MECHANICAL ENGINEERING
SYLLABUS OF EXAMINATIONS
1998 EDITION

For textbook information please refer to the **Textbooks** section on page 3 of the document entitled **Information for Students and Examinations Candidates**.

GROUP A
COMPULSORY EXAMINATIONS (SIX REQUIRED)

98-Mec-A1 Applied Thermodynamics and Heat Transfer

Applied Thermodynamics: Review of fundamental laws and their applications to closed and open systems. Vapour cycles for power and refrigeration; cycle modifications including reheat, regeneration. Gas cycles; spark ignition and compression ignition cycles. Gas turbine cycles, including modifications such as regeneration and intercooling; effects of component efficiency on performance.

Heat Transfer: Conduction in one and two-dimensional systems; steady state and transient regimes. Natural- and forced-convection problems. Radiation heat exchange between black, gray, and real surfaces. hermal design of heat exchangers.

98-Mec-A2 Fluid Mechanics and Applications

Review of basic concepts; elementary two-dimensional potential flow, vorticity and circulation, one-dimensional compressible flow of an inviscid perfect gas, isentropic flow through nozzles, shock waves, frictional compressible flow in conduits, equations of viscous flow, laminar and turbulent boundary layers. Bernoulli's equation and Navier-Stokes equations. Dimensional analysis and similitude. Application to pumps, fans, compressors, hydraulic turbines; pump system matching, pump/turbine similarity analysis, and idealized velocity diagrams and head calculations; limitations due to unsteady flow, stalling, and cavitation.

98-Mec-A3 Kinematics and Dynamics of Machines

Kinematic and Dynamic Analysis: Graphical and analytical methods for kinematic analysis of space mechanisms and elementary body motion in space, static and dynamic force analyses of mechanisms, gyroscopic forces, dynamics of reciprocating and rotating machinery, cam and gear mechanisms and specifications.

Vibration Analysis: Free and forced vibration of underdamped lumped systems with multidegrees of freedom, analytical and numerical techniques of solution, viscous damping, vibrational isolation, vibration measurement and control.

98-Mec-A4 Advanced Strength of Materials

Stress-Strain Analysis: Stress and strain, graphical representation by Mohr's circles of biaxial and triaxial cases, generalized Hooke's law, equations of equilibrium and compatibility, plane strain and plane stress problems.

Euler critical loads for columns, shear flow in beams with thin sections, torsion of non-circular members, shear centre, membrane analogy, thick-walled cylinders and rotating discs, curved beams, contact stresses, strain gauges and application, stress concentrations. Failure theories and limit analysis.

Energy Methods: Strain energy principles, virtual work, Castigliano's theorem. Applications to cases in axial, bending, and torsional loadings. Applications to statically indeterminate problems.

98-Mec-A5 Design and Manufacture of Machine Elements

Stress, strain and material properties. Fundamentals of machining, metal forming, plastic moulding, and powdered metallurgy processes; non-traditional material removal processes: electric discharge machining, laser beam cutting and machining. Load analysis, static body stresses, elastic strain, deflection, and stability. Failure theories, safety factors, and reliability. Fatigue of machine elements, effect of surface treatments, notches, holes, cracks, and other stress raisers. Applications to the design of: threaded fasteners, power screws, bolted connections, welded joints, springs, roller bearings, gears, rotating shafts.

98-Mec-A6 Electrical and Electronics Engineering

Steady state and transient analysis of electric circuits. Time domain and frequency domain analyses. Single phase and polyphase circuits. Introduction to analogue and digital semiconductor devices. Transistor amplifiers and switches. Power semiconductor devices, rectifiers, dc power supplies and voltage regulation. Operational amplifiers and application circuits. Combinational and sequential digital logic circuits. Protection of electrical apparatus and systems. Electrical safety. Practical approach to electronic instrumentation, measurement systems and transducers. Magnetic circuits and transformers, DC machines: motors and generators. AC machines: induction motors, synchronous motors, and alternators. Power factor correction.

GROUP B
ELECTIVE EXAMINATIONS (THREE REQUIRED)

98-Mec-B1 Advanced Machine Design

Stress analysis and design of machine elements under conditions of: shock, impact, inertial forces, initial and residual stresses, corrosion environments, wear, elevated temperatures (creep), and low temperatures (brittle fracture). Hydrodynamic lubrication. Applications to the design of: journal bearings, clutches, brakes, couplings, and linkages. Introduction to probabilistic methods in mechanical design.

