams, bending of beams under transverse loads, torsion of prismatic bars, torsion of bars of variable diameter, combined bending and twisting of bars.

UNIT-III

Plastic analysis of beams and frames: limit analysis of beams, limit analysis of plane frames, displacements in plane frames, variable repeated loading, minimum weight design, influences of axial forces, limit analysis of space frames.

UNIT-IV

Steady problems in plane strain: Symmetrical extrusion through square dies, unsymmetrical and multi-hole extrusion, limit analysis of plane strain extrusion, cold rolling of strips, analysis of hot rolling.

UNIT-V

Non-steady problems in plane strain: Indentation of flat punch, yielding of notched bars in tension, bending of single notched bars, bending of double notched bars, bending of beams and curved bars.

Text Book:

1. Theory of Plasticity by J. Chakrabarty, Butterworth-Hienemann.

Reference:

1. Plasticity theory by Jacobe Lubliner, Pearson Education, Inc.

EPRMD 323: SIGNAL ANALYSIS AND CONDITION MONITORING
(Elective - III)

Periods per week: 4 End Examination: 60 Marks
Credits : 4 Sessionals: 40 Marks

UNIT-I

Introduction: Basic concepts, Fourier analysis, Bandwidth, Signal types, Convolution. **Signal analysis:** Filter response time, Detectors, Recorders, Analog analyzer types.

UNIT-II

Practical analysis of stationary signals: Stepped filter analysis, Swept filter analysis, High speed analysis, Real-time analysis.

UNIT-III

Practical analysis of continuous non-stationary signals: Choice of window type, Choice of window length, Choice of incremental step, Practical details. Scaling of the results.

UNIT-IV

Practical analysis of transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

UNIT-V

Condition monitoring in real systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations.

Text Book:

1. Condition Monitoring of Mechanical Systems by Kolacat

References:

1. Frequency Analysis by R.B.Randall. Bruel Kjaer.
2. Mechanical Vibrations Practice with Basic Theory by V. Ramamurti, Narosa Publishing House.

EPRMD 324: ADVANCED FINITE ELEMENT ANALYSES
(Elective - III)

Periods per week: 4 End Examination: 60 Marks
Credits: 4 Sessionals: 40 Marks

UNIT I

Introduction: Mathematical models, numerical simulations, finite element method, nonlinear analysis.

The Finite Element Method-A Review: Introduction, one dimensional problems, two dimensional problems, library of two dimensional finite elements, numerical integration, computer implementation

UNIT II

Heat Transfer and other Field Problems in One Dimension: Model differential equations, weak formulation, finite element model, solution procedure, computer implementation.

Nonlinear Bending of Straight Beams: Introduction, Euler-Bernoulli beams, Timoshenko beams.

UNIT III

Heat Transfer and other Field Problems in Two Dimensions: Model equations, weak form, finite element model, solution procedures, computer implementation.

Nonlinear Bending of Elastic Plates: Introduction, classical plate theory, variational formulation of PPT, finite element models of PPT, computer implementation aspects and numerical results of PPT elements, first order shear deformation plate theory, finite element models of FSDP, computer implementation aspects and numerical results of FSDP elements, theory of doubly curved shells, finite element analysis of shells.

UNIT IV

Flows of Viscous Incompressible Fluids: Introduction, governing equations, governing equations in terms of primitive variables, velocity-pressure finite element model, penalty finite element model, computational aspects, computer implementation, numerical examples, least square finite element models

Nonlinear Analysis of Time-Dependent Problems: Introduction, time approximations, stability and accuracy, transient analysis of non-linear problems, computer implementation, numerical examples

UNIT V

Finite Element Formulations of Solids and Structures: Introduction, strain and stress measures, strain and stress measures between configuration, constitutive equations, total Langrangian and update Langrangian formulations of continua, finite element models of two dimensional models of continua, shell finite element

Material Nonlinearities and Coupled Problems: Introduction, nonlinear elastic problems, small deformation theory of plasticity, nonnewtonial fluids, coupled fluid flow and heat transfer.

Text Book:

1. An Introduction to Nonlinear Finite Element Analysis, J. N. Reddy, Oxford University press.

References:

1. Nonlinear Finite Elements for Continua and Structures by T. Belytschko,W. K. Liu, and B. Moran, JohnWiley and Sons.
2. Computational Inelasticity by J. C. Simo and T. J. R. Hughes, Springer.
3. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis by T. J. R. Hughes, Dover Publications.

EPRMD 311: SEMINAR

Hours per week: 3
Credits: 2

End Examination: 40 Marks
Continuous Evaluation: 60 Marks

EPRMD 312: COMPREHENSIVE VIVA-VOCE

Credits: 2
End Semester Viva-voce - Examination: 100 Marks

EPRMD 313: PROJECT

Credits: 6
Instruction: Whole semester
Continuous Evaluation: 50 Marks
End Semester Viva-voce - Examination: 50 Marks

M.Tech. (Machine Design)
FOURTH SEMESTER
EPRMD 411: PROJECT

Credits: 14
Instruction: Whole semester
Continuous Evaluation: 50 Marks
End Semester Viva-voce - Examination: 50 Marks

Each student is required to submit a detailed Thesis report about the work on topic of Thesis as per the guidelines decided by the department. The Thesis work is to be evaluated through Presentations and Viva-voce during the semester and final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time.
The candidate has to present/publish one paper in national/international conference/ seminar/journal of repute is must before submission. However candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.