Syllabus for Ph.D. Entrance Test
Department of Electronics and Communication Engineering

The Entrance Test for Ph.D. in Electronics and Communication Engineering will consist of two parts:

- Part-I: Research Methodology
- Part-II: Subject Specific (Electronics and Communication Engineering)

SYLLABUS

PART-I: Research Methodology

Introduction of research methodology: meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India; Research problem: definition, necessity and techniques of defining research problem, formulation of research problem, objectives of research problem; Research design: meaning, need and features of good research design, types of research designs, basic principles of experimental designs, design of experiments, synopsis design for research topic.

PART-II: Subject Specific (Electronics and Communication Engineering)

- **Networks, Signals and Systems**
  Circuit Analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform. Linear 2-port network parameters, wye-delta transformation. Continuous-time Signals: Fourier series and Fourier transform, sampling theorem and applications. Discrete-time Signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

- **Electronic Devices**
  Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier Transport: Diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations. P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

- **Analog Circuits**
  Diode Circuits: Clipping, clamping and rectifiers. BJT and MOSFET Amplifiers: Biasing, AC coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers. Op-amp Circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

- **Digital Circuits**
  Number Representations: Binary, integer and floating-point- numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders. Sequential Circuits: Latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay. Data Converters: Sample and hold circuits, ADCs and DACs. Semiconductor Memories: ROM, SRAM, DRAM. Computer Organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

- **Control Systems**
  Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

- **Communications**
  Random Processes: Auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems. Analog Communications: Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers. Information Theory: Entropy, mutual information and channel capacity theorem. Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver. SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

- **Electromagnetics**
  Maxwell's Equations: Differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector. Plane Waves and Properties: Reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth. Transmission Lines: Equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibres, dipole and monopole antennas, linear antenna arrays