Roll No.:......................

National Institute of Technology, Delhi

Name of the Examination: B. Tech.

Branch	: Electrical & Electronics Engg.	Semester	: V
Title of the Course	: Electrical Machines-II	Course Code	: EE302

Time: 3 Hours Maximum Marks: 50

SECTION-A (10 Marks)

Note: All parts of this question are compulsory and carry one mark each. Answer should be precise and to the point.

Q1.

- **i.** Potier's method uses OCC and ZPFC to yield information about __________.
- **ii.** Explain the constructional features and benefits of deep bar and double squirrel cage rotors.
- **iii.** What is skewing and why is it done?
- **iv.** Classify the different types of losses taking place in any rotating electrical machine.
- **v.** Which parameters are considered while defining the ratings of synchronous machines?
- **vi.** Explain the process of separating our core losses from friction and windage losses.
- **vii.** What is cogging and crawling in an induction motor.
- **viii.** The power factor of a synchronous motor is better than that of induction motor because:
  (a) stator supply is relieved of responsibility of producing magnetic field
  (b) mechanical load on the motor can be adjusted
  (c) synchronous motor runs at synchronous speed
  (d) synchronous motor has large air gap
- **ix.** A synchronous machine with low value of short-circuit ratio has:
  (a) lower stability limit (b) high stability limit
  (c) good speed regulation (d) good voltage regulation
- **x.** A synchronous motor connected to infinite bus-bars operates at constant full load, 100% excitation and unity power factor. On changing the excitation only, the armature current will have:
  (a) no change of power factor
  (b) lagging power factor with over-excitation
  (c) leading power factor with under-excitation
  (d) leading power factor with over-excitation

SECTION-B (20 Marks)

Note: Attempt any four questions, each question carries 5 marks.

Q2. Explain the operation of synchronous motor at constant load and variable excitation with neatly drawn suitable phasor diagrams. What is the significance of the conclusions drawn.

Q3. Draw neat and clear phasor diagrams representing the operation of three-phase induction motor operating under (a) stationary condition and (b) operation at slip 's' for lagging power factor condition.

Q4. A 600 V, 6-pole, 3-phase, 50 Hz, star-connected synchronous motor has a resistance and synchronous reactance of 0.4 W and 7 W respectively. It takes a current of 15 A at upf when operating with a certain field current. With the field current remaining constant, the load torque is increased until the motor draws a current of 50 A. Find the torque (gross) developed and the new power factor.

Q5. A 6.6 kV star connected three-phase synchronous motor is operated at constant voltage and constant excitation. Its synchronous impedance is 1.5+j12 ohms per phase. When the input power is 1000 kW, the power factor is 0.8 leading. Find the power factor when input is increased to 1500 kW. Draw clear phasor diagram, if required.

Q6. A 10 kW, 400 V, 3-phase induction motor has full load efficiency of 0.87 and power factor of 0.85. A standstill and at rated voltage, the motor draws 5 times its full-load current and develops a starting torque of 1.5 times its full-load torque. An auto-transformer is installed to reduce the starting current and to give full-load torque at starting. Neglecting exciting current of auto-transformer, determine at the time of starting:

(a) The voltage applied to the motor terminal.
(b) The current drawn by the motor.
(c) The line current drawn from the supply mains.

SECTION-C (20 Marks)

Note: Attempt any two questions, each question carries 10 marks.

Q7. Explain the procedure for determination of synchronous reactance through open circuit and short circuit characteristics. Also explain what short circuit ratio is and what short circuit losses are. Draw neat diagrams wherever necessary.

Q8. A 1000 kVA, 3-phase, 11 kV, star-connected synchronous motor has negligible resistance and a synchronous reactance of 35 ohm per phase. (a) What is the excitation emf of the motor if the power angle is 10° and the motor takes rated current at: (i) lagging power factor, and (ii) leading power factor. (b) What is the mechanical power developed and the power factor in part (a)? (c) At what power angle will this motor operate if it develops an output of 500 kW at the rated line voltage and with an excitation emf of 10 kV (line)? What is the corresponding power factor? (d) What is the minimum excitation at which the motor can deliver 500 kW at the rated line voltage without losing synchronism?

Q9. A 10 kW, 400 V, 3-phase, 50 Hz slip ring induction motor develops rated output at rated voltage and frequency with slip rings short circuited. The maximum torque equal to twice the full-load torque occurs at a slip of 10% with zero external resistance in the rotor circuit. Stator resistance and rotational losses are neglected. Determine:
(i) slip and rotor speed at full load torque, (ii) rotor ohmic losses at full-load torque, (iii) starting torque at rated voltage and frequency, (iv) starting current in terms of full load current, (v) stator current at maximum torque, in terms of full-load current and (vi) full-load efficiency. The rotor resistance is now tripled, for same full-load torque find (vii) slip at maximum torque, (viii) full-load slip and rotor speed, and (ix) starting toque.

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