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) Wave winding is suitable for_____current, _____voltage d.c. generator.
(a) high, low (b) low, high
(c) low, low (d) high, high

(ii) The most economical method of finding no load losses of a large d.c. shunt motor is
(a) Hopkinson's test (b) Swinburne's test
(c) Retardation test (d) Field's test.

(iii) The T-I_a characteristics of a d.c. series motor is
(a) Straight line throughout
(b) Rectangular hyperbola
(c) Parabola up to full load and straight line at overloads
(d) Drooping characteristics.

(iv) The essential condition for parallel operation of two single phase transformers is that they should have same
(a) polarity (b) KVA rating
(c) voltage ratio (d) percentage impedance.

(v) The main purpose of performing short circuit test on a transformer is to measure its
(a) copper loss (b) core loss
(c) total loss (d) insulation resistance.

(vi) In an ideal transformer
(a) winding have no resistances (b) core has no losses
(c) core has infinite permeability (d) all of (a), (b) and (c).

(vii) The efficiency of a transformer is maximum when its
(a) Iron loss=Copper loss (b) Iron loss>Copper loss
(c) Iron loss<Copper loss (d) none of (a), (b) and (c).

(viii) The value of slip of a 3 phase induction motor during plugging is
(a) 0 (b) 1
(c) 2-s (d) 2+s.

(ix) At what r.p.m a 6 pole alternator is to be driven in order to generate a voltage at 50 Hz
(a) 3000 r.p.m (b) 1500 r.p.m
(c) 1000 r.p.m (d) 750 r.p.m.

(x) In a synchronous motor, damper winding is provided in order to
(a) stabilize rotor motion (b) suppress rotor oscillations
(c) develop necessary starting torque (d) both (b) and (c).

Group – B

2. (a) Derive the emf equation of a dc generator.

(b) The shunt generator gives full load output of 30 KW at a terminal voltage of 200 V. The armature and field resistances are 0.05 Ω and 50 Ω respectively. The iron and friction losses are 1000 W. Calculate (i) generated emf, (ii) copper losses and (iii) efficiency of the machine.

(c) What do you mean by armature reaction in a d.c. machine?

4 + 6 + 2 = 12

3. (a) Derive the torque equation of a dc motor.

(b) A shunt generator delivers 50 KW at 250 V when running at 400 rpm. The armature and field resistances are 0.02 Ω and 50 Ω respectively. Calculate the speed of the machine when running as a motor and taking 50 KW input at 250 V. Allow 1 V voltage drop per brush.

(b) Explain why the starter is needed for starting of a dc motor.

4 + 6 +2 = 12

Group – C

4. (a) Derive the EMF equation of a transformer.

(b) A 25 KVA single phase transformer has 500 turns on the primary and 40 turns on the secondary winding. The primary is connected to 3000 V, 50 Hz supply. Determine (i) the secondary emf, (ii) primary and secondary currents at full load and (iii) the maximum flux in the core.

(c) Draw and explain the phasor diagram of a transformer operating under lagging power factor load.

4 + 4 + 4 = 12

5. (a) Draw the phasor diagram and circuit diagram of a Yd_1 connected three phase transformer.

   (b) Derive the condition of maximum efficiency of a transformer.

   (c) A transformer is rated at 100 kVA. At full load its copper loss is 1400 W and iron loss is 940 W. Calculate the efficiency of transformer (i) at full load, unity power factor and (ii) at half load, 0.8 power factor lagging.

4 + 4 + 4 = 12

Group – D

6. (a) Explain the working principle of a 3 phase induction motor.

   (b) Derive the expression of torque for a 3 phase induction motor and hence find out the condition for maximum torque.

   (c) Draw the torque slip characteristics of a 3 phase induction motor.

5 + (4 + 2) + 1 = 12

7. (a) Explain the various methods of braking for 3 phase induction motor.

   (b) A 6 pole, 50 Hz induction motor has no load speed of 980 rpm and full load speed of 960 rpm. Calculate: (i) synchronous speed, (ii) no load slip, (iii) full load slip, (iv) frequency of rotor induced emf at full load, (v) frequency of rotor current at no load and (vi) frequency of rotor current at stand still.

6 + 6 = 12

Group – E

8. (a) Derive an expression of distribution factor of alternator.

   (b) A 3 phase, 6 pole, star connected alternator revolves at 1000 r.p.m. The stator has 90 slots and 8 conductors per pole. The flux per pole is 0.05 Wb (sinusoidally distributed). Calculate the line and phase induced voltage voltages if the winding factor is 0.96.

5 + 7 = 12

9. (a) Explain the brief working principle of a synchronous motor.

   (b) Explain the effect of field current variation in 3 phase synchronous motor and hence draw the v-curve.

5 + 7 = 12