

Part B - Syllabus

ELECTRONICS AND COMMUNICATION ENGINEERING (ECE)

Electronic Devices and Circuits: Semiconductor physics: energy bands, carrier concentration, drift and diffusion; p-n junction: characteristics and models; BJT and MOSFET: structure, operation, and small-signal models; biasing and stability; diode applications: rectifiers, clippers, clampers, and voltage regulators; special devices: Zener, tunnel diode, SCR, IGBT, and UJT; frequency response of amplifiers; multistage amplifier design.

Analog Circuits: Single-stage amplifier configurations: CE, CB, CC; feedback amplifiers: types, effects on gain, bandwidth, and stability; op-amp characteristics: ideal and practical; op-amp applications: inverting/non-inverting amplifiers, integrators, differentiators, Schmitt trigger, and comparators; oscillators: Barkhausen criterion, RC, LC, and crystal oscillators; active filter design: Butterworth and Chebyshev; waveform generators; voltage regulators: linear and switching.

Digital Electronics and Logic Design: Number systems and code conversions; Boolean algebra: theorems and De Morgan's laws; Karnaugh maps and Quine-McCluskey minimisation; combinational circuits: adders, multiplexers, encoders, and decoders; sequential circuits: SR, JK, D, and T flip-flops; registers, counters, and state machines; Mealy and Moore models; memory: SRAM, DRAM, ROM, Flash, EEPROM; HDL: VHDL and Verilog basics; FPGA architecture.

Signals and Systems: Continuous-time and discrete-time signals; LTI systems: impulse response and convolution; CTFT, DTFT, DFT, and Z-transform; Laplace transform; sampling theorem and aliasing; correlation functions; power spectral density; causality and stability; signal reconstruction; modulation and demodulation fundamentals.

Control Systems: Transfer functions and block diagram reduction; signal flow graphs; time-domain analysis: transient response and steady-state error; frequency-domain analysis: Bode plot, Nyquist plot, and Nichols chart; stability: Routh-Hurwitz criterion and root locus; compensator design: lead, lag, and PID; state variable analysis; controllability and observability; digital control systems.

Communications Engineering: Amplitude, frequency, and phase modulation; DSB-SC, SSB, and VSB; pulse modulation: PAM, PPM, PDM, PCM; digital modulation: ASK, FSK, BPSK, QPSK, QAM, and OFDM; noise in communication systems: SNR, noise figure; superheterodyne receiver; information theory: entropy, mutual information, channel capacity, and Shannon-Hartley theorem; error control coding: Hamming, cyclic, convolutional, and turbo codes.

Electromagnetics and Transmission Lines: Electrostatics and magnetostatics; Maxwell's equations; EM wave propagation; plane waves: polarisation and reflection; transmission lines: characteristic impedance, VSWR, reflection coefficient; Smith chart; impedance matching; waveguides: modes and cutoff frequency; antenna parameters: gain, directivity, and radiation pattern; dipole, loop, and array antennas; radio wave propagation modes.

VLSI Design: CMOS logic design: static and dynamic gates; VLSI fabrication: lithography, oxidation, diffusion, and metallisation; IC design flow: RTL, synthesis, placement, and routing; low-power design techniques; timing analysis: setup and hold; testing and verification; FPGA vs ASIC design trade-offs; DFT techniques: scan chains and BIST; advanced technologies: FinFET and SOI.

Digital Signal Processing: DFT and IDFT; FFT algorithms: DIT and DIF; FIR filter design: windowing and frequency sampling methods; IIR filter design: Butterworth and Chebyshev, bilinear transformation; multirate signal processing: decimation and interpolation; adaptive filters: LMS and RLS algorithms; spectral estimation; DSP processor architecture; real-time DSP implementation.

NRIU Ph.D. ENTRANCE EXAMINATION : 2026-26

Microprocessors and Embedded Systems: 8085/8086 architecture: registers, instruction set, and memory organisation; 8051 microcontroller: timers, interrupts, and serial communication; ARM Cortex-M: architecture and programming; interfacing: ADC, DAC, LCD, and keyboard; RTOS concepts: tasks, scheduling, and inter-process communication; embedded C programming; peripheral drivers; bootloaders and firmware updates; IoT integration basics.

Wireless and Advanced Communication: Cellular systems: 2G, 3G, 4G LTE, and 5G NR; CDMA and TDMA; OFDM and MIMO technologies; spread spectrum: FHSS and DSSS; satellite communication: link budgets, orbital mechanics, and transponders; optical fibre communication: multimode and single-mode fibre, attenuation, and dispersion; WDM systems; antenna diversity and beamforming; cognitive radio; IoT and M2M communication.