ELECTRIC MACHINE - I
(ELEC 2201)

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)   Tesla is a unit of
            (a) Magnetic field strength   (b) Self inductance
            (c) Magnetic flux density   (d) Magnetic flux.

    (ii)   What is the percentage increase in torque with respect to the initial torque
            when the current drawn by a DC series motor increases from 20 A to 28 A?
            (a) 10.7%   (b) 12%
            (c) 20.3%   (d) 25.4%

    (iii)   Wave winding is employed in a DC machine with
            (a) high current and low voltage rating
            (b) low current and high voltage rating
            (c) high current and high voltage rating
            (d) low current and low voltage rating.

    (iv)   Maximum mechanical power is developed in a DC motor when its back EMF is equal to
            (a) The applied voltage   (b) Double the applied voltage
            (c) One third of the applied voltage   (d) Half the applied voltage.

    (v)   A cumulatively compound DC generator is supplying 20A 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 voltage (d) Will become less than 200 V

    (vi)   Open circuit test of a transformer gives
            (a) hysteresis loss   (b) eddy current loss
            (c) sum of hysteresis & eddy current loss (d) copper loss

    (vii)   Which loss in a transformer varies significantly with load?
            (a) Hysteresis loss   (b) Eddy current loss
            (c) Iron loss   (d) Copper loss

(viii)   A transformer has full load loss of 900W and copper loss of 1600W. At what percentage of the load, the transformer will have maximum efficiency?
(a) 100%   (b) 90%
(c) 75%   (d) 50%

(ix)   Scott connection are used for
(a) single phase to three phase   (b) three phase to single phase
(c) three phase to two phase   (d) three phase to six phase

(x)   Third harmonics current can flow from a line into a transformer bank if the windings are
(a) grounded star/delta   (b) delta/delta
(c) star/star   (d) delta/star.

Group – B

2.   Derive an expression of electromechanical force acting on the movable plunger in singly excited magnetic system.

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3.   (a)   Derive the relation between electrical angle and mechanical angle in relation to rotating machines.

(b)   What are the advantages of distributing a winding in rotating electrical machines?

(c)   The induced EMF in each turn of a single-phase AC generator with uniformly distributed T single turn coils is 1 V (rms).Calculate EMF of the whole winding.

3 + 3 + 6 = 12

Group – C

4.   (a)   Explain with net circuit diagram, the Ward-Leonard method of speed control of DC shunt motors.

(b)   During Swinburne's test, a 230 V Dc shunt motor takes 2A at no load. Its armature resistance and shunt field resistance are 0.2Ω and 230Ω respectively. Estimate the kW output and efficiency when the motor takes 45 A.

(3 + 2) + (4 + 3) = 12

5.   A DC shunt generator supplies a full load current of 118 A at a constant voltage of 110 V. The shunt field winding resistance is 50Ω. The summation of mechanical losses and iron losses is 600W,The full load efficiency is 80%.Calculate
(i)   the armature resistance
(ii) the efficiency at half load
(iii) load current for maximum efficiency

(4 + 4 + 4) = 12

Group – D

6. (a) A 100 kVA single-phase transformer when working at unity pf has an efficiency of 90% at full load and also at half load. Determine the efficiency when it operates at unity pf and 75% of full load.

   (b) Why the core loss is neglected in short circuit test and copper loss in open circuit test.

   (c) A 20 kVA, 1500/500 V, 1-phase transformer has the parameters $R_1=6\Omega$, $R_2=0.4\Omega$, $X_1=15\Omega$, $X_2=1\Omega$. Find the secondary terminal voltage at full load 0.8 pf lagging when the primary voltage is 1500V.

   4 + 4 + 4 = 12

7. (a) Find the condition for maximum efficiency in a transformer.

   (b) How to reduce the core loss in a transformer?

   (c) A 22000/2200 V, 600 kVA transformer having percentage resistance and reactance of 1.5% and 6% respectively is connected in parallel with a 22000/2200 V, 1200 kVA transformer having percentage resistance and reactance of 1% and 6.2% respectively to share a load of 500kW at 0.8 pf lagging. Find the kVA shared by each transformer.

   3 + 2 + 7 = 12

Group – E

8. (a) In a Scott-connected transformers, teaser transformer supplies unity p.f. load of 500 kW at 200 V and the main transformer supplies 0.8 p.f. lagging load of 400 kW at 200 V. For a 3-phase input voltage of 6600 V, determine the primary line currents.

   (b) Draw the connection diagram for Dz0.

   7 + 5 = 12

9. (a) Explain how the exciting (or no-load) current of a single-phase transformer contains harmonics even when the supply voltage is a sine wave.

   (b) A 50kW, 400 V 3-phase load operates at 0.8 p.f. lagging is to be supplied by transformers connected in open-delta from an 6.6 kV line.
   (i) Determine kVA rating of each of the two transformers.
   (ii) Determine the line currents on the l.v. and h.v. sides. At what p.f. is each transformer operating.
   (iii) What is the real power supplied by each transformer?
   (iv) What would be the available capacity, if third transformer of the same rating is used to form the closed delta?

   4 + 8 = 12

Department & Section	Submission Link
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