B.TECH/EE/5TH SEM/ELEC 3101/2016

ELECTRICAL MACHINE II
(ELEC 3101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) Which kind of rotor is most suitable for turbo alternators?
(a) Salient pole type (b) Non-salient pole type
(c) Both (a) and (b) above (d) None of the above.

(ii) Damper winding is provided in synchronous motors to
(a) provide starting torque (b) prevent hunting
(c) increase speed (d) both (a) and (b).

(iii) An alternator is said to be under excited if it operates at
(a) unity power factor (b) leading power factor
(c) lagging power factor (d) none of the above.

(iv) A voltmeter gives 120 oscillations per minute when connected to the rotor of an IM. The stator frequency is 50Hz. The slip of the motor is
(a) 2% (b) 2.5% (c) 4% (d) 5%.

(v) A synchronous capacitor is
(a) ordinary static capacitor bank
(b) an over excited synchronous motor
(c) an over excited synchronous motor without load
(d) none of the above.

(vi) If the maximum torque of a three-phase induction motor is 200 kg-m at a slip of 12%, the torque at 6% slip would be
(a) 100 kg-m (b) 80 kg-m
(c) 50 kg-m (d) none of the above.

(vii) In induction motor, torque is related with supply voltage as
(a) $T \propto V^{1/2}$ (b) $T \propto \frac{1}{V}$ (c) $T \propto V$ (d) $T \propto V^2$.

(viii) The stepping angle for 3-phase, 24 pole, permanent magnet stepping motor is
(a) 15^0 (b) 8^0 (c) 5^0 (d) 4^0.

(ix) When a single phase supply is connected across a single phase winding, the nature of magnetic field produced is
(a) pulsating in nature
(b) rotating in nature
(c) constant in magnitude but rotating at synchronous speed
(d) constant in magnitude and direction.

(x) The direction of rotation of a single-phase induction motor can be reversed by
(a) reversing the connection of both main and auxiliary winding
(b) reversing the connection of main winding
(c) reversing the supply connection
(d) can not be reversed.

Group – B

2. (a) For a 3-phase slip-ring induction motor, the maximum torque is 2.5 times the full-load torque and the starting torque is 1.5 times the full load torque. Determine the percentage reduction in rotor circuit resistance to get full load torque at a slip of 3%. Neglect stator impedance.

(b) Discuss why the power-factor of a 3-phase induction motor is low at no-load.

(c) An 18.65 kW, 4-pole, 50-Hz, 3-phase induction motor has friction and windage losses of 2.5 percent of the output. The full-load slip is 4%. Compute for full load
(i) the rotor Cu loss
(ii) the shaft torque.

4 + 4 + 4 = 12

3. (a) A 3-phase, 400/200-V, Y-Y connected wound rotor induction motor has 0.06Ω rotor resistance and 0.3Ω standstill rotor reactance per phase. Find the additional resistance required in the rotor circuit to get maximum torque at starting. Neglect stator impedance.

(b) Explain why in the frequency variation scheme of speed control of 3-phase induction motor the ratio v/f is generally maintained constant.

(c) A squirrel cage induction motor when started by means of a star/delta starter takes 150% of full-load line current and develops 30% of full-load torque at starting. Calculate the starting torque and current in terms of full-load values, if an autotransformer with 75% tapping were employed.

4 + 4 + 4 = 12

Group – C

4. (a) What is an universal motor? How is it different from DC series motor? Mention its application.

(b) A 230 V, 50 Hz capacitor start single-phase induction motor gave the following test results at standstill :
Main winding excited alone : 50 V, 2 A, 60 W
Auxiliary winding excited alone : 100 V, 1 A, 80 W
Determine the value of capacitance for obtaining the maximum torque at starting. Derive the formula used.

6 + 6 = 12

5. (a) A 230 V, 50 Hz, resistance-start single phase induction motor has the following data at standstill:
Main winding impedance, Zm = (5.0 + j10) Ω
Auxiliary winding impedance, Za = (12.0 + j15.0) Ω
Find the value of external resistance required in series with the auxiliary winding to get maximum torque at starting. Derive the formula used.

(b) Write a short note on stepper motor.

(c) Explain why a single phase single winding induction motor produces no starting torque.

6 + 4 + 2 = 12

Group – D

6. A 3-phase, 2 MVA, star-connected, 50Hz, 2.5kV alternator has a resistance between each pair of terminals as measured by direct current is 0.2Ω. Assume that the effective resistance is 1.6 times the ohmic resistance. A field current of 65A produces a short-circuit current equal to full-load current of 375A in each line. The same field current produces an e.m.f of 725 V on open circuit. Determine the

synchronous reactance of the machine and full-load voltage regulation at 0.6 power factor leading.

(5 + 7) = 12

7. (a) Two Alternators A and B operate in parallel. Station capacity of A is 50 MW and that of B is 40 MW. Full-load speed regulation of station A is 3% and full-load speed regulation of B is 4%.Calculate the load sharing if the connected load is 50 MW. Assume the no-load frequency of both alternator to be 50 Hz.

(b) A 3 MVA, 3-phase, 6-pole alternator is connected to 6 kV, 50 Hz busbars and has a synchronous reactance of 4Ω per phase. Calculate the synchronizing power and the synchronizing torque per mechanical degree of rotor displacement at no-load. Assume normal excitation.

(3 + 3) + (3 + 3) = 12

Group – E

8. The 400V, 50 kVA, 0.8 power factor leading, delta connected synchronous motor is supplying a 10 kW load with initial power factor of 0.8 lagging. The windage and friction losses are 1.5 kW and the core losses are 1.5 kW.
(i) Calculate the line current, armature current and excitation voltage.
(ii) If the flux of the motor is increased by 35% determine the excitation voltage, armature current and the new power factor.

(2 + 2 + 2) + (2 + 2 + 2) = 12

9. Explain the effect of varying excitation on armature current and power factor in a synchronous motor. Draw the phasor diagram of a salient pole synchronous generator operating under lagging load condition.

(6 + 2 + 4) = 12