98-Mec-B2 Environmental Control in Buildings

Heating, ventilating, and air conditioning: Psychrometrics, heating load, cooling load, comfort, ventilation, and room air distribution. Humidifying and dehumidifying, duct and fan design, piping and pump design. Heating, ventilating and cooling systems, and components. Refrigeration.

Noise control: Sound wave characteristics, measurement instruments. Sources of noise, absorption, and transmission. Free field and reverberant conditions. Noise control techniques in buildings.

Energy management technology: Energy usage in buildings, control systems and instrumentation, lighting systems operation, engineering/economic analysis principles, energy audit procedures.

98-Mec-B3 Energy Conversion and Power Generation

Fuel sources and characteristics: hydrocarbon fuels, nuclear fission and fusion fuels. Fuel reserves. Applications of steam and gas cycles for large scale commercial power generation; combustion of hydrocarbon fuels, theory and practice of fossil fuel boilers, nuclear reactors, steam and gas turbines and hydroturbines. Methods of improving conversion efficiency of power generation systems. Energy storage methods and limitations. Renewable energy methods: wind, solar heating and photovoltaics, hydroelectric, geothermal, ocean thermal energy conversion, waves. Fuel cells.

98-Mec-B4 System Analysis and Control

Open-loop and feedback control. Laws governing mechanical, electrical, fluid, and thermal control components. Mathematical models of mechanical, hydraulic, pneumatic, electric and electronic processes, and control devices. Block diagrams, transfer functions, response of servomechanisms to typical input signals (step function, impulse, harmonic), stability analysis, and stability criteria.

Improvement of system response by introduction of simple elements in the control circuit. Regulation of physical process: proportional, integral, and derivative control. Theory of linear controller design.

98-Mec-B5 Production Planning and Manufacturing

Production Engineering: Production engineering and its role in the management function, product design development and value engineering, planning and control of production. Economic decision models, breakeven and minimum cost analysis, allocation and scheduling of resources. Analysis of plant layout and material handling systems, product range and mix and the effect on plant layout and materials handling, and techniques for facility layout. Types of inspection and inspection procedures.

Design for Manufacturability: Control of quality, principles of design, and measurement of gauges. Analysis of design, use of metrology equipment for testing of flatness, roundness, and concentricity. Measurement of angular surfaces, use of autocollimator and alignment telescope. Analysis of errors, quality assurance, statistical quality control, acceptance sampling. Concepts

of reliability: life, sequential, environmental, and accelerated methods of component testing. Use of statistical and probability theory in determining reliability of components and systems.

98-Mec-B6 Fluid Machinery

Review of dimensional analysis and similitude. Performance characteristics. Specific speed and machine selection. System characteristics and operating point and matching. System regulations, momentum and energy transfer, thermodynamic analysis, and efficiency definitions. Two-dimensional cascade analysis and performance. Axial-flow compressors and turbines, impulse and reaction designs, radial-flow machines, secondary flows and losses. Performance limits due to cavitation.

98-Mec-B7 Aerodynamics of Flight

Review of basic equations of incompressible and compressible flow. Atmospheric characteristics relating to flight; measurement of air speed. Prediction of 2-D lift and drag using momentum and pressure methods; boundary layers and friction drags; dimensional analysis and wind tunnel measurements pertaining to lift and drag; induced drag and total airplane drag. Propulsion systems: turbo-fan and propeller/engine combinations; propulsion efficiency; thrust/power characteristics. Airplane performance; climb rate, time of climb, ceiling, generalized power required curve; range-payload characteristics; turns, take off, and landing; flight performance including stall, structural, and gust envelopes. Static stability and control.

98-Mec-B8 Aircraft Materials and Structures

Behaviour of aircraft materials: Testing of aircraft materials. Working properties of steel and aluminum, magnesium, and titanium alloys. Working properties of plastics and fibre-reinforced composites. Selection of materials. High and low temperature problems. Strength theories for triaxial cases, stress concentration, fatigue analysis and endurance limit, plastic behaviour, residual stresses, creep and stress relaxation. Fatigue and crack propagation.

Design and Analysis of Structures: Torsion of shells and box beams. Bending of thin-walled beams with open and closed sections. Flexural axis, shear lag, effects of stringers and booms. Pressure cabin problems, introduction to dynamic loading, normal modes, response to gust and landing loads. Aeroelastic effects, flutter and divergence.

98-Mec-B9 Finite Element Analysis

Shape functions, derivatives, numerical integration, continuity, convergence, numerical solution of simultaneous equations, weighted residual methods, natural coordinates, Jacobian matrix, accuracy, stability, conversion from continuous to nodal variables, generalized coordinates, imposition of boundary conditions, interpolation. Finite-element application to heat transfer, fluid flow, and stress analysis problems.

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