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Question Paper Code : 20465

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Sixth Semester

Electrical and Electronics Engineering

EE 6604 — DESIGN OF ELECTRICAL MACHINE

(Regulations 2013)

(Also common to PTEE 6604 – Design of Electrical Machines for B.E. (Part-Time) Fifth Semester – Electrical and Electronics Engineering /Regulation 2014)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the various duty cycles of motor.

2. What are the different conducting materials used in rotating machines?

3. What are the constituents of magnetic circuits in a DC machine?

4. Define specific electric and magnetic loading.

5. What are the advantages of stepped core in transformers?

6. How is iron loss reduced in transformers?

7. Why induction machine is called a rotating transformer?

8. What is cogging? How is it avoided in induction motor?

9. Define runaway speed of an alternator.

10. Distinguish salient pole and smooth cylindrical rotor construction of alternators.

PART B — (5 × 13 = 65 marks)

11. (a) Discuss in detail the desirable properties and classification of insulating materials used in rotating machines. (13)

Or

(b) Discuss in detail the factors affecting the choice of specific electric and magnetic loading in rotating machines. (13)

12. (a) (i) Derive an expression for the mmf for air gap of a slotted armature with ducts. (6)

(ii) Determine the air gap length of a D.C machine from the following data. Gross core length = 0.12 m, number of ducts = 1 of 10 mm width, slot pitch = 25 mm, slot width = 10 mm, Carters coefficient for slots and ducts = 0.32, gap density at pole center = 0.7 T. Field mmf per pole = 3900 AT, mmf required for iron parts of magnetic circuit = 800 AT. (7)

Or

(b) Calculate the diameter and length of armature for a 55 kW, 110 V, 1000 rpm, 4 pole DC shunt generator assuming specific electric and magnetic loadings as 26000 amp-cond/m and 0.5 wb/m^2 respectively. The pole arc should be about 70% of the pole pitch and length of core about 1.1 times the pole arc. Allow 10 A for the field current and assume a voltage drop of 4 V for the armature circuit. Specify the winding used and also determine suitable values for the number of conductors and number of armature slots. (13)

13. (a) (i) Derive the output equation of three phase transformer. (6)

(ii) Determine the dimensions of core and yoke for a 200 kVA single phase core type transformer. A cruciform core is used with distance between centres of adjacent limbs equal to 1.6 times the width of largest lamination. Assume voltage per turn is 14 V, Maximum flux density, B_m = 1.1 wb/m^2. Window space factor 0.32, current density = 3 A/mm^2. Stacking factor = 0.9. The net iron area is 0.56 d^2 for cruciform core. Width of largest stamping = 0.85 d (7)

Or

(b) A 250 kVA, 6600 / 400 V, three phase core type transformer has a total loss of 4800 W at full load. Transformer tank is 1.25 m in height and 1 m × 0.5 m in plan (top view). Design a suitable scheme for cooling tubes if the temperature rise is to be limited to 35°C. The diameter of the tubes is 50 mm and are placed 75 mm from each other. The average height of the tube is 1.05 m. Sp. heat of dissipation through radiation and convection are 6 and 6.5 W/m^2 – °C. Assume that the convection is improved by 35% due to the provision of tubes. (13)

14. (a) Find the main dimensions, number of radial ventilating ducts, number of stator slots and number of turns per phase of a 3.7 kW, 400 V, 3 phase, 4 pole, 50 Hz, squirrel cage Induction motor to be started by a star delta starter. Work out the winding details. Assume average flux density in the airgap equal to 0.45 wb/m^2, Ampere conductors per meter = 23000, η = 0.85, power factor = 0.84. Choose main dimensions to achieve cheap design. Winding factor = 0.955, Iron stacking factor = 0.9. (13)

Or

(b) (i) Derive an expression for the endring current in three phase Induction motor. (6)

(ii) A 11 kW, three phase 6 pole, 50 Hz, 220 volts star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the value of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 86 percent and a power factor of 0.85. The rotor MMF may be assumed to be 85 percent of stator MMF. Also find the bar and the end ring sections if the current density is 5 A/mm^2. (7)

15. (a) Determine the main dimensions of a 75000 kVA, 13.8 kV, 50 Hz, 62.5 RPM, 3 phase star connected alternator. The peripheral speed should be about 40 m/s. Assume average gap density = 0.65 Wb/m^2, Ampere conductors per meter = 40,000, current density = 4 A/mm^2. Also find the number of stator slots, conductors per slot and conductor area. Assume slot pitch = 55 mm. (13)

Or

(b) Explain the design procedure for the field system of a salient pole alternator. (13)

PART C — (1 × 15 = 15 marks)

16. (a) The armature of a 10 pole 1000 kW, 500 V, 300 RPM DC generator has a diameter of 1.6 m. There are 450 coils. Determine suitable length and diameter of the commutator, giving details of brushes having regard to commutation conditions and temperature rise. The design limitations are; peripheral speed of commutator $\leq$ 20 m/s, pitch of segments $\geq$ 4, current per brush $\leq$ 70 A, Temperature rise $\leq$ 40°C. The other data given are : The brushes span three segments approximately, brush contact drop 1.5 V, coefficient of friction 1.5, brush pressure 20 kN/m^2. Cooling coefficient = $\frac{0.012}{1+0.1V_c}$. Make suitable assumptions for clearance between brushes, staggering of brushes and end play. (15)

Or

(b) (i) Explain the design of damper winding in synchronous machine. (7)

(ii) A 250 kVA, 3 phase, 6600 V, salient pole alternator has the following data. Airgap diameter = 1.6 m; length of core = 0.45 m; number of poles = 20; a_c = 28000; pole arc to pole pitch ratio = 0.68; stator slot pitch = 28 mm; current density in damper winding = 3 A/mm^2. Design a suitable damper winding for the machine. (8)
