CS/B.TECH/NEW/EE/EEE/SEM-4/EE-401/2013

2013

ELECTRICAL MACHINE – I

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The waveform of armature mmf in a d.c. machine is

a) Square b) Rectangular

c) Triangular d) Sinusoidal.

ii) For a P-pole machine, the relation between electrical and mechanical angles is given by

a) $\theta_C = \frac{2}{p}\theta_m$ b) $\theta_C = P\,\theta_m$

c) $\theta_C = \frac{4}{p}\theta_m$ d) $\theta_C = \frac{p}{2}\theta_m$.

iii) A Delta /Star transformer has a line to line voltage transformation ratio of K. The line-to-live voltage ratio of star/Delta connection is given by

a) $K/\sqrt{3}$ b) $\sqrt{3}\,K$

c) $K/3$ d) $\sqrt{3}\,/K$.

iv) Scott-connections are used for

a) single phase to three phase transformation.

b) Three phase to single phase transformation

c) Three phase to two phase transformation

d) Three phase to six phase transformation.

v) In the equivalent circuit of a three phase induction motor, the mechanical load on the motor can be represented by a resistance of value (R_2 = rotor resistance, S = slip)

a) R_2/S b) $R_2\,(1-s)$

c) $R_2\,\frac{(1-s)}{s}$ d) $R_2\,/\,(1-s)$.

vi) The current drawn by a 120 V d.c. motor with back emf of 110 V and armature resistance of 0·4 Ohm is

a) 4A b) 25 A

c) 200 A d) 10 A.

vii) A 3-phase induction motor is supplied with a 400 V, 3 - ϕ, 50 Hz Supply and the motor runs of 1470 rpm. The rotor current will have a frequency of

a) 2·0 Hz b) 1·0 Hz

c) 4·0 Hz d) 48 Hz.

viii) The number of parallel paths for simple lap winding in a d.c. machine is

a) two b) four

c) six d) number of poles.

ix) The condition for maximum starting torque in an induction motor is

a) $R_2 = X_2/_2$ b) $R_2 = \sqrt{R_1^2 + (X_1 + X_2)^2}$

c) $R_2 = (X_1 + X_2)/2$ d) $R_2 = (R_1 + X_1 + X_2)$.

x) If the supply voltage decreases by 4%, the torque in a 3-phase induction motor would decrease by

a) 4% b) 8%

c) 16% d) 6%.

xi) A series motor (d.c.) is running drawing a load current of 1A. If the load is reduced such that the current drawn is halved ; the speed of the motor would be approximately

a) unchanged b) reduced by 50%

c) increased by 50% d) increased by 100%.

xii) A transformer, designed for a supply frequency of 50Hz, is supplied with 60 Hz system of the same voltage. Therefore,

a) The eddy current and hysteresis loses will increase

b) eddy current loss will decrease and hysteresis loss will increase

c) eddy current loss will not change but hysteresis loss will decrease.

d) eddy current loss will be same but hysteresis loss will increase.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Two transformers A and B with no load voltage ratios 1000/500 V are connected in parallel and excited by 1000 V supply. The resistance and reactance are 1% and 5% for A and 2% and 2% for B respectively. Determine the load on each transformer.

3. Show how in an autotransformer having the same KVA rating, conductor material is saved, compared to a two winding transformer.

4. What are the advantages of distributed winding in rotating electrical machine ? Show that $K_d = \frac{Sin\ (m\alpha/2)}{m \sin(\alpha/2)}$, Where k_d = distribution factor, m = no. of slots per pole per phase, α = angular slot pitch in electrical radians. 2 + 3

5. The power input to a three phase induction motor is 60 KW. Total stator losses are 1 KW. Find the total mechanical power developed and the rotor copper loss per phase, if the motor is running with a slip of 3%.

6. a) What are the essential conditions for 'Building up' of voltage of a d.c. shunt generator ?

   b) What are critical resistance and critical speed ? Explain these with the help of the external characteristics of the generator and building up process. 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Derive the expressions for the emf and the electromagnetic torque of a D.C. machine.

   b) A 230V, 4-pole, Shunt motor has two circuit armature winding with 500 conductors. The armature resistance is 0·25 ohm, the field resistance is 125 ohm and the flux per pole is 0·02 wb. Armature reaction is neglected. If the motor draws 14A from the mains, then find the speed and the internal torque developed. 8 + 4 + 3

8. a) Explain how a balanced 3-phase supply applied to a 3-phase stator winding (balanced) can produce a rotating magnetic field of constant magnitude in an induction motor.

   b) Derive an expression for the Torque developed by the rotor in an induction motor. Also determine an expression for the mechanical power developed.

9. a) What is the advantage of V-V connection of 3-phase transformers ?

   b) Explain the use of Tertiary winding in a 3-phase transformer.

   c) Three single phase transformers, connected in delta-delta, supply a balanced 3-phase load of 1500 KW at 400 V at 0·8 p.f. lagging. The transformers are supplied from 3-phase mains at 11000 V. Find the current in the windings of each transformer. If one of the transformers is removed because of a sudden fault, and the supply is maintained in V-U connection, determine the currents in the windings and the power supplied by each of the transformers. 2 + 3 + 5 + 5

10. a) Why are the pole shoes in a d.c. machine laminated though the field winding carries a direct current and not an alternating current ? 3

    b) A 10 KW 6-pole d.c. generator develops an emf of 200V at 1500 rpm. The armature has a lap connected winding. The average flux density over a pole piteh is 0·9 T. The length and diameter of the armature are 0·25 m and 0·2 m respectively. calculate.

       i) the flux per pole

       ii) the total number of active conductors in the armature

       iii) the torque developed by the machine when the armature supplies a current of 50 amps. 4 + 4 + 4

11. a) Derive the necessary expression to draw the speed-torque characteristics of d.c. series motor and shunt motor.

b) At 50% of full load, the armature current drawn by a d.c. shunt motor is 40A, when connected to 200 V d.c. mains. By decreasing the field current its speed is raised by 20%, causing a 10% increase in the load torque. Calculate the percentage change in field current. The armature resistance including the brushes is 1 ohm. Neglect saturation, armature reaction and the drop across the air gap in the brush. 4 + 4 + 7