MMPD – 101 Advance Mathematics

UNIT 1
Linear Algebra: Linear transformation, vector spaces, hash function, Hermite polynomial, Heavisite's unit function and error function. Elementary concepts of Modular mathematics

UNIT 2
Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabolic) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haar transform.

UNIT 3
Probability, compound probability and discrete random variable, Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations.

UNIT 4
Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Application of Eigen value problems in Markov Process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS)

UNIT 5
FEM: Variational functionals, Euler Lagrange's equation, Variational forms, Ritz method, Galerkin's method, descretization, finite elements method for one dimensional problem.

Reference Books:
1. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
2. Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
3. Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
4. Introductory Methods of Numerical Analysis by S.S. Shastry,
5. Introduction of Numerical Analysis by Forberg
6. Numerical Solution of Differential Equation by M. K. Jain
7. Numerical Mathematical Analysis By James B. Scarborogh
8. Fourier Transforms by J. N. Sheddon
9. Advance Mathematics for Engr and Sc, Spiegel, Schaum Series, TMH

MMPD – 102 Advance Machine Design

Unit 1 Introduction to Advanced Mechanical Engineering Design, Review of materials & processes for machine elements, Case studies of mechanical engineering design failures, Review of static strength failure analysis, theories of failure including Von-Mises theory based strength design, Fatigue Strength Design of Mechanical Elements, Exercises of fatigue design of shafting and gears. Surface fatigue design failures. Exercises of surface fatigue design of rolling contact bearings including linear bearings.

Unit 2 Stiffness based design. Design for creep, combined creep and fatigue failure prevention, Tribo-design with applications to design of sliding bearings and mechanical seals, Selection of lubrication systems, Design for corrosion, wear, hydrogen-embrittlement, fretting, fatigue and other combined modes of mechanical failure.

Unit 3 Dynamically sound designs of machine elements like springs and shafts, Introduction to dynamic design of mechanical equipment and its implementation.

Unit 4 Gear and Gear Trains, Synthesis of tooth profile for circular spur gears, noncircular spur gears with constant distance, Generation of logarithmic function, Elliptical gears, equiangular spirals teeth of lion 'circular, Gear trains, Determination of gear train for a given velocity-ratio up to a desired degree of accuracy, Change speed gears, preferred numbers, three shaft, step change of speed, arrangement of change speed gear box.

Unit 5 Cams, Forces in rigid system, Mathematical models, analytical methods, position error, jump, shock, unbalance, spring, surge and winding, Synthesis of cams, High speed cam design, kloomoek and Muffley analytical function of cycloid, harmonic and eigntu power polynomial. Analytical cam design, Analytical ram design, Disc cam with radial flat faced follower, disc cam with radial roller follower and oscillating roller follower, Linkages, Number synthesis , type synthesis dimensional synthesis four bar linkage Freudenstein’s Equation.

References:

I. Budynas Richard, Nisbett JK; Shigly’s mechanical engineering design; TMH
2. Hall AS, Holowenko AR, Laughlin, Somani SK; Schaums outline Machine design; TMH
3. Spotts; Design of machine elements; Pearson Education
4. Juvinall; Fundamentals of machine component design; John Wiley
4. Sharma Purohit; design of machine elements; PHI
5. M.H.Magic, P.W.Oevirk, J.S. Beggs; Mechanism and dynamics of machinery
6. Baggs; Mechanisms -.
7. Dudley; Gears - Hand book
8. Rothbart; Cams -.
9. Ghosh and Malik; Mechanisms and Machines -

MMPD – 103 Material Technology and Failure Analysis

Unit 1 Crystal Structure of Metals: General review of crystal structure of metals, Molecular structure, crystallographic notation of atomic planes, imperfections in crystals, surface imperfections. Electronic Theory of Metals: Electron and Bonding, Bonds in crystals and their effect on the properties of metals, Electron structure of atoms, conductors and insulators and semiconductors.

Unit 2 Elasticity: Thermo-elastic effect, relaxation time, measurement of damping capacity, creep phenomenon, hot and cold working of metals, theories of fracture, fatigue limit and its significance, theory of radiation heat treatment of metals.

Unit 3 Deformation of Metals: Dislocation and slip phenomenon, work-hardening and recrystallization, elastic deformation of metals, atomic basis of elastic behavior.
Plastic deformation of Metals, grain boundary, strain hardening, strain aging strain rate.

Unit 4 FATIGUE: Concepts of fatigue failure, statistical methods, Endurance limit, S.N.diagram, stress strain cycling, Goodman and Gerber relations, and their application to design problems. Review of stress concentration.(Controlling factors)- Effect of frequency of the cyclic stress, effect of temperature, size, form, surface condition, surface protection, residual stresses, corrosion environment fatigue, Fatigue Testing CREEP: Mechanisms of creep, Transient creep, viscous creep. creep fractures, Anaysis of creep curves, stress relaxation, creep tests.

Unit 5 FRACTURE, Historical background, modes of crack displacement, opening mode, sliding mode, tearing node, Stress intensity factor of a crack, stress intensity factor in finite bodies; Fracture criterion Griffith.s fracture stress, Fatigue toughness (Critical stress intensity). Fracture crack propagation, plastic deformation around crack tip, crack opening displacement, Application to design of steam turbine rotor discs, thin walled pressure vessels and thin walled pressure piping.

