Ph.D. Entrance Examination Syllabus –

Electronics & Communication Engineering

Exam Structure

Part A: Program Specific Core Subjects

Part B: Research Methodology

PART A-PROGRAM SPECIFIC SYLLABUS

Module 1: Networks, Signals and Systems

1. Circuit analysis: nodal, mesh, superposition, Thevenin, Norton, reciprocity
2. Sinusoidal steady-state, phasors, complex power, maximum power transfer
3. Transient analysis of RL, RC, RLC circuits using Laplace transforms
4. Two-port networks and parameter representations
5. Continuous-time signals: Fourier series, Fourier transform, sampling theorem
6. Discrete-time signals: DFT, DTFT, Z-transform
7. LTI systems: causality, stability, convolution, impulse response
8. Poles, zeros, frequency response, group delay, phase delay
9. Aliasing, correlation, spectral leakage, zero padding

Module 2: Electronic Devices

1. Semiconductor physics: energy bands, intrinsic/extrinsic semiconductors
2. Carrier transport: drift, diffusion, mobility, recombination
3. PN junction characteristics and depletion region
4. Zener breakdown mechanism
5. BJT characteristics and current control principle
6. MOS capacitor and MOSFET operating regions
7. Optoelectronic devices: LED, photodiode, solar cell
8. Hall effect measurements
9. Noise mechanisms: thermal noise, shot noise

Module 3: Analog Circuits

1. Diode circuits: clipping, clamping, rectifiers
2. BJT/MOSFET amplifiers: biasing, small-signal analysis, frequency response
3. Differential amplifiers and current mirrors
4. Operational amplifier circuits:
    a) Integrator, differentiator
    b) Active filters
    c) Summers and comparators

    d) Schmitt trigger
5. Oscillators: Wien bridge, crystal oscillators, phase noise
6. Amplifier concepts:
    a) Gain-bandwidth product
    b) Negative feedback
    c) Slew rate
    d) CMRR
    e) Power amplifier efficiency (Class A)
7. PLL fundamentals and blocks

Module 4: Digital Circuits and Systems

1. Number systems and representations
2. Boolean algebra and logic minimization (K-maps)
3. CMOS logic implementation
4. Combinational circuits: MUX, decoders, arithmetic circuits
5. Sequential circuits:
    a) Latches, flip-flops
    b) Counters, shift registers
    c) Finite state machines
6. Timing concepts:
    a) Propagation delay
    b) Setup/hold time
    c) Clock skew
    d) Metastability
    e) Hazards
7. Memories: ROM, SRAM, DRAM
8. Data converters: ADC, DAC, sample-and-hold
9. Computer organization:
    a) ALU, datapath, instruction cycle
    b) Pipelining
    c) Cache memory
10. Digital design technologies:
    a) FPGA architecture
    b) ASIC concepts
    c) Hardware description languages (VHDL)

Module 5: Control Systems

1. Modeling of systems
2. Transfer functions and block diagrams
3. Signal flow graphs
4. Stability analysis:
    a) Routh criterion
    b) Nyquist criterion
    c) Bode plots
    d) Root locus

5. Gain margin and phase margin
6. Time-domain specifications
7. Compensation techniques: lag, lead, lag-lead
8. State-space analysis:
    a) State variables
    b) Controllability
    c) Observability
    d) State equations

Module 6: Communication Systems

1. Random processes and noise
2. Autocorrelation and PSD
3. Analog communication:
    a) AM, FM, modulation/demodulation
    b) Superheterodyne receiver
    c) Image frequency
4. Information theory:
    a) Entropy
    b) Channel capacity
5. Digital communication:
    a) PCM, DPCM
    b) ASK, PSK, FSK, QAM
    c) ISI and eye diagram
    d) Matched filter detection
    e) BER and SNR
    f) MAP and ML detection
6. Error control coding: Hamming codes, CRC
7. Spread spectrum and diversity techniques
8. RF front-end concepts:
    a) Mixers
    b) LNA
    c) Noise figure

Module 7: Electromagnetics

1. Maxwell’s equations (integral and differential forms)
2. Boundary conditions
3. Wave equations and propagation
4. Plane waves and polarization
5. Phase velocity and group velocity
6. Skin effect and skin depth
7. Transmission lines:
    a) Characteristic impedance
    b) VSWR
    c) Matching techniques
    d) Smith chart

8. Waveguides: cutoff frequency
9. Optical fiber propagation basics
10. Antennas:
    a) Radiation resistance
    b) Gain and directivity
    c) Dipole and monopole antennas
    d) Antenna arrays
    e) Microstrip antennas

PART B — RESEARCH METHODOLOGY

1. Research problem identification
2. Literature survey techniques
3. Research design
4. Hypothesis formulation
5. Data analysis basics
6. Interpretation of results
7. Academic ethics and plagiarism
8. Technical paper writing
9. Citation methods
10. Experimental validation
11. Reproducibility
12. Intellectual property basics