Electronics & Communication Engineering Department
National Institute of Technology Srinagar

Syllabus for Ph. D Entrance Test (2021 Session) for ECE Department

General Aptitude and Mathematics Section – 15 Questions

I. **General Aptitude**

II. **Mathematics:** The calculus of the Finite Difference : Differences, Differences Formulae, Difference table, Operator E, Properties of the operator E and Δ, Leibnitz rule – Interpolation with equal intervals, unequal intervals, Central difference interpretation formulae.; Numerical Differentiation and Integration and Inverse Interpolation; Numerical solution of ordinary difference equations of the first and second order; Simultaneous linear algebraic equations – methods of solution using the inverse of the matrix, method of successive elimination.; Iterative method – gauss Siedel method, Relaxation methods;

III. **Introduction to Finite Element Analysis:** various steps in solving a problem by finite Element Method (displacement approach). Two-dimensional method elements.; Formulation of the finite element method using (i) Principle of virtual work (ii) Minimization of total potential energy of a system, Discrete Element Method.

Core Section: Part A – 15 Questions

I. **Electronic Devices & Circuits:** Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers, p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASER. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process. Small Signal Equivalent circuits of diodes, BJTs and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency

response of amplifiers. Simple op-amp circuits. Sinusoidal oscillators; criterion for oscillation.

II. **Electric Circuits & Networks:** Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin's and Norton's maximum power transfer, 3 phase and Wye-Delta transformation. Transient and Steady state analysis of AC and DC circuits. Time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks. Filters.

Core Section: Part B – 15 Questions

I. **Signals and Systems:** Definitions and properties of Laplace transform, continuous-time and discrete time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

II. **Communications:** Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, super-heterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem, Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA.

Allied Section – 15 Questions

I. **Antennas & Wireless Communications:** Transmission lines- Distortion less & Dissipation less lines, Open and short circuit lines and lines of different lengths. Basic Antenna parameters, Antenna arrays, parabolic reflector, folded dipole. Cellular concepts, frequency reuse, co channel interference, Cell splitting. Radio propagation characteristics; models for path loss, shadowing and multipath fading. Diversity techniques and Rake demodulator. Wave propagation through various media.

II. **Digital circuits:** Boolean algebra, minimization of Boolean functions; logic gates; Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Microprocessor (8085): architecture, programming, memory and I/O interfacing.

III. **Computer Networks:** Review of data communication techniques. Data transmission, line coding, error control coding. Switching. LAN topologies and protocols. MAC protocols, Routing and congestion control. Quality of Service. Network Security: Services, attacks and mechanisms. Cryptography: Secret and Public key. Hash functions, Digital Signatures.

IV. **Computer Organization and Architecture:** Computer cycle control, CPU organization, Memory Organization, I/O organization, Pipelining.

V. **Digital Image processing**: Imaging and imaging devices, Image sampling and Quantization, relationship between pixels and imaging geometry, Image Enhancement techniques: in Spatial Domain and in Frequency Domain, Image Segmentation: using edge detection and edge linking techniques, Image threshold and region-oriented segmentation, Morphological Image processing: Dilation and Erosion, Opening and Closing, The Hit or Miss Transformation, Morphological Algorithms.

VI. **Programming and Data Structures:** Programming in C; Functions, Recursion, Parameter passing, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.