References:

1. Lessels-J& W; Strength and Resistance of Metals -.
2. Richards; Engg. Material Science-; Prentice Hall.
3. David Brock; Elementary Engg. Fracture Mechanics; Nordhoff
4. A.Mubeen; Advanced Machine Design- -Khanna.
5. The structure and properties of metals- Vol.I,III.IV. Wolf Series.
6. Van Vlack; Element of materials science-.
7. Reed Hill; Physical Metallurgy Principles-.
8. Richards CW; Engg. Material Science
9. Narula; Material Science -

MMPD – 104 Theory of Vibration

Unit 1 Review of single degree freedom free, damped and forced vibration, isolation, Transmissibility; Two degree freedom System: Free vibrations, principal modes of vibration, various examples such as double pendulum, two rotor system torsional oscillations etc, Un-damped forced vibrations with harmonic excitation, Principle of vibration absorbers, un-damped dynamic vibration absorber, tuning of vibration absorber, Torsional vibration absorber system.

Unit 2 Many degrees of freedom systems (Exact analysis): relation between discrete and continuous system, boundary value and Eigen value problems, Un-damped free vibrations. Influence numbers and Maxwell's reciprocal theorem, axial vibration of rods, bending vibration of bars, torsional vibrations of circular shaft and multi-rotor system, vibrations of geared systems, Vibrations of strings.

Unit 3 Finite element and Numerical Methods: Element stiffness matrix and equation of motion, reference system, assembly process, interpolation function, hierarchical FEM and inclusion principle, Rayleigh's method, Dunkerley's method, Stodola's method, Matrix iteration method,

Unit 4 Nonlinear Vibration: Various Examples. Perturbation method, forced vibrations with nonlinear spring forces, Jump phenomenon. Self Excited Vibrations: Elementary idea of stable and unstable oscillations, self excited vibrations caused by dry friction, various examples.

Unit 5 Random Vibration: introduction, ensemble and time averages, probability density function, autocorrelation function, Fourier transform, narrow band and wide band random process, continuous and multi-degree freedom system to random excitation.

References:

I. Grover GK; Mechanical Vibration;
2. Thomson WT; Theory of Vibration with applications; PHI
3. Ambekar; Mechanical vibrations and noise engineering; PHI
4. Dukkipati, sriniwas; Textbook of mechanical vibrations; PHI
5. Meirovitch; Leonard; Fundamentals of VIBRATION; TMH
6. Grahm Keiiy, Kudari Shashidhar K; Schaum outline Mecanical vibrations; TMH
7. Tongue Benson H; Principles of Vibration; Oxford University Press
8. Srinivas P; MECHANICL VIBRATION ANALYSIS
9. Gokhale Nitin S et al, Practical Finite Element Analysis; Finite to Infinite Pub, Pune

MMPD 105 Computer Aided Engineering and optimization

Unit 1 Methods to solve engineering problems- analytical, numerical, experimental, their merits and comparison, discretization into smaller elements and effect of size/ shape on accuracy, importance of meshing, boundary conditions, Computer Aided Engineering (CAE) and design, chain-bumpingstages vs concurrent-collaborative design cycles, computer as enabler for concurrent design and Finite Element Method (FEM), degree of freedom (DOF), mechanical systems with mass, damper and spring, $F(t)= m\, dx_2/dt_2 + c\, dx/dt + k\, x$, stiffness constant K for tensile, bending and torsion; Practical applications of FEA in new design, optimization/ cost-cutting and failure analysis,

Unit 2 Types of analysis in CAE, static (linear/ non linear), dynamic, buckling, thermal, fatigue, crash NVH and CFD, review of normal, shear, torsion, stress-strain; types of forces and moments, tri-axial stresses, moment of inertia, how to do meshing, 1-2-3-d elements and length of elements; force stiffness and displacement matrix, Rayleigh-Ritz and Galerkin FEM; analytical and FEM solution for single rod element and two rod assembly.

Unit 3 Two-dimension meshing and elements for sheet work and thin shells, effect of mesh density and biasing in critical region, comparison between tria and quad elements, quality checks, jacobian, distortion, stretch, free edge, duplicate node and shell normal.

Unit 4 Three-dimension meshing and elements, only 3 DOF, algorithm for tria to tetra conversion, floating and fixed trias, quality checks for tetra meshing, brick meshing and quality checks, special elements and techniques, introduction to weld, bolt, bearing and shrink fit simulations, CAE and test data correlations, post processing techniques

Unit 5 Review of linear optimization, process and product optimization, design for manufacturing (DFM) aspects in product development, use of morphing technique in FEA, classical design for infinite life and design for warranty life, warranty yard meetings and functional roles, climatic conditions and design abuses, case studies.

References:

1.Gokhle Nitin; et al; Practical Finite Element Analysis; Finite to Infinite, 686 Budhwar Peth, Pune.
2.Krishnamoorthy; Finite Element Analysis, theory and programming; TMH
3.Buchanan; Finite Element Analysis; Schaum series; TMH
4.Seshu P; Textbook of Finite Element Analysis; PHI.
5.Desai Chandrakant S et al; Introduction to finite element Method ,
6.Zienkiewicz; The finite element Method; TMH
7.Reddy an introduction to finite element method; TMH
8.Martin and Grahm; Introduction to finite element Analysis (Theory and App.)