Syllabus for Qualifying Test for the Post of Assistant Professor (EE)

1. ELECTRIC DRIVE SYSTEM

Unit 1: Dynamics of Electric Drives: Fundamentals of torque equation. Speed torque convention and multi-quadrant operation, components of load torque.

Unit 2: Classification of load torques steady state stability. Load equation, Speed control and drive classification. Close loop control of drives.

Unit 3: DC motor Drives-Modeling of DC machines. Steady state characteristics with armature and speed control. Phase controlled DC motor drives, chopper controlled DC motor drives.

Unit 4: Poly-phase induction machines- Dynamic modeling of induction machines. Small signal equations, control characteristics of induction machines. Phase-controlled induction machines. Stator voltage control. Slip energy recovery scheme, frequency control and vector control of induction motor drives.

Unit 5: Traction motor: Starting. Speed-Time characteristics. Braking. Traction motors used in practice.

Unit 6: Industrial Drives-Digital Control of Electric Drives. Stepper motor. Servo motor and their Applications.

2. MODELING AND ANALYSIS OF ELECTRICAL MACHINES

Unit 1: Principles of Electromagnetic Energy Conversion. General expression of stored magnetic energy. Co-energy and force/torque, example using single and doubly excited system.

Unit 2: Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

Unit 3: Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form. Application of reference frame theory to three phase symmetrical induction and synchronous machines. Dynamic direct and quadrature axis model in arbitrarily rotating reference frames.

Unit 4: Determination of Synchronous machine dynamic equivalent circuit parameters. Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

Unit 5: Special Machines - Permanent magnet synchronous machine. Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle. Dynamic modelling and self-controlled operation.

Unit 6: Analysis of Switch Reluctance Motors. Brushless D.C. Motor for space Applications. Recent trends.

3. POWER ELECTRONIC CONVERTERS

Unit 1: Analysis of power semiconductor switched circuits with R, L, RL, RC loads. D.C. motor load. Battery charging circuit.

Unit 2: Single-Phase and Three-Phase AC to DC converters. Half controlled configurations-operating domains of three phase full converters and semi-converters. Reactive power considerations.

Unit 3: Analysis and design of DC to DC converters. Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converters, Cuk converters.

Unit 4: Single phase and three phase inverters. Voltage source and Current source inverters. Voltage control and harmonic minimization in inverters.

Unit 5: AC to AC power conversion using voltage regulators. Choppers and cyclo-converters. Consideration of harmonics, introduction to Matrix converters.

Unit 6: Design aspects of converters, Few practical applications.

4. DIGITAL CONTROL OF POWER ELECTRONICS AND DRIVE SYSTEMS

Unit 1: Review of numerical methods. Application of numerical methods to solve transients in D.C. Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.

Unit 2: Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with AC supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

Unit 3: State space modelling and simulation of linear systems. Introduction to electrical machine modelling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

Unit 4: Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers. Converters with self-commutated devices- simulation of power factor correction schemes.

Unit 5: Simulation of converter fed DC motor drives. Simulation of thyristor choppers with voltage. Current and load commutation schemes. Simulation of chopper fed DC motor.

Unit 6: Simulation of single and three phase inverters with thyristors and self-commutated devices. Space vector representation. Pulse-width modulation methods for voltage control. Waveform control. Simulation of inverter fed induction motor drives.