

Syllabus for Ph. D. Entrance Examination Department of Mechanical Engg.

(Design)

Imperfections in solids, diffusion mechanisms, dislocations and plastic deformation, strengthening mechanisms. Brittle fracture, Ductile fracture, Fatigue, S-N diagram, theories of fatigue, cumulative fatigue damage, crack initiation and propagation, Effect of different variables on fatigue, Creep, mechanisms of creep, creep fracture.

Geometry of Turbo Machine Blade, Timoshenko Beam, Coupled Vibrations, Ressonance Principle. Dean and Plass Method. Potential Energy Method, Ritz Method, Rayleigh & Ritz Method, Collocation Method, Transfer Matrix Method, FEM approach Central Difference Method, FDM, Random & Nonlinear Vibrations, Holzer's Method, Stodla Method .Matrix Iteration & inversion method.

Introduction to 1-DFEM, Problems in structural mechanics using two dimensional elements; Plane stress, plane strain, Axis-symmetric analysis; three dimensional stress analysis; Solution of heat conduction, fluid flow, vibration, stability, and nonlinear, large scale systems.

Friction, wear and lubrication, Types of Engg. Contacts: Conforming and non-conforming. Types of motion: rubbing sliding, oscillating, Rolling, Surface of interactions : elastic and plastic deformations, properties of materials, surface energy and flash temperature theory. Laws of sliding friction, concept of adhesion, sliding & rolling friction, measurement of friction. Laws of wear, types of wear such as adhesive, declamation, abrasive, fatigue, corrosive, fretting, erosive, electricals and Oxidative Measurement of wear in dry atmosphere and different environments. Prevention and control of wear and friction in machines, wear of cutting tool and dies, study of abrasion in grinding, lapping and honing. Mechanics of lubrication, Boundary, squeeze film hydrodynamic and elasto-hydrodynamic and elasto-hydrodynamic and hydrostatic lubrications, plasto-hydrodynamic lubrication, solution of Reynold's equation in two and three dimensional flow, Pressure distribution load carrying capacity friction forces in oil film and coefficient of friction in journal bearing, Solid lubricants, types and application. Design of Bearings: Clearance in journal bearing, minimum film thickness, Sommarfield Number, Oil grooves and flow of oil in axial and circumferential grooves cavitation and turbulence in oil bearing. Heat generation and cooling or bearing hydrostatic and hydrodynamic and their application in machine tools. Design of air bearing and other gas bearings. Reynold's slip, Heathe Cote concept, selection of roller bearings and their methods of lubrication, design aspects and modes of bearing failures and elasto-hydrodynamic lubrication. Their applications in metal forming processes.

(Production Stream)

Materials properties, Imperfections in solids, diffusion mechanisms, dislocations and plastic deformation, strengthening mechanisms. Brittle fracture, Ductile fracture, Fatigue, S-N diagram, theories of fatigue, cumulative fatigue damage, crack initiation and propagation, Effect of different variables on fatigue, Creep, mechanisms of creep, creep fracture. Heat treatment processes and defects.

Fundamentals of Metal cutting, System of Tool Nomenclature, tool standards, Tool Geometry, Mechanism of Chip formation, Cutting Tools: Tool materials, optimum tool life, tool life equations, Tool life test, machining optimization, Theory of tool wear, Test of Machinability and influence of metallurgy on machinability. Fundamentals of Metal Casting, Characteristics, ingredients and additives of moulding sand, Sand testing, core sands. Nature of cast metals, solidification of metals, Nucleation and growth in metals and alloys, constitutional supercooling, freezing of alloys, centerline feeding resistance, rate of solidification, time of solidification, fluidity. Casting defects : their causes and removal, repair of castings, Special Casting processes. die casting of aluminium and its alloys, brass and bronze.

Welding as a Fabrication and repair process. Solidification structures in weld joints, Various types of welding processes. Electron beam and laser beam welding. Welding equipment, weld joint design, operations, techniques metal fusion and weld penetration.

Fundamentals of Metal Working, elements of the Theory of plasticity, mechanics of metal working, Metallurgical structures, workability, Various metal working processes. Forging, rolling, drawing of rod, wires and tubes, extrusions and sheet metal forming.

