

Subject: Electrical Machines and their Applications
Time: 3 hours.

Paper : EE 305
Branch : CST
Full Marks : 70

Answer six questions taking not more than three from each half

Figures in the margin indicate marks

(i) All questions carry equal marks

(ii) Two marks are reserved for neatness in each half

First Half

1. a) Briefly explain the speed control methods of a dc series motor using *field flux control*. Discuss their relative merits and demerits. [5]

b) A 230V dc series motor has an armature resistance of 0.2Ω and a field resistance of 0.1Ω . At rated voltage the motor draws a line current of 40A and runs at a speed of 1000rpm. Find the speed of the motor for a line current of 20A at 230V. Assume that field flux at 20A line current is 20% of the flux at 40A line current. [6]

2. a) Which part of the losses of a dc series motor is constant? Derive the condition for achieving maximum efficiency in a dc shunt motor. [6]

b) A 250 V, 15KW, shunt motor has a maximum efficiency of 88% and at a speed of 700 rpm, when delivering 80% of its rated output. The resistance of the shunt field resistance is 100Ω . Determine the efficiency of the motor when it draws a current of 78 A from supply mains? [5]

3. a) An induction motor cannot run at synchronous speed, why? [4]

b) A 220V, 3-phase, 4-pole, 50 Hz squirrel cage induction motor develops a maximum internal torque of 250% of its full load torque at a slip of 16%, when operating at rated voltage and frequency. If the effect of the stator impedance is neglected, determine the maximum internal torque that the motor would develop, if operating at 220V, 60 Hz. Under this condition, at what speed, would the maximum torque be developed? [7]

4 (a) A 240V d.c. shunt motor has armature & field circuit resistances of 0.04Ω and 100Ω respectively. Compute what resistances must be added in the field winding to increase the speed from 1200 rpm to 1500rpm, when the supply current is 20A. [6]

(b) The rotor of a 6-pole, 50 Hz, three-phase slip-ring induction motor has a resistance of 0.2Ω per phase and runs at 960 rpm on full load. Calculate the resistance per phase to be inserted in the rotor circuit such that speed is reduced to 800 rpm, the torque being same as before. [5]

5. Write short notes on any two of the following : [$5\frac{1}{2} \times 2$]

a) Speed control of Induction Motors

- b) Testing of DC motors
- c) Ward-Leonard method of speed control.

Second Half

Answer any THREE questions taking at least TWO questions from **Group-A** and ONE question from **Group-B**

Group- A

- 6 a) The primary side of a 3-phase step down transformer is energized from 11KV, 50Hz supply. If the line current drawn by the transformer from the supply mains is 20A, calculate the secondary side line voltage and secondary side phase current, for each of the following connections:
- (i) Delta-star
 - (ii) Delta-zigzag. [5]
- b) What are the different methods of three-phase to six phase conversion? Explain them briefly with the help of phasor diagrams. [6]
- 7 a) In a pair of Scott-connected transformers, show that if load is balanced on the two phase side, it is also balanced on the three phase side. [5]
- b) Two single phase furnaces I & II are supplied at 100 V by means of Scott connected transformers. Furnace I takes a load of 300 kW at unity power factor and is supplied by teaser transformer secondary. Furnace II takes the load of 200 kW at 0.8p.f. lagging and is supplied by main transformer secondary. Determine the primary line currents if the input voltage is 3 phase, 11kV, 50Hz. [6]
8. a) In the light of double revolving field theory explain why a single winding single phase Induction Motor does not have any starting torque. Sketch the torque speed characteristic of such motor. [5]
- c) What are the different methods of starting a single phase induction motor employing split-phase configuration? Explain with a neat diagram the operation of a single phase capacitor start capacitor run Induction Motor. Which capacitor has the higher value, the start or run capacitor? Give reasons. [6]

Group B

9. A 3-phase induction motor runs at 999 rpm at no load and 948 rpm at full load when supplied with power from a 50Hz 3-phase supply.
- (i)How many poles the motor has? *At full load:* (ii) What is the per-cent slip? (iii) What is the corresponding frequency of rotor voltages? (iv)What is the corresponding speed of the rotor field with respect to rotor? (v) What is the corresponding speed of

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rotor with respect to the stator? (vi) What is the corresponding speed of the rotor field with respect to stator field? [11]

10. (a) What is meant by *Constant Power Drive* and *Constant Torque Drive*? Explain how a dc motor can be adopted for these types of drive. [6]

(b) A 220V shunt motor has armature resistance of 0.5Ω and takes a current of 40A at full load. By how much must the main field flux be changed to raise the speed by 50%, if the developed torque is constant? [5]