Syllabus for Ph.D. Admission Written Test (ECE)

Part A

Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, Eigen values and eigen vectors, rank, solution of linear equations- existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.

Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability.

Quantitative Aptitude

Data interpretation: data graphs (bar graphs, pie charts, and other graphs representing data), 2- and 3-dimensional plots, maps, and tables Numerical computation and estimation: ratios, percentages, powers, exponents and logarithms, permutations and combinations, and series Mensuration and geometry Elementary statistics and probability

Analytical Aptitude: Logic: deduction and induction, Analogy, Numerical relations and Reasoning.

Signals and systems: LTI systems, Fourier series, Fourier transform, Laplace transform and Z-transforms.

Basic Electrical Engineering: Circuits and Networks, PN diode, BJT transistors.

Basics of C-programming

Part B

Section I

Autonomous Electric Vehicles (AEV)

Power electronics: DC-DC converters (Non-isolated and Isolated), Rectifiers, Inverters. Control systems: Modelling of servo motor, Time domain analysis, Frequency domain analysis, Bode plots, Design of P PI and PID controllers, Basics of state space representation

Section II

Communication Systems

Digital modulations and demodulations: BPSK (Binary Phase shifts keying), QPSK, 8-PSK, M-ary PSK; M-ary ASK, OOK; FSK, CPFSK, MSK, GMSK.
Symbol Error Rate and Bit Error Rate formulations for different Digital Modulations.
Introduction to optimum coherent and non-coherent receivers.

Section III

VLSI Design

Semiconductors, p-n junctions, Metal – Semiconductor Junction, Schottky Barrier Diode, Schottky, and Ohmic contacts, Band Diagrams, MOS capacitors: Surface potential, Accumulation, Depletion and Inversion, Band Diagram, Flat Band Voltage, Polysilicon-gate work function and depletion effects, Threshold voltage, MOS under non-equilibrium, Oxide charges, C-V characteristic of the MOS Capacitor. Basic MOSFET behavior and analysis, I-V characteristics, different regions of operations, body effect, channel length modulation, Limitation of long channel analysis, short-channel effects.

MOS Inverters: Static Characteristics; CMOS Inverter; V-I characteristics; Switching Threshold; Noise Margin; Effect on CMOS characteristic by W/L ratio, threshold voltage, and process, voltage, temperature (PVT).

Combination MOS Logic: CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates); Dynamic Logic Circuits: Basic Principles of Pass Transistor Circuits: Working Principle, V-I Characteristics.

Overview of different types of memories: SRAM, DRAM, CAM, ROMs. Node Transition Activity and Power, Glitching or Dynamic Hazards, Techniques to Reduce Activity, Path Balancing for Glitches.

Section IV

Smart Grid and Storage Technology

Smart grids, basics of renewable energy systems, energy storage systems applications, grid integration of storages.

Section V

Embedded Systems

Representation of Embedded Systems – Finite State Machines, State Charts, Process Networks. Sensors and Actuators – Sensors (principles, characteristics, errors, calibration), Signal

Conditioning, Actuators, driving signals and circuits. Computing components – Microprocessors, Microcontrollers, FPGA, DSP etc. Embedded Communication – characteristics, topology, medium access, addressing, protocols (UART, SPI, I2C, CAN). Coding – For any microcontroller that you have studied in your undergraduate or graduate studies.

Section VI

Computer vision

Digital Image Fundamentals: Image representation, image sampling and quantization, key stages in digital image processing, intensity transformations, histogram processing.

Machine Learning: Introduction to ML, Types of Learning Paradigms: Supervised and Unsupervised Learning, ML workflow, challenges in ML.