Introduction to Production System, generalized model of production systems, Lifecycle concepts in production systems, facilities location and layout planning. Design of mass production systems; balanced assembly lines. Planning of production, systems model of aggregate production planning: Batch production system planning Multistage production inventory system. In process inventory, sequencing and scheduling models, Materials requirement planning. Plant location Factors and theories, Location of plant with multi-plant operations, locational dynamics, transportation model in plant location. Facilities planning, types of layouts. Charts required for facilities planning. Role of templates in plant layout, SPC & Quality control charts, Reliability and maintainability.

Introduction and need of Non-conventional machining Processes, Principle, theory of material removal, Process Parameters, Advantages, Limitation and applications of USM, EDM, LBM, ECM & EBM etc. Rapid Prototyping, Honing, Lapping and Super finishing, physical vapor deposition, chemical vapor deposition, Electroless coating and thermal metal spraying, Fabrication of wafers and micro electronic circuits Machines: component Sequencing, Insertion, PCB Staffing wave soldering.

Introduction to 1-DFEM, Problems in structural mechanics using two dimensional elements; Plane stress, plane strain, Axis-symmetric analysis; three dimensional stress analysis; Solution of heat conduction, fluid flow, vibration, stability, and nonlinear, large scale systems.

(Thermal Stream)

Review of fluid Mechanics and Thermodynamics relevant to theory of Rotodynamics Machine, Energy Transfer between Rotor and Fluid, Euler's equation, Deviation of actual flow from assumed ideal flow, Thermodynamics of Turbo machine, Processes Compression and Expansion Efficiency, Reheat Factor, Overall efficiency for finite number of stages, Basic Steam Cycles used in Steam Turbine Plant, Two Dimensional Flow in Machines, Force due to Fluid flow with circulation and vortices creation of circulation around an aerofoil, Determination of circulation through velocity triangle, Vortex free flow in axial planes, Stream function in vortex free flow, axial symmetric flow in guides and runners, Distribution of meridian velocity in blade-less space with vortex flow. Theory of Axial Flow Machines, Through flow in a straight cascade in the basis of weing's theory and application to axial flow machine, Determination of cascade parameters for given velocity triangles and conversely to determine the velocity triangles from given cascade geometry, Derivation of flow at the outlet of runner, Deflection of Peripheral component of absolute and relative velocities, determination of meridional component of axial machine relative flow through circular cascade for axis symmetric machines, performance characteristics of Axial Flow Machines. Centrifugal Pumps and Compressor, Flow in Impeller channel, Pre-rotation, Inducing Section, Theoretical Analysis and Experimental observation of channel flow, vane and channel shape, Flow in discharge casing, Losses in Pumps and compressors, specific speed as a type characteristic. Operation of Pumps in series and parallel, Surging and choking in compressor, Pump and compressor characteristics Performance of Turbines, Part load and overload characteristics. Turbine and Compressor Matching, Turbine blading and comparison of different type of Turbines, Energy Losses in Turbo machines.

Navierstokes' equations. Potential flow theory and transformation, Flow around bodies, cylinders and aerofoil, Transformation of circle into aerofoil, Prediction of velocity and pressure distribution, boundary layer problems, laminar and turbulent boundary layers, separation criterion, General differential equations of continuity, momentum and energy applied to compressible in viscid fluids, Sonic Velocity, Mach number and propagation of disturbance in a fluid flow. Inentropic flow and stagnation properties, Flow through nozzles and diffusers, Fanno, Reyleigh and isothermal flows through pipes, Normal and oblique shocks, Supersonic expansion by urning, Prandtle-Mcyeer function, Reflection, refraction and intersection of oblique shock waves, Detached shock, Linearization and small perturbation theory. General solutions of supersonic flow, elements of supersonic thin airfoil theory, Method of characteristics for solving non-linear equations, Hodograph method for mixed subsonic and supersonic flow, Wind tunnel and its instrumentation.

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Introduction to 1-DFEM, Problems in structural mechanics using two dimensional elements; Plane stress, plane strain, Axis-symmetric analysis; three dimensional stress analysis; Solution of Heat conduction, Convection and Radiation and their applications.
