



Name :

Roll No. :

Invigilator's Signature :

CS / B.TECH (EE-N) / SEM-6 / EE-601 / 2011

2011

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 × 1 = 10

- i) The efficiency of a transformer is maximum when
 - a) copper losses are zero
 - b) iron losses are zero
 - c) copper losses are 50% of the iron losses
 - d) copper losses are equal to iron losses.
- ii) The capacitance of capacitor is not influenced by
 - a) plate thickness
 - b) plate separation
 - c) plate area
 - d) nature of dielectrics.



- iii) In a transformer, electric power is transformed from the primary to the secondary without the change in
- a) voltage
 - b) current
 - c) frequency
 - d) turns
 - e) none of these.
- iv) The direction of rotation of a d.c. shunt motor can be reversed by interchanging the
- a) supply terminals only
 - b) field terminals only
 - c) armature terminals only
 - d) both field & armature terminals.
- v) The residual magnetism of a self-excited d.c. generator is lost. To enable the machine to regain residual field
- a) the field winding must be replaced
 - b) the armature connection must be reversed
 - c) the field winding connection must be reversed
 - d) the field winding must be excited by low voltage d.c. supply.
- vi) The heating element is
- a) cobalt
 - b) nichrome
 - c) silver
 - d) silicon.
- vii) Semi-closed slots is considered for
- a) D.C. motor
 - b) Transformer
 - c) Induction motor
 - d) Stepper motor.



- viii) Round wire type heating elements are used for measuring
- a) high temperature
 - b) low temperature
 - c) ambient temperature
 - d) lower than ambient temperature.
- ix) Transformer tapping is provided on
- a) HV side b) LV side
 - c) HV or LV side d) HV and LV sides.
- x) Important characteristic necessary in transformer oil is
- a) high dielectric strength
 - b) low viscosity
 - c) both (a) and (b)
 - d) none of these.
- xi) The maximum value of flux density that is used in transformer design is
- a) 1.6 Wb/m^2 b) 2.3 Wb/m^2
 - c) 1.2 Wb/m^2 d) 0.6 Wb/m^2
 - e) none of these.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. A horse-shoe type magnet has to lift a mass of 150 kg from a distance of 10 mm. The area of Pole face is $5 \times 10^{-3} \text{ m}^2$. Find the current required if the excitation coil has 5000 turns. Assume that the *mmf* required for iron parts = 10% of air gap *mmf*. Neglect fringing.
3. A heating furnace operates at 250V and is made of nichrome wire. If the electric power input is 2.5 kW for raising the temperature to 1000°C, what should be the length and diameter of wire ? $p = 0.424 \Omega \text{ m}$ at 1200°C, emissivity = 0.9 and radiating efficiency = 1. The ambient temperature is 20°C.
4.
 - a) What is pulsation loss in electric machines ?
 - b) Derive an expression of “gap contraction factor” for ducts in electrical machines.
5. What are the functions of conservator and breather of the transformer ?
6. Discuss the factors which determines the choice of
 - a) average flux density in the air gap.



- b) ampere-conductor per metre in the design of 3-Phase induction motor.

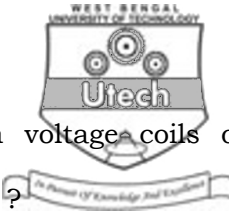
GROUP – C

(Long Answer Type Questions)

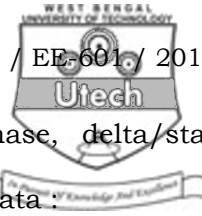
Answer any *three* of the following. $3 \times 15 = 45$

7. a) Design an iron cored choke to be connected to 230V, 50 Hz supply and suitable for 5 amp inductive current.
- b) What are the different types of electro-magnet ? Describe. $10 + 5$
8. a) Which factor should be considered when estimating the length of air gap of induction motor ? Why should the air gaps be as small as possible ?
- b) Estimate the stator dimension, number of stator slots and number of stator conductors per slot for a 100 kW, 3.3 kV, 50 Hz, 12-pole star connected slip-ring 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.

$5 + 10$



9. a) Why are the few end-turns of high voltage coils of transformer given reinforced insulation ?
- b) Why is it necessary to use stranded conductors in large 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 :
- emf 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. 3 + 3 + 9
10. a) 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 . Give an analytical support in favour of the discussion.
- b) Explain why the LV and HV current densities are kept nearly the same in transformers.



- c) A 25 kVA, 6600/440V, 50 Hz, 3-phase, delta/star core-type transformer has the following data :

$$emf \text{ per turn} = 2.12 \text{ V}$$

$$\text{Window space factor} = 0.3$$

$$\text{Maximum flux density} = 1.1 \text{ tesla}$$

$$\text{Current density} = 2.3 \text{ A/mm}^2$$

$$\text{Window height / window width} = 3$$

For a cruciform core, find (i) diameter of the circumscribing circle, (ii) width and height of window, (iii) conductor cross-section for both windings, and (iv) turns per phase in both windings. 5 + 2 + 8

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

- a) Limitations in electrical machine design
- b) Area product concept of inductor design
- c) Cooling methods of transformer
- d) Cogging and crawling.

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