PhD Entrance test syllabus (50 marks)

School of Engineering & Technology

1. Civil Engineering (50 marks)

Engineering Mechanics: Concurrent, Non-concurrent and parallel forces in a plane, conditions of equilibrium, Principle of virtual work, Area and Mass moment of Inertia, Static Friction, Kinematics and Kinetics of particle and rigid bodies.
Strength of Materials: Simple Stress and Strain, Elastic constants, shear force and bending moment, theory of simple bending, shear Stress, deflection of beams, Torsion of Shafts, Columns
Structural Analysis: Castiglianios's theorems I and I, Slope deflection, moment distribution, rolling loads and Influences lines, Three hinged, two hinged arches, Matrix methods of analysis, Plastic analysis of beams and frames - Finite element Analysis - Theory of Elasticity and Plasticity -Structural dynamics
Structural Steel Design: Riveted, bolted and welded joints, Design of tension and compression member, beams of built-up section, plate girders, gantry girders, Trusses
Building Materials: Classification and testing of bricks, characteristics of good quality stones, IS specifications and tests on cement
Concrete Technology: Quality tests on cement and aggregates, Fresh and Hardened properties on concrete, durability of concrete, special concretes
Fluid Mechanics: properties of fluids, principle of conservation of mass, moment urn, energy and Corresponding equations, potential flow, applications of momentum and Bernoulli's equation
Water Resources: Duty Delta Hydrograph, Irrigation channel hydraulics-Hydropower Environmental Engineering: Water Supply and sanitary aspects - quality and quantity assessment
Transportation Engineering: Highway Planning: Geometric design of Highways, testing and specification of paving materials, design of flexible and rigid pavements. Traffic Engineering: Traffic characteristic, Theory of Traffic flow, intersection design traffic signs and signal design, highway capacity.

2. Mechanical Engineering (50 marks)

Thermal and Fluid Systems (10 marks)
(i) Heat Transfer (ii) Fluid Mechanics (iii) Energy Systems (iv) Advanced Concepts
Manufacturing and Material Science (10 marks)
(i) Manufacturing Processes (ii) Material Science (iii) Welding and Joining (iv)
Composites and Advanced Materials
(v) Metallurgy and Heat Treatment (vi) Quality Control and Testing
Design and Dynamics (10 marks)
(i) Mechanical Design (ii) Dynamics of Machinery (iii) Vibrations (iv) Kinematics and Mechanisms and Stress Analysis
Energy and Power Systems (5 marks)
Thermal Power Systems (ii) Energy Efficiency and Management
Structural and Solid Mechanics (5 marks)
(i) Stress and Strain (ii) Beam and Bending (iii) Structural Stability and Fracture Mechanics
Nanotechnology and Microelectromechanical Systems (MEMS) (5 marks)
(i) Nanotechnology (ii) MEMS Basics (iii) Sensors and Actuators in MEMS
Industrial Engineering (5 marks)
(i) Operations Research (ii) Production Planning and Control (iii) Quality Control

3. Computer Science and Engineering (50 marks)

Programming and Data Structures: Programming in C/C++, recursion, arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs
Algorithm Design: Searching, sorting, asymptotic worst case time and space complexity, algorithm design techniques, graph traversals, minimum spanning trees, shortest paths
Digital Logic: Boolean algebra, combinational and sequential circuits, number representations
Theory of Computation: Regular expressions and finite automata, context-free grammars and push-down automata, pumping lemma, turing machines, undecidability
Compiler Design: Lexical analysis, parsing, syntax-directed translation, intermediate code generation, local optimisation
Operating System: System call, processes, concurrency and synchronization, deadlock, process scheduling, memory management and virtual memory

Databases: Relational algebra, tuple calculus, SQL, integrity constraints, normal forms, file organization, transactions and concurrency control
Computer Networks: Concept of layering, OSI and TCP/IP protocol stacks, basics of packet, framing, error detection, medium access control, routing protocols, IP addressing, network address translation, flow control and congestion control, UDP, TCP, application layer protocols
Artificial Intelligence: State Space Search, knowledge representation and reasoning
Machine Learning: Supervised, unsupervised, reinforcement learning, binary classification, ensemble learning
Blockchain and Cyber Security: Working principle of blockchain network, fundamentals of cyber security

4. Electrical Engineering (50 marks)

Unit 1: Power Systems
Power generation, AC/DC transmission, transmission line and cable models, compensation, insulation, distribution systems and per-unit concepts. Y-bus formation, load flow (GS/NR methods), voltage–frequency control and power-factor correction. Fault analysis, protection (overcurrent, differential, and distance), circuit breakers and system stability including equal area criterion are also included.
Unit 2: Electrical Machines
Single- and three-phase transformers, their tests, efficiency, regulation and parallel operation. Electromechanical energy conversion, DC machine operation, characteristics, starting and speed control. Three-phase and single-phase induction motors, synchronous machines, their performance, regulation, starting and efficiency/loss calculations form the rest of the unit.
Unit 3: Power Electronics
Characteristics and operation of power semiconductor devices such as diodes, thyristors, triacs, GTOs, MOSFETs and IGBTs Single/three-phase rectifiers, line-commutated converters, harmonic issues and power factor. Covers single- and three-phase inverters and sinusoidal PWM.
Unit 4: Electric Circuits
KCL, KVL, node/mesh analysis, transient and steady-state behaviour of RLC circuits, and resonance. Includes passive filters, network theorems (Thevenin, Norton, superposition, maximum power transfer), two port networks, three-phase circuits and AC power/power factor concepts.

Unit 5: Control Systems
Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix

5. Electronics and Communication Engineering (50 marks)

Unit 1: Electronic Devices and Circuits
Semiconductor physics, carrier transport, PN junctions and characteristics of diodes, BJTs, JFETs and MOSFETs. Small-signal and large-signal models, biasing, frequency response and stability of amplifiers. Includes differential amplifiers, current mirrors, operational amplifiers, feedback amplifiers, oscillators, voltage regulators and analog IC building blocks.
Unit 2: Digital Electronics and VLSI
Boolean algebra, logic gates, minimization techniques, combinational and sequential circuits including flip-flops, counters and registers. A/D and D/A converters, timing analysis, FSM design and memory elements. CMOS logic families, stick diagrams, layout rules, propagation delay, power dissipation and scaling concepts. Also covers MOS device modelling, VLSI design flow and testing fundamentals.
Unit 3: Signals and Systems
Continuous- and discrete-time signals, time/frequency domain analysis, convolution, Fourier series and Fourier transform. Laplace and Z-transform, sampling theorem, properties of LTI systems, stability, modulation techniques, and random signals. Includes spectral density, correlation, and basics of digital communication signal representation.
Unit 4: Communication Systems
Analog communications including AM, FM and PM, transmitters/receivers and noise analysis. Digital communication principles—PCM, DPCM, DM, line coding, ISI, equalization, detection and probability of error. Covers ASK, FSK, PSK, QAM, spread spectrum, multiple access (TDMA/FDMA/CDMA/OFDMA), and fundamentals of wireless communication including fading, link budget and basic

MIMO concepts.

Unit 5: Electromagnetics and Microwave Engineering

Vector calculus, static electric and magnetic fields, Maxwell's equations, wave propagation in different media and transmission lines. Waveguides, Smith chart, impedance matching and scattering parameters. Microwave components such as couplers, tees, circulators and isolators. Antenna parameters, radiation patterns, arrays, aperture antennas, and radar basics.