

Mechanical Engineering Department

School of Engineering

Syllabus for Screening and Written Test for Ph.D. Entrance Examination

Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses. DESIGN: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints, shafts, spur gears, rolling and sliding contact bearings, brakes and clutches.

Engineering Materials: Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

Vibrations: Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints, shafts, various types gears (spur, bevel, helical, worm etc) rolling and sliding contact bearings, brakes and clutches.

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey

surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Power Engineering: Steam Tables, Rankine, Brayton cycles with regeneration and reheat. I.C. Engines: air-standard Otto, Diesel cycles. Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes.

Turbo-machinery: Pelton-wheel, Francis and Kaplan turbines — impulse and reaction principles, velocity diagrams. Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, and drawing) and sheet (shearing, deep drawing, and bending) metal forming processes; principles of powder metallurgy.

Joining: Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

Machining and Machine Tool Operations: Different Machining Processes, Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.

Syllabus for Ph.D. Entrance Examination in Electrical Engineering

Circuits and Networks: Circuit's Elements and Theorems, Transient Response and Steady State Response for Sinusoidal and Arbitrary Inputs, Properties of Networks, Resonant Circuits, Three-phase Circuits, Transfer Function, Two-port Networks, Network Synthesis.

Power Electronics, Electrical Machines & Drives: Electric and magnetic fields and associated laws, DC machines – Separately Excited, Series and Compound Machines, Induction Machines – Squirrel Cage and Wound Rotor, Synchronous Machines, Methods of Speed Control of DC and Induction Machines, Transformers, Testing of Machines, AC/DC Drives, Thyristor controlled reactors, characteristics and applications of power semiconductor devices. PWM techniques, UPS and SMPS, Power semi-conductor devices, Inverters, Converters and choppers

Power Systems: Analysis of Transmission lines, Excitation System, Load Flow analysis, Economic Operation of Power System, Power System Stability and control, Automatic Generation Control, Fault Analysis, Power System Protection, Relays & Circuit breakers, FACTS Devices, power quality, HVDC & HVAC transmission, Electric Power Generation, Power Stations, Renewable Energy Sources and their applications, Energy management systems. Genetic Algorithms, Fuzzy Logic Algorithms, Neural Networks.

Instrumentation and Control: Units, Standards, Electrical measurements, Measurement of resistance, capacitance and frequency, Errors and analysis, Analog and Digital Measuring Instruments, Bridges and Potentiometers, Sensors and Transducers, Electronic measuring instruments, Data Acquisition Systems, Mathematical Modeling of Control Systems, Control System Components-electromechanical, hydraulic and pneumatic components, Transfer Function, Block Diagrams, Signal Flow Graphs, Stability analysis of Linear Systems using Routh array, Nyquist plot, Bode plot and Root locus. State Space Model. P, PI, PID Controllers, Basic concepts of compensator design, Discrete Data Systems, State Variable representation, Digital & Optimal Control systems.

Analog, Digital Circuits and Micro-processors: Semiconductor physics, diodes and transistors, various electronic devices and applications, switching behavior, biasing circuits, frequency response, small signal and large signal amplifiers, multi-stage and feed-back amplifiers, Oscillators. Coupling methods push pull and OPAMs, wave shaping circuits. Multi-vibrators and flip-flops, Digital logic and gates, universal gates, combinational circuits, sequential logic circuits, Counters, registers, ADC/DAC Converters. RAM and ROMs, 80 family Micro-processor architecture, Instruction set and assembly language programming, Interfacing for memory and I/O, Applications of Micro-processors in electrical engineering.

Ph. D Syllabus for Civil Engineering Examination-2018

STRUCTURAL ENGINEERING:

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler's equations of motion; Impulse-momentum; Energy methods; Principles of virtual work.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural steel – composition, material properties and behaviour; Concrete – constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen. Construction Management; Types of construction projects; Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis – PERT and CPM.

Concrete Structures: Working stress, Limit state and ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Pre-stressed concrete; Analysis of beam sections at transfer and service loads.

Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections – simple and eccentric, beam-column connections, plate girders and trusses; Plastic analysis of beams and frames.

WATER RESOURCES ENGINEERING:

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics – Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology – steady state well hydraulics and aquifers; Application of Darcy's law.

Irrigation: Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable

foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

ENVIRONMENTAL ENGINEERING:

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity and characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Syllabus for Ph.D. Examination (GPTR-2018)

AR ARCHITECTURE AND PLANNING

Section 1: Architecture and Design

Visual composition in 2D and 3D; Principles of Art and Architecture; Organization of space; Architectural Graphics; Computer Graphics– concepts of CAD, BIM, 3D modeling and Architectural rendition; Programming languages and automation. Anthropometrics; Planning and design considerations for different building types; Site planning; Circulation- horizontal and vertical; Barrier free design; Space Standards; Building Codes; National Building Code. Elements, construction, architectural styles and examples of different periods of Indian and Western History of Architecture; Oriental, Vernacular and Traditional architecture; Architectural developments since Industrial Revolution; Influence of modern art on architecture; Art nouveau, Eclecticism, International styles, Post Modernism, Deconstruction in architecture; Recent trends in Contemporary Architecture; Works of renowned national and international architects.

Section 2: Building Materials, Construction and Management

Behavioral characteristics and applications of different building materials viz. mud, timber, bamboo, brick, concrete, steel, glass, FRP, AAC, different polymers, composites. Building construction techniques, methods and details; Building systems and prefabrication of building elements; Principles of Modular Coordination; Estimation, specification, valuation, professional practice; Construction planning and equipments; Project management techniques e.g. PERT, CPM etc.

Section 3: Building and Structures Principles of strength of materials; Design of structural elements in wood, steel and RCC; Elastic and Limit State design; Structural systems in RCC and Steel; Form and Structure; Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems; Principles and design of disaster resistant structures.

Section 4: Environmental Planning and Design

Ecosystem- natural and man-made ecosystem; Ecological principles; Concepts of Environmental Impact Analysis; Environmental considerations in planning and design; Thermal comfort, ventilation and air movement; Principles of lighting and illumination; Climate responsive design; Solar architecture; Principles of architectural acoustics; Green Building- Concepts and Rating; ECBC; Building Performance Simulation and Evaluation; Environmental pollution- types, causes, controls and abatement strategies.

Section 5: Urban Design

Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing

Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc. Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Section 7: Planning Techniques and Management

Tools and techniques of Surveys – Physical, Topographical, Landuse and Socioeconomic Surveys; Methods of non-spatial and spatial data analysis; Graphic presentation of spatial data; Application of G.I.S and Remote Sensing techniques in urban and regional planning; Decision support system and Land Information System. Urban Economics; Law of demand and supply of land and its use in planning; Social, Economical and environmental cost benefit analysis; Techniques of financial appraisal; Management of Infrastructure Projects; Development guidelines such as URDPFI; Planning Legislation and implementation – Land Acquisition Act, PPP etc.; Local self-governance.

Section 8: Services, Infrastructure and Transportation

Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.

Urban Infrastructure – Transportation, Water Supply, Sewerage, Drainage, Solid Waste Management, Electricity and Communications.

Process and Principles of Transportation Planning and Traffic Engineering; Road capacity; Traffic survey methods; Traffic flow characteristics; Traffic analyses and design considerations; Travel demand forecasting; Land-use – transportation - urban form inter-relationships; Design of roads, intersections, grade separators and parking areas; Hierarchy of roads and level of service; Traffic and transport management and control in urban areas;; Mass transportation planning; Paratransits and other modes of transportation, Pedestrian and slow moving traffic planning; Intelligent Transportation Systems.

Principles of water supply and sanitation systems; water treatment; Water supply and distribution system; Water harvesting systems; Principles, Planning and Design of storm water drainage system; Sewage disposal methods; Methods of solid waste management - collection, transportation and disposal; Recycling and Reuse of solid waste; Power Supply and Communication Systems, network, design and guidelines.