Faculty of Engineering & Technology
Research Entrance Test (RET)
Syllabus: Electronics and Communication Engineering

SECTION A: RESEARCH METHODOLOGY

Unit-1: Engineering Mathematics

Matrix theory, Eigen values & Eigen vectors, system of linear equations, Numerical methods for solution of non-linear algebraic equations and differential equations, integral calculus, partial derivatives, maxima and minima, Line, Surface and Volume Integrals. Fourier series, linear, non-linear and partial differential equations, initial and boundary value problems, complex variables, Taylor's and Laurent's series, residue theorem, probability and statistics fundamentals, Sampling theorem, random variables, Normal and Poisson distributions, correlation and regression analysis.

Unit-2: Computer Fundamentals

Number systems, Boolean algebra, arithmetic functions, Basic Architecture, Central Processing Unit, I/O and Memory Organization; peripheral devices, data representation and programming, basics of Operating system and networking, virtual memory, file systems; Elements of programming languages, typical examples.

Unit-3: VHDL and ASIC Design

ASIC Design flow, Design Methodologies, Introduction to Hardware Description Language (VHDL): Structural, Behavioral, Data flow modeling, Concurrent and sequential VHDL, RAM and ROM, Test Benches, Finite State Machines, RTL Synthesis Test Methodology, Programmable Logic Design, Basics of Programmable logic devices, CPLD, Architecture and its building blocks, FPGA Architectures and its building blocks, Technology mapping for FPGAs, Design implementation using CPLD and FPGA, Floor planning and Placement.

Unit-4: MATLAB Electronics Applications

Fourier analysis, Fourier transforms and applications.

Unit-5: Research Report and Ethics :

Research attitude & Choosing Research Problem; Different types of scientific writing (thesis, paper, review, proposal, CV, Cover letter, popular article); Communicating Science (research journalism, lecture, poster); IPR, Plagiarism, use of computers, search engines, language and grammar, answering in interviews, Basic Statistical Concept.

Ph.D. Entrance Examination:2025-26

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Unit 1: Electronic Devices and Circuits: Introduction to Semiconductor, energy bands in solids, concept of effective mass, density of states, Fermi levels. PN Junction, Diode equation and diode equivalent circuit, Breakdown in diodes, Zener diode, Tunnel diode, Metal semiconductor junction – Ohmic and Schottky contacts, Characteristics and equivalent circuits of JFET, MOSFET. Low dimensional semiconductor devices – quantum wells, quantum wires, quantum dots. High Electron Mobility Transistor (HEMT). Solar cells – I-V characteristics, fill factor and efficiency, LED, LCD and flexible display devices.
Emerging materials for future Devices: Graphene, Carbon Nano tubes (CNT), ZnO, SiC etc.

Unit 2: VLSI Design and Technology: IC fabrication – crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding and packaging. MOS technology and VLSI, scaling of MOS devices, NMOS and CMOS structures and fabrication. Characteristics of MOS transistors and threshold voltage, NMOS and CMOS inverters, Charge-Coupled Device (CCD) – structure, charge storage and transfer, Basics of VLSI design, stick diagrams, Layout design rules, Pass Transistor logic, Transmission gate, Dynamic MOS design: pseudo NMOS logic, clocked CMOS (C2 MOS) logic, domino logic, NORA.

Unit 3: Networks, Signals and Systems: Superposition, Thevenin, Norton and Maximum Power Transfer Theorems, Network elements, Network graphs, Nodal and Mesh analysis. Laplace Transform, Fourier Transform and Z-transform. Time and frequency domain response, Passive filters, Two-port Network Parameters: Z, Y, ABCD and h parameters, Transfer functions, Signal representation, State variable method of circuit analysis, AC circuit analysis, Transient analysis, Zero and Poles, Bode Plots.
Continuous time signals, Fourier Series and Fourier transform representations, Sampling theorem and applications, Discrete time signal, Discrete Fourier transform (DFT), Fast Fourier transform (FFT), DTFT, Basic concepts of digital signal processing, digital filters – IIR, FIR.

