

ELECTRICAL MACHINES
(ELEC 3133)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 × 1 = 10
- (i) The armature of d.c machine is made of
(a) Silicon steel (b) wrought iron
(c) cast steel (d) soft iron.
- (ii) In a d.c. series motor torque is
(a) directly proportional to I_a (b) directly proportional to I_a^2
(c) inversely proportional to I_a (d) not dependent on I_a
- (iii) In a 4-pole, 50 Hz, 3-phase induction motor running at 1485 rpm with a rotor copper loss of 2 kW, the rotor input is
(a) 100 kW (b) 200 kW
(c) 50 kW (d) none of these.
- (iv) Which motor has the best speed regulation
(a) series (b) cumulative compound
(c) shunt (d) differentially compound.
- (v) By open circuit test of a Single Phase Transformer, we determine
(a) hysteresis loss (b) eddy current loss
(c) both hysteresis and eddy current loss (d) copper loss.
- (vi) The primary and secondary of a transformer are coupled.
(a) electrically (b) magnetically
(c) both (a) and (b) (d) none of the above.
- (vii) A transformer has full load copper loss of 400 W. The copper loss at half full load will be
(a) 100 W (b) 200 W (c) 400 W (d) 300 W.

- (viii) The relationship between the rotor frequency f_2 , slip s and the stator supply frequency f_1 is given by
(a) $f_1 = sf_2$ (b) $f_2 = sf_1$
(c) $f_2 = (1-s)f_1$ (d) $f_1 = (1-s)f_2$.
- (ix) The starting torque of 3 phase induction motor is..... supply voltage.
(a) independent of
(b) directly proportional to
(c) directly proportional to square of
(d) none of the above.
- (x) At the time of starting of a d.c. motor, back emf (E_b) is
(a) maximum (b) equal to V
(c) zero (d) none of these.

Group - B

2. (a) Draw the operating characteristics of d.c series generator(only graph).
(b) With the help of suitable characteristics show how voltage can build up in d.c shunt generator.
(c) What is critical field resistance and critical speed? 4 + 4 + 4 = 12
3. (a) Explain why starting current is high in a DC motor.
(b) Explain in brief the working principle of a three point starter.
(c) A 50 kW, shunt generator is running at 400 r.p.m. on 250 V bus. Its gear breaks suddenly and the generator starts running as a motor consuming 5 kW. Find the speed of the machine. Armature resistance is 0.3 Ω and shunt field resistance is 250 Ω . Neglect the armature reaction effect. 2 + 5 + 5 = 12

Group - C

4. (a) Derive the emf equation of a single phase transformer.
(b) Draw the phasor diagram of a single phase transformer operating with lagging load.
(c) A single phase 2200/250 V, 50 Hz transformer has a net core area of 36 cm² and a maximum flux density of 1.5 wb/m². Calculate the no. of turns of primary and secondary. 4 + 4 + 4 = 12

5. (a) Derive the condition of maximum efficiency of single phase transformer.
- (b) A 200 KVA, 50 Hz, 220/11000 V, single phase transformer has an efficiency of 98.2% when supplying full load at 0.8 lagging power factor and an efficiency of 99% when supplying half full load at unity power factor. Calculate core and copper losses at full load. At what load will the efficiency be maximum?

$$4 + 8 = 12$$

Group - D

6. (a) Write down the different types of 3 phase induction motor.
- (b) What is slip? A 6 pole 3 phase induction motor is connected to 50 Hz supply. If it is running at 970 rpm, find the synchronous speed, slip and rotor current frequency.
- (c) Explain with derivations how the rotating magnetic field is produced in a 3 phase induction motor?

$$2 + 4 + 6 = 12$$

7. (a) Write down the different power stages of 3 phase induction motor.
- (b) Draw the phasor diagram and equivalent circuit of 3-phase induction motor.
- (c) The power input to the rotor of 440V, 50 Hz, 6 pole induction motor is 80 KW. The rotor emf is observed to make 100 complete alternations per minute. Calculate (i) the slip, (ii) the rotor speed, (iii) the mechanical power developed, (iv) the rotor copper loss per phase, (v) the rotor resistance per phase if the rotor current is 65 A.

$$3 + 4 + (1 + 1 + 1 + 1 + 1) = 12$$

Group - E

8. (a) Why the Synchronous Motor is not self-starting?
- (b) Explain the working principle of Synchronous Motor.
- (c) Write down the application of Synchronous Motor.

$$3 + 6 + 3 = 12$$

9. Write short notes on any two of the following: $(2 \times 6) = 12$
- (i) Stepper motor
- (ii) A.C servomotor
- (iii) Tachogenerator