B.TECH/ME/5TH SEM/MECH 3133/2021

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) Lap winding is suitable for _____ current, _____ voltage d.c. generator
(a) high, low (b) low, high (c) low, low (d) high, high.

(ii) The T-Ia 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.

(iii) 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.

(iv) In an ideal transformer
(a) winding have no resistances (b) core has no losses
(c) core has infinite permeability (d) all of the above.

(v) A 200 KVA transformer has an iron loss of 1 KW and full load copper loss of 2 KW. The KVA delivered by the transformer corresponding to maximum efficiency is
(a) 100 KVA (b) 141.4KVA (c) 50KVA (d) 200 KVA.

(vi) In three-phase squirrel-cage induction motors
(a) Rotor conductors are kept open
(b) Rotor conductor ends are short-circuited through slip rings
(c) Rotor conductors are short-circuited through end rings
(d) Rotor conductors are connected to the insulation.

(vii) What is the ratio of rotor input power to rotor copper loss in an induction motor?
(a) 1/(1-s) (b) 1/s (c) s (d) 1-s

(viii) The condition for maximum running torque is
(a) $R_2 = sX_2$ (b) $R_2 = X_2$
(c) $R_2 = X_2/2$ (d) $R_2 = s \times (X_2/2)$.

(ix) What happens if the field winding of the synchronous motor is short-circuited?
(a) First, starts as induction motor then run as synchronous motor
(b) Not start
(c) Motor will burn out
(d) Run as induction motor.

(x) For power factor correction, synchronous motors operate at
(a) No load with over-excited fields
(b) No load with under-excited fields
(c) Normal load with minimum excitation
(d) Normal load with zero excitation.

Group – B

2. (a) Sketch and explain the load characteristics of dc shunt generator. [(CO1) (Analyze/IOCQ)]
(b) An 8 pole generator has 600 armature conductors and has a useful flux per of 0.06wb. What will be the generated emf if it is lap wound and runs at 1000rpm? What must be the speed at which it is to be driven to produce the same emf if it is wave wound? [(CO1) (Evaluate/HOCQ)]
(c) What do you mean by critical speed and critical field resistance of a dc shunt generator? [(CO1)(Remember/LOCQ)]

4 + 4 + 4 = 12

3. (a) What do you mean by back emf? [(CO2)(Remember/LOCQ)]
(b) Sketch and explain the speed vs torque and speed vs armature current characteristics of a dc series motor. [(CO2) (Analyze/IOCQ)]
(c) A 450V dc series motor runs at 500rpm taking a current of 40A. Evaluate the speed and percentage change in torque if the load is reduced so that the motor is taking a current of 30A. The total armature and field resistance is 0.8Ω. Assume that the flux is proportional to the field current. [(CO2) (Evaluate/HOCQ)]

2 + 5 + 5 = 12

Group – C

4. (a) Discuss briefly about the open circuit test of transformer. [(CO3)(Understand/LOCQ)]
(b) Derive the condition of maximum efficiency of a transformer. [(CO3)(Analyze/IOCQ)]

(c) A 11KV/400V distribution transformer takes a no load primary current of 1A at a power factor of 0.24 lagging. Estimate (i) core loss current, (ii) magnetizing current, (iii) iron loss of transformer. [(CO3)(Evaluate/HOCQ)]

4 + 5 + 3 = 12

5. (a) Describe the phasor diagram of transformer working under lagging power factor load. [(CO3) (Understanding/LOCQ)]
   (b) Construct an equation for regulation of transformer operating under lagging power factor load. [(CO3) (Apply/IOCQ)]
   (c) A 75kVA transformer has 500 turns on primary and 100 turns on secondary. The primary and secondary winding resistances are 0.4Ω and 0.02Ω respectively and corresponding leakage reactances are 1.5Ω and 0.045Ω respectively. The supply voltage is 2200 volts. Determine the voltage regulation at full load 0.8 power factor lagging. [(CO3) (Evaluate/HOCQ)]

4 + 5 + 3 = 12

Group – D

6. (a) Explain the principle of operation of a three phase induction motor. [(CO4)(Remember/LOCQ)]
   (b) Demonstrate why an induction motor cannot run at synchronous speed. Why must slip be present for motor action? [(CO4)(Analyze/IOCQ)]
   (c) If an 8 pole three phaseinduction motor running from a supply of 50 Hz has an emf in the rotor of frequency 1.5 Hz. Determine the slip and speed of the motor. [(CO4)(Evaluate/HOCQ)]

4 + (3 + 2) + 3 = 12

7. (a) Explain how regenerative braking is carried out in an induction motor. [(CO4)(Understand/LOCQ)]
   (b) Examine the method of speed control foran induction motor by stator voltage controller. [(CO4)(Analyze/IOCQ)]
   (c) The stator loss of a 3 phase induction motor is 2 kW. When the power input is 90 kW what will be the rotor mechanical power developed and rotor copper loss if the motor is running with a slip of 4%. [(CO4)(Evaluate/HOCQ)]

4 + 5 + 3 = 12

Group – E

8 (a) List various parts of a synchronous generator and draw a neat cross sectional diagram showing its various parts. [(CO5)(Remember/LOCQ)]
   (b) Construct the emf equation of synchronous generator. [(CO5) (Apply/IOCQ)]
   (c) Investigate the effect of field current variation in a synchronous generator. [(CO5)(Analyze/IOCQ)]

4 + 5 + 3 = 12

9. (a) Explain why a 3 phase synchronous motor is not a self-starting. Hence explain how starting torque is produced. [(CO6) (Remember/LOCQ)]

(b) Demonstrate how synchronous motor can be used for power factor improvement. [(CO6)(Analyse/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.29%	45.83%	21.88%

Course Outcome (CO):

After the completion of the course students will be able to

CO1: Acquire the knowledge of the constructional details and operating principle of DC generator and analyze the performance under various operating conditions to solve complex electrical engineering problems.

CO2: Acquire the knowledge of the operating principle of DC motor and analyze the performance under various operating conditions to solve complex electrical engineering problems.

CO3: Identify and analyze the problems related to performance analysis of single phase transformer reaching substantiated conclusion.

CO4 Identify, formulate and solve the numerical problems related to three phase induction motor.

CO5: Acquire the knowledge of synchronous generator to identify and analyze the problems related to performance analysis.

CO6: Understand the knowledge of synchronous motor to solve complex engineering problems related to various applications.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	**Submission link:**
ME	https://classroom.google.com/c/NDAwOTEyNDA0NDEy/a/NDYzODYzMDU1MjAy/details