Unit 4:Analog Circuits: Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and FETs, operating point and stability, Amplifiers, Classification of amplifiers, Concept of feedback, Hartley, Colpitt's and Phase Shift oscillators, Operational amplifiers (OPAMP) - characteristics, computational applications, comparators, Schmitt trigger, Instrumentation amplifiers, wave shaping circuits, Phase locked loops, Active filters, Multivibrators, Voltage to frequency convertors (V/F), frequency to voltage convertors (F/V).

Unit 5: Digital Electronics: Logic Families, Logic Gates, Boolean algebra and minimization techniques, Combinational circuits, Programmable Logic Devices (PLD), CPLD, flip-flops, Sequential Circuits: Counters – Ring, Ripple, Synchronous,

Asynchronous. Shift registers, multiplexers and demultiplexers, A/D and D/A converters. Analysis and Design of fundamental mode state machines: State variables, State table and State diagram. Semiconductor Memories: ROM, SRAM, DRAM. Sequential PLD, FPGA, Analysis and Design of digital circuits using HDL.

Unit 6: Microprocessors and Microcontrollers: Introduction of Microprocessor 8086: Architecture. Addressing modes, instruction set, interrupts, Programming, Memory and I/O interfacing.
Introduction of Microcontrollers – 8051 for embedded systems. Architecture and register set of Microcontroller 8051, Addressing modes, Instruction set of 8051 – Data transfer instructions, Arithmetic instructions, Logic instructions, bit level and byte level control transfer instructions, 8051 assembly programming – stack operations, subroutines, interrupts, 8051 programming as timer/counter, 8051 serial communication, 8051 interfacing RS232, LED/LCD display, Keyboard, Stepper motor.

Unit 7: Electromagnetics: Electrostatics - vector calculus, Gauss's Law, Laplace and Poisson's equations. Magnetostatics – Biot Savert's law, Ampere's law and electromagnetic induction. Maxwell's equations and wave equations, Plane wave propagation in free space, dielectrics and conductors, Poynting theorem, Reflection and refraction, polarization, interference, coherence and diffraction, Transmission lines and waveguides – line equations, impedance, reflections and voltage standing wave ratio, rectangular waveguides. Antennas – retarded potential and Hertzian dipole, half wave antenna, antenna patterns, radiation intensity, gain, effective area and Friis's free space receiver power equation.
Microwave Sources and Devices -Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode.
Radar – block diagram of Radar, frequencies and power used,
Radar range equation. Waveguide modes, Light propagation
in optical fibers.

Unit 8: Communications: Analog modulation and demodulation - AM, FM and PM, Principle of super heterodyne receiver, Random signals, noise, noise temperature and noise figure. Basic concepts of information theory, Error detection and correction, Digital modulation and demodulation – PCM, ASK, FSK, PSK, BPSK, QPSK and QAM, Time and Frequency-Division Multiplexing, Multiple Access techniques, Data Communications – Modems, Codes, Principles of Mobile and Satellite Communication, Optical communication, Optical sources - LED, spontaneous and stimulated emission, semiconductor Lasers, Detectors – PIN photodiodes, Avalanche photodiodes (APD), Optical fibers – attenuation and dispersion characteristics, Bandwidth, Wavelength division multiplexing, ISI, TDMA, FDMA, and CDMA.
Fundamentals of Internet of Things (IoT) for communication.

Unit 9: Control Systems: Control Systems-Classification of signals and systems; Application of signal and system theory; System realization; Transforms& their applications; Signal flow graphs, Routh-Hurwitz criteria, root loci, Nyquist/Bode plots; Feedback systems-

open & closed loop types, stability analysis, steady state, transient and frequency response analysis: Design of control systems, compensators, elements of lead/lag compensation, PID and industrial controllers.

Unit 10: Electronic Measurements & Instrumentation: Transducers – Resistance, Inductance, Capacitance, Piezoelectric, Thermcelectric, Hall effect, Photoelectric, Measurement of displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH. Measuring Equipment – Measurement of R, L and C, Bridge and Potentiometers, voltage, current, power, energy, frequency/time, phase, Digital Multimeters, CRO, Digital Storage Oscilloscope, Spectrum Analyzer, Sensors for IoT applications.