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Paper Code : EE-401

ELECTRIC 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 flux in transformer core

a) increases with load

b) decreases with load

c) remains constant irrespective of the load

d) none of these.

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

a) the eddy current and hysteresis losses 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.

iii) For successful parallel operation of two transformers, the essential condition is that their

a) percentage impedances should be equal

b) turns ratio should be exactly equal

c) polarities must be properly connected

d) kVA rating should be equal.

iv) A 3-phase transformer has its primary connected in delta and secondary in star. Secondary to primary turns ratio per phase is 5. For a primary voltage of 400 V, the secondary voltage would be

a) 2000 V b) 80 V

c) 3464 V d) $80\sqrt{3}$ V.

v) Tertiary winding is used in case of

a) delta-delta b) star-zigzag

c) star-star d) none of these.

vi) Unbalanced 3-phase voltage supply to an induction motor results in excessive heating of

a) rotor shaft b) rotor

c) stator d) none of these.

vii) The rotor power output of a three-phase induction motor is 15 kW. The rotor copper losses at a slip of 4% will be

a) 600 W b) 625 W

c) 650 W d) 700 W.

viii) Maximum torque in a 3-phase induction motor varies as

a) f b) $\frac{1}{f}$

c) $\frac{1}{f^2}$ d) $\frac{1}{f^3}$.

ix) Star-delta starting of poly-phase induction motor is equivalent to auto transformer starting with

a) 85% tapping b) 58% tapping

c) 52% tapping d) 33% tapping.

x) A cumulatively compounded d.c. generator is supplying 20 A at 200 V. Now if the series field winding is short circuited, the terminal voltage

a) will remain unaltered at 200 V

b) will rise to 220 V

c) will shoot up to very high value

d) will become less than 200 V.

xi) The armature *mmf* in a *d.c.* machine is

a) stationary with respect to field poles

b) stationary with respect to armature

c) rotating with respect to field poles

d) rotating with respect to armature.

xii) A 4-point starter is used to start a

a) DC shunt motor with armature resistance control

b) DC shunt motor with field weakening control

c) DC series motor

d) DC compound motor.

GROUP – B

(Short Answer Type Questions)

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

2. Draw the connection diagram and corresponding phasor diagram for the vector groups (i) Dy 11 (ii) Dd 6.

3. Show that the application of 3-phase balanced supply to a 3-phase symmetrical winding produces a rotating magnetic field of constant amplitude and speed.

4. A 400 V, 50 Hz, 4-pole, three phase induction motor has a rotor resistance of 0·04 Ω per phase. The maximum torque occurs at a speed of 1200 rpm. Calculate the ratio of the starting torque to the maximum torque.

5. What is armature reaction in a DC machine ? How does it affect commutation ? What steps are taken to have effective commutation ?

6. Explain with neat circuit diagram, the Ward-Leonard method of speed control of d.c. series motor. What are the advantages and disadvantages ?

GROUP – C

(Long Answer Type Questions)

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

7. a) Write the essential and desirable conditions for parallel operation of two three-phase transformers.

   b) Two equal ratio, 3-phase transformers *A* and *B*, are operating in parallel to supply a demand of 600 kVA at 0·8 power factor lag at 6600 V. The rating and impedance of the transformers are

   Transformer *A* : 400 kVA, Z = 0·01 + j 0·05 p.u.

   Transformer *B* : 200 kVA, Z = 0·012 + j 0·04 p.u.

   Find the currents supplied by each transformers and its power factor. 5 + 10

8. a) In open-delta transformers, show that the secondary line voltages form a balanced 3-phase system of voltages, in case the supply voltages are balanced.

   b) Three single phase transformers, connected in Δ / Δ supply a balanced 3-phase load of 1500 kW at 4400 V at 0·8 power factor lagging. The transformers are supplied from 3-phase mains at 11000 V. Find the current in the windings of the each transformer. If one transformer is found faulty and is removed and the supply is maintained in V-V connection, determine the currents in the windings and power supplied by each of the transformers. 7 + 8

9. a) Sketch and explain the torque-slip characteristics of a 3-phase induction motor using the expression of the torque in terms of slip. Show that maximum torque is independent of rotor resistance. State assumption made, if any.

   b) The shaft output power of a 3-phase, 50 Hz induction motor is 20 kW at 1440 rpm. Total stator i^2r losses are 650 W and stator core losses are 720 W. Friction and windage losses amount to 12% of shaft output power. Determine the rotor and stator input. 7 + 8

10. a) Draw and explain the method of speed control of a DC motor by flux control method. Discuss the ranges of speed control by the flux control method.

    b) A shunt generator delivers 40 kW at 240 V when running at 450 rpm. The armature and field resistances are 0·03 ohm and 60 ohm respectively. Calculate the speed of the machine running as a shunt motor and taking 40 kW input at 240 V. Allow 1 V per brush for contact drop. 6 + 9

11. Write short notes on any *three* of the following : 3 × 5

    a) Three-phase to two-phase conversion

    b) Difference between shell type and core type transformers

    c) Cogging and crawling in induction motors

    d) Grounding transformer

    e) EMF polygon.

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