

## EE 302: ELECTRICAL MACHINES II (3-1-2: 5)

### **Polyphase Induction Machines**

Construction, principle of operation, slip, phasor diagram, equivalent circuits, expression for torque, and output power, slip torque characteristics, effect of variation of supply voltage and rotor resistance on the characteristics, circle diagram, predetermination of characteristics from the circuit diagram, drawing circle diagram from design parameters and no load and blocked rotor test data, starting of induction motors, direct on line starter, star-delta starter and autotransformer starter for cage induction motor, rotor resistance starter for slip ring induction motor, speed control of induction motor by varying supply voltage, supply frequency and pole changing, speed control of slip ring induction motor by rotor resistance.

### **Special Machines**

High torque induction motor, double cage and deep bar rotor construction, mains operated and self-excited induction generators, hysteresis motor, reluctance motor and stepper motor, brushless motors.

### **Single Phase Induction Motors**

Principle of operation, double revolving field theory, equivalent circuit, performance calculations and characteristics, starting methods, maximum starting torque conditions.

### **Synchronous Machines**

Types of Exciters for synchronous machines, MMF and EMF phasor diagrams for cylindrical rotor synchronous machines, armature reaction, open and short circuit characteristics, leakage reactance, synchronous reactance, phasor diagram under loaded conditions, load characteristics, predetermination of regulation by EMF and Potier triangle methods for non-salient pole alternators, steady state power flow equations, power angle characteristics, constant excitation and constant power output, circle diagram for synchronous machines. two reaction theory for salient pole alternators and pre-determination for regulation, slip test, V curves, inverted V curves, compounding curves for synchronous motors, synchronizing power, synchronizing torque, hunting phenomenon, starting of synchronous motor, synchronous condenser.

### **Parallel Operation of Alternators**

Synchronizing, Synchroscope, parallel operation of alternators, alternator on infinite bus-bar, effect of change of excitation and prime mover inputs, expressions for power developed as a function of torque angle, maximum power.

### **Suggested list of Experiments:**

1. No load, blocked rotor and load test on a three phase induction motor
2. No load, blocked rotor and load test on a single phase induction motor
3. Open circuit, short circuit and ZPF tests of alternator and estimation of regulation by various methods
4. Synchronization and V-curves of a synchronous motor
5. Parallel operation of alternators
6. Speed control of 3-phase induction motor using variable voltage, variable frequency sinusoidal source

7. Study of starters for A C motors
8. Operation of induction machine as an isolated generator-estimation of suitable capacitance for self-excitation,
9. Stepper motor characteristics

**Test Books**

1. P S Bhimbra, "Electrical Machinery", Khanna Publishers.
2. Fitzgerald, Kingsley and Uman, "Electrical Machinery", TMH.

**References**

1. A S Langsdorf, "Theory of A.C. Machines", PHI.
2. M G Say, "The performance and Design of Alternating current-machines".