PhD Entrance Test (ECE) Syllabus (2025)

1. Engineering Mathematics

- Basic matrix operations and types of matrices
- Rank of a matrix and elementary transformations
- Eigenvalues and eigenvectors
- First-order and second-order differential equations
- Basics of Laplace transform and standard formulas
- Basics of Fourier transform and simple properties
- Partial differentiation and simple optimization
- Basics of Z-transform and ROC
- Simple Fourier series expansions
- Basic convolution concepts (time-domain)

2. Basic Network Theory & Signals

- Ohm’s law, KVL, KCL
- Series and parallel RLC circuits
- Nodal and mesh analysis
- Basic network theorems: Thevenin, Norton, Superposition
- Fundamental resonance concepts in RLC circuits
- Basic two-port concepts (Z, Y parameters)
- Introduction to network functions
- Basic filters: low-pass, high-pass
- Types of signals: energy, power signals
- Basic system properties: linearity, time-invariance

3. Analog Electronics

- PN diode basics and simple rectifier circuits
- Zener diode regulation
- BJT operation in CE configuration
- FET (JFET/MOSFET) characteristics
- Biasing methods (CE biasing, voltage divider)
- Low-frequency small-signal models
- Feedback concept (positive and negative)
- RC-coupled amplifier basics
- Sinusoidal oscillators: RC and LC basics
- Power amplifiers: Class A and Class B introduction

4. Digital Electronics & Basic VLSI

- Number systems and conversions
- Boolean algebra laws and simplification
- Karnaugh map (up to 4 variables)
- Basic combinational circuits: MUX, DEMUX, encoder, decoder
- Half-adder and full-adder design
- Flip-flops: SR, JK, D, T basics
- Counters: asynchronous and synchronous
- Shift registers and simple applications
- Introduction to FPGA and ROM/RAM
- Basic CMOS logic functions

5. Signals and Systems

- Classification of signals (CT, DT)
- LTI system basics
- Convolution
- Fourier series basics
- Fourier transform properties
- Laplace transform basics
- Sampling theorem and aliasing
- Basic Z-transform fundamentals
- ROC concept
- Frequency response basics

6. Digital Signal Processing

- Discrete-time signals and sequences
- Linear convolution and circular convolution
- Difference equations
- DFT definition and basic properties
- Basics of FFT (Decimation-in-time overview)
- Spectrum analysis fundamentals
- FIR filter characteristics
- IIR filter basics
- Simple windowing techniques
- Sampling and quantization basics

7. Communication Systems

- Basics of AM (modulation index, simple spectra)
- FM basics (frequency deviation, bandwidth approximation)
- PM introduction
- Pulse modulation: PAM, PWM, PPM basics
- PCM: quantization and encoding
- Digital modulation basics: ASK, FSK, PSK
- Noise basics: SNR concept
- Basic error probability ideas
- Multiplexing (TDM/FDM) overview
- Bandwidth requirements for basic modulations

8. Control Systems (Introductory)

- Open-loop and closed-loop systems
- Transfer function basics
- Block diagram reduction
- Time response of first-order systems
- Time response of second-order systems
- Stability concept introduction
- Routh-Hurwitz basics (simple arrays)
- Bode plot basics (magnitude/phase idea)
- Root-locus concept (qualitative)
- Basic PID controller idea

9. Electromagnetics & Microwave Basics

- Vectors and coordinate systems
- Gauss and Ampere law
- Maxwell's equations
- Wave propagation basics (lossless/lossy medium idea)
- Transmission line fundamentals
- Reflection coefficient and basic Smith chart reading
- VSWR concept
- Waveguides (rectangular waveguide basics)
- Microwave diode basics (Gunn diode)
- Basic antennas (dipole, monopole overview)

10. Wireless Communication & Intro to VLSI

- Free-space path loss
- Fading types: multipath, shadowing
- Basic propagation models (Okumura/Hata overview)
- Cellular concept basics: reuse, handoff
- GSM/CDMA overview
- Basics of OFDM
- CMOS inverter basics
- Static CMOS design rules
- Basic layout concepts (stick diagrams)
- Combinational CMOS gate basics