	Utech
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CS/B.TECH (EE-NEW)/SEM-6/EE-601/2010 2010

ELECTRICAL MACHINE DESIGN

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)

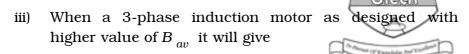
1. Choose the correct alternatives for any *ten* of the following :

 $10 \times 1 = 10$

- The least desired property of a magnetic material for making electrical machines is
 - a) high electrical resistivity
 - b) high magnetic permeability
 - c) low loss coefficient
 - d) large hysteresis loop.
- ii) Outside surface of electrical machines is painted with dull dark paints to
 - a) enhance cooling by radiation
 - b) enhance coolling by conduction
 - c) prevent corrosion
 - d) reduce heat loss.

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- a) high full load p.f.
- b) higher starting torque
- c) higher full load efficiency
- d) higher overload capacity.
- iv) The purpose of providing an iron core in a transformer is to
 - a) provide support to windings
 - b) reduce hysteresis loss
 - c) reduce eddy current loss
 - d) decrease the reluctance to the magnetic path.
- v) The maximum flux density of a rotating electrical machine occurs at
 - a) the air gap
 - b) the minimum tooth section of the rotor
 - c) the rotor core
 - d) the stator core.
- vi) A 12 pole machine will pass through electrical degrees in one revolution of value
 - a) 60°

b) 360°

c) 1080°

d) 2160°.

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- vii) Harmonics torques can be reduced by
 - a) chording
 - b) integral slot winding
 - c) skewing
 - d) all of these.
- viii) In squirrel cage induction motor, the rotor slots are made skewed to
 - a) reduce windage loss
 - b) reduce eddy current loss
 - c) reduce accumulation of dirt and dust
 - d) reduce magnetic locking.
- ix) The minimum permissible temperature for Class-B insulation is
 - a) 90°C

b) 105°C

c) 150°C

- d) 120°C.
- x) The type(s) of slot normally used in induction motors is/are
 - a) semi-enclosed
- b) open

c) closed

- d) both (a) and (b).
- xi) As volts per turn of a transformer increases, the per unit reactance will
 - a) not change
- b) decrease
- c) inverse
- d) vary randomly.

- xii) A distribution transformer has which one of the following as compared with power transformer?
 - a) Low % impedance and low copper to iron loss ratio
 - b) High % impedance and low copper to iron loss ratio
 - c) Low % impedance and high copper to iron loss ratio
 - d) High % impedance and high copper to iron loss ratio.

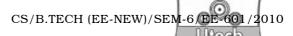
GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- 2. What is pulsation loss in electric machines? What is slot leakage permeance?
- 3. A heating furnace operates at 230 V and is made of nichrome wire. If the electric power input is 2.5~kW for raising the temperature to $1200^{\circ}C$, what should be the length and diameter of wire ? $\rho = 0.424~\Omega$ m at $1200^{\circ}C$, emissivity = 0.9 and radiating efficiency = 1. The ambient temperature is $20^{\circ}C$.
- 4. a) Which types of materials are used in the core of electromagnets?
 - b) What is space factor ? What is its implication in electromagnet design. 2 + 3

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- 5. Develop the design procedure of a choke.
- 6. a) Why are the few end turns of high voltage coils of transformer given reinforced insulation?
 - b) The voltage per turn of a transformer winding is given by $K\sqrt{(\text{rated kVA})}$, where K may be regarded as a constant coefficient for a particular range of transformers of similar design. Discuss the factors affecting the value of K. 2+3

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

- 7. a) Why is it necessary to use stranded conductors in large transformers?
 - b) Discuss the relative merits and demerits of core and shell type transformers.
 - c) Calculate the overall dimensions of the magnetic frame (limb, yoke) for a 200 kVA, 6600/440 V, 50 Hz, 3 phase core type transformer. The following design data are available:

e.m.f. per turn = 10 V,

maximum flux density = 1.3 Wb/m^2 ,

current density = 2.5 A/mm^2 ,

window space factor = 0.3, stacking factor = 0.9, use a square core. 2 + 4 + 9

- 8. a) Discuss the phenomena of cogging and crawling and indicate with reasons how they are taken care of in the design of induction motors.
 - b) Estimate the stator core dimension, number of stator slots and number of stator conductors per slot for a 100 kW, 3·3 kV, 50 Hz, 12 pole star connnected slipring induction motor. Assume :
 - average gap density = 0.4 Wb/m 2 , specific electric loading = $25{,}000$ A/m, efficiency = 0.9, power factor = 0.9 and winding factor = 0.96. Choose the main dimension to give best power factor. The slot loading should not exceed 500 ampere conductor. 6+9
- 9. a) What are the sources of stray iron losses in an electrical machine?
 - b) Calculate the specific iron loss in a specimen of alloy steel for a maximum flux density of 3.5 W/m 2 and a frequency of 50 Hz, using 0.5 mm thick laminations. The resistivity of alloy steel is 0.4 \times 10 $^{-6}$ Ω/m . Its density is 7800 kg/m 2 . Hysteresis loss in each cycle is 500 J/m 3 . 8+7
- 10. a) What are the mechanical forces that are developed in transformer windings?
 - b) Write a short note on 'change of parameters of a transformer with change of frequency'.
 - c) The ratio of flux to full load mmf in a 500 kVA, 50 Hz, single phase core type power transformer is $2\cdot4\times10^{-6}$. Calculate the net iron area and the window area of the transformer. $B_m=1\cdot3$ Wb/m 2 , current density = $2\cdot7$ A/mm 2 and window space factor $0\cdot26$. Also calculate full load mmf. 5+5+5

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- 11. a) Which factor should be considered when estimating the length of the air gap of induction motor? Why should the air gaps be as small as possible?
 - b) What are the effects of space harmonics?
 - c) A 3-phase, 4-pole, 50 Hz induction motor has 24 stators and 28 rotor slots. Prove that it has a tendency to run as a synchronous motor at 214.3 r.p.m. 5+5+5

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