

**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) A commutator in a dc generator is used for
 (a) converting ac to dc (b) converting dc to ac
 (c) collecting the current from armature (d) reducing friction.
- (ii) In d.c generator armature reaction is produced by
 (a) field current (b) armature current
 (c) both (a) and (b) (d) none.
- (iii) In a series motor, the field flux before magnetic saturation is
 (a) directly proportional to the armature current
 (b) nearly constant
 (c) inversely proportional to the armature current
 (d) proportional to the square of the armature current.
- (iv) When induction motor is standstill, the slip is
 (a) zero (b) 1 (c) infinity (d) none of these.
- (v) DC series motors are used in those applications where _____ is required.
 (a) high starting torque (b) constant speed
 (c) no load speed (d) none of the above.
- (vi) 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) $f_1 = (1-s)f_2$
- (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 relation among synchronous speed (N_s), rotor speed (N) and slip 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) An open circuit test on a transformer is performed to determine
 (a) Cu loss (b) iron loss
 (c) leakage impedance (d) regulation.
- (x) For lap wound d.c. motor, no. of parallel path is equal to
 (a) 2 (b) no. of poles
 (c) no. of armature conductors (d) none of these.

Group - B

2. (a) Derive the emf equation of dc machine.
 (b) A 6-pole lap wound dc generator has 250 armature conductors, a flux of 0.04 Wb per pole runs at 1200 rpm. Find the generated emf.
 (c) What is armature reaction?
4 + 4 + 4 = 12
3. (a) Draw the characteristics (T_a/I_a , N/I_a , N/T_a) of dc shunt motor (only graph).
 (b) Write down the field flux control of dc series motor.
 (c) A 250 V, shunt motor has an armature resistance of 0.5 Ω and a shunt field resistance of 250 Ω. When running on no load, it takes 5 A from the lines and its speed is 1500 rpm. Calculate the speed, when taking 50 A from the lines.
4 + 4 + 4 = 12

Group - C

4. (a) Draw the phasor diagram of 1-phase transformer at lagging p.f load and also draw the equivalent circuit.
 (b) A 20 kVA, 2000/200 V, 50 Hz single phase transformer gave the following test results:-
 O. C test: 200 V, 1 A, 120 W
 S. C test: 60 V, 10 A, 300 W.
 Find (i) efficiency of the transformer at half full load and 0.8 p.f. lagging.
 (ii) maximum efficiency and the load at which it occurs at the same p. f.
6 + 6 = 12

5. (a) Write down the different types of losses of single phase transformer.
- (b) Derive the condition of maximum efficiency of single phase transformer.
- (c) A 100 KVA, 50 Hz, 440/11000 V, single phase transformer has an efficiency of 98.5% when supplying full load current at 0.8 lagging power factor and an efficiency of 99% when supplying half full load current at unity power factor. Calculate core and copper losses at full load current.

$$2 + 4 + 6 = 12$$

Group - D

6. (a) What is slip of an induction motor? What is the frequency of its rotor current?
- (b) A 3-phase, 50 Hz, induction motor runs at 950 rpm. Calculate (i) the synchronous speed (ii) slip and (iii) frequency of the rotor emf.
- (c) Write down the working principle of 3-phase induction motor.

$$(2 + 2) + 4 + 4 = 12$$

7. (a) Draw the Torqui-Slip characteristics of 3-phase induction motor.
- (b) Draw the equivalent circuit of 3-phase induction motor.
- (c) The power input to a 3-phase induction motor is 60 kW. The stator losses 1 kW. Find the total mechanical power developed and the rotor Cu loss per phase if the motor is running with a slip of 3%.

$$4 + 4 + 4 = 12$$

Group - E

8. (a) Draw the phasor diagram of a synchronous generator for lagging, leading and unity p.f. load.
- (b) A 500V, 50 kVA single phase alternator has an effective armature resistance of 0.2 Ω . A field current of 10 A produces 200 A armature current on short circuit and an emf of 450 V on open circuit. Calculate the synchronous impedance and synchronous reactance.

$$8 + 4 = 12$$

9. Write short notes on the following: $(2 \times 6) = 12$
- (i) stepper motor
- (ii) AC servomotor