ELECTRICAL MACHINES
(MECH 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 DC generator works on the principle of
(a) Fleming's left hand rule (b) Fleming's right hand rule
(c) Lenz's law (d) None of these.

(ii) In DC generator armature reaction is produced by
(a) field current (b) armature current
(c) both (a) and (b) (d) none of these.

(iii) The DC series motor has a relatively
(a) high starting torque (b) medium starting torque
(c) low starting torque (d) zero starting torque.

(iv) The EMF generated by a DC generator depends on
(a) flux (b) speed
(c) flux and speed (d) terminal voltage.

(v) When an induction motor is standstill, the slip is
(a) zero (b) 1
(c) infinity (d) none of these.

(vi) By open circuit test of a single phase transformer, we determine
(a) iron loss (b) regulation
(c) leakage impedance (d) copper loss.

(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) 400W (d) 300 W.

(viii) The relation among synchronous speed (N_S), rotor speed (N) and slip(s) is _____
(a) $N = (s-1)N_S$ (b) $N = (1-s)N_S$
(c) $N = (1+s)N_S$ (d) $N = s\,N_S$

(ix) A 4-pole, 50-Hz induction motor runs at a speed of 1440 RPM. The frequency of rotor current is
(a) 3 Hz (b) 2.5 Hz (c) 2 Hz (d) 1 Hz.

(x) An induction motor works with
(a) DC only (b) AC only
(c) both DC and AC (d) none of the above.

Group – B

2. (a) Derive the EMF equation of a DC machine.

(b) With the help of suitable characteristics, show how voltage can build up in DC shunt generator.

(c) What are critical field resistance and critical speed?

3 + 5 + 4 = 12

3. (a) What is back EMF?

(b) Derive the torque equation of a DC motor.

(c) A 230V DC shunt motor runs at 1000 RPM on full load drawing a current of 10A. The shunt field resistance is 230Ω and the armature resistance is 0.5Ω. Calculate the resistance to be inserted in series with the armature so that the speed at full load is 950 RPM.

2 + 6 + 4 = 12

Group – C

4. (a) Draw the phasor diagram and equivalent circuit of 1-phase transformer at lagging PF load.

(b) A 25 kVA, 2000/200 V transformer has the iron loss and full load copper loss of 350 W and 400 W respectively. Find the efficiency at unity PF at (a) full load and (b) half full load. Also determine the load at which maximum efficiency occurs and its maximum efficiency.

6 + 6 = 12

5. (a) A 200 kVA, 2000/440 V, 50-Hz single-phase transformer gave the following test results : -
O.C test: 2000V, 1.8A, 1.75 kW .....on H.V. side.

S.C test: 13V, 300A, 1 Kw .....on L.V side.
Obtain the equivalent circuit as referred to H.V. side.

(b) Derive the condition for zero and maximum voltage regulation.

(c) Calculate the % voltage regulation of a transformer in which the percentage resistance drop is 1% and percentage reactance drop is 5% when the power factor is (i) 0.8 lagging (ii) unity and (iii) 0.8 leading.

6 + 3 + 3 = 12

Group – D

6. (a) Write down the different types of 3-phase induction motor.

(b) What is slip? The frequency of the EMF in the stator of a 4-pole induction motor is 50 Hz and that in the rotor is 1.5 Hz. Find the slip and speed of the motor.

(c) Write down the working principle of a 3-phase induction motor.

2 + (2 + 3) + 5 = 12

7. (a) Derive the condition of maximum torque of a 3-phase induction motor.

(b) Draw and explain the torque-slip characteristics of a 3-phase induction motor.

(c) The input power of a 6-pole, 3-phase induction motor is 42 kW. The speed of the motor is 970 RPM. The stator losses are 1.2 kW and friction and windage losses are 1.8 kW. Find (i) The rotor copper loss and (ii) the efficiency of the motor.

4 + 4 + 4 = 12

Group – E

8. (a) Derive EMF equation of an alternator.

(b) Define pitch factor and distribution factor.

(c) A 3-phase, 50 Hz, 8-pole alternator has a star connected winding with 120 slots and 8 conductors per slot. The flux per pole is 0.05Wb. (sinusoidally distributed). Determine the phase and line voltages.

4 + 4 + 4 = 12

9. (a) Draw the equivalent circuit and phasor diagram of a synchronous motor for lagging, leading and unity PF load.

(b) Draw the V-curves of synchronous motor with proper explanations.

(c) What is synchronous condenser?

6 + 4 + 2 =12