Ph. D Written Test Format and Syllabus

Electrical Engineering, Faculty of Engineering

Ph.D. Admission Test Format

The written test consists of two parts.

1. **Part A:** Research Methodology 25 questions.
2. **Part B**: EE 25 questions

Part A: Research Methodology Syllabus:

Research Fundamentals:

Meaning of research; objectives of research; characteristics of good research, Research problem: Identification, selection, and techniques for defining research problem, Research process, Research outcomes, Review of Literature, Hypothesis: Definition and Types

Types of Research:

Types of research, fundamental and applied research, qualitative and quantitative. Research Design: Types of research design – Exploratory, Descriptive, Casual Analytical

Sampling, Data Collection and analysis:

Types and sources of data: Primary and secondary, Methods of collecting data: questionnaire, interview, observation, case study, experiments etc., Sampling and sampling methods, characteristics of good sample, sampling techniques, Statistical Methods for Data Analysis: measures of central tendency and dispersion

Research Report:

Main body of report, abstract and keywords, Referencing styles and bibliography. Journal and author indexing

Ethics in Research:

Biasing: Definition and Types, Plagiarism -Definition and forms, IPR, copyright infringement, AI Generated Content

Part B: Electrical Engineering Syllabus

Electric circuits:

The course covers electrical network analysis, including ideal and dependent sources, RLC elements, KCL, KVL, node and mesh analysis, and network theorems such as Thevenin's, Norton's, Superposition, and Maximum Power Transfer. It also includes transient and steady-state analysis, resonance, two-port networks, three-phase circuits, and power calculations. Electromagnetic field topics include Coulomb's law, Gauss's law, capacitance, magnetic circuits, Faraday's law, and inductance, Fourier series and transforms, and calculation of RMS and average values of periodic waveforms.

Electrical Machines:

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics; Operating principle of single-phase induction motors; Synchronous machines: cylindrical and salient pole machines; Special Machines: stepper motors, servo motors, BLDC motors, PMSM, switched reluctance motors, hysteresis motors, linear motors, and universal motors including construction, operating principles, characteristics, control methods, and industrial applications.

Power Systems:

Basic concepts of electrical power generation, AC and DC transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss- Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion. Optimization techniques in power systems covering economic load dispatch, unit commitment, optimal power flow, renewable energy integration, and stability enhancement.

Control Systems:

Laplace and Z transforms, sampling theorem, Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, Solution of state equations of LTI systems.

Power Electronics:

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of AC to DC converters; Single-phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation. electrical drives, motor control techniques, braking methods, speed control, drive dynamics and industrial applications.