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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; June - 2016

Electrical Machine Design

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data may suitably assume.

UNIT - I

1 a. Discuss the choice of number of poles used in DC machines. 6

b. Derive an expression for output equation connecting main dimension, speed, specific magnetic and electrical loading. 6

c. A 150 kW, 230 V, 500 rpm dc shunt motor has a square field coil. Find its number of poles, main dimensions and the air gap length. Assume the average gap density over the pole is as 0.85 T and the AC/m (ampere conductor/m) as 29000. The ratio of width of pole body to the pole pitch is 0.55 and the pole arc to pole pitch is 0.7. The efficiency is 91%. Assume that the mmf required for air gap is 55% of armature mmf and the gap contraction factor is 1.15. 8

2 a. Explain clearly the factors which impose limitations in the design of electrical machines. 6

b. Write a short note on materials used in electrical machines. 6

c. A design is required for a 50 kW, 4-pole, 600 rpm DC shunt generator, the full load terminal voltage, being 220 V. The maximum gap density is 0.83 wb/m^2 and the armature ampere conductor / m are 30,000, calculate suitable dimensions of armature core to give a square pole face. Assume that the full load armature voltage drop is 3% of the rated terminal voltage, and the field current is 1% of the rated full load current ratio of pole arc to pole pitch is 0.67. 8

UNIT - II

3 a. Derive an expression for number of armature coils of DC machine. 8

b. Mention the different methods adopted to reduce the effect of armature reaction. 6

c. A 500 kW, 375 rpm, 8-pole, DC generator has a flux / pole of 0.0885 webers. Determine the armature demagnetizing and cross magnetizing mmf/pole if the brushes are given a lead of 5% of pole pitch. Assume power developed by armature to be equal to rating of the machine. 6

4 a. Explain the design procedure for shunt field winding of DC machine. 10

b. A shunt field coil has to develop an mmf of 9000 A. the voltage drop in the coil 40 V, and the resistivity of round wire used is 0.021 ohm /mm^2. The depth of winding is 35 mm approximately and the length of mean turn is 1.4 m. Design a coil so that the power dissipated is 700 W/m^2 of the total coil surface. Take the diameter of the insulated wire 0.2 mm greater than that of the bare wire. 10

UNIT - III

5 a. Derive an expression for minimum cost of a single phase transformer. 8

Contd…2

b. Determine the main dimensions of the core, the number of turns and the cross section of the conductors for a 5 kVA, 11000/400 V, 50 Hz, single phase core type distribution transformer, the net conductor area in the window is 0.6 times the net cross section of iron in the core. Assume a square cross section for the core, a flux density 1 wb/m^2, a current density 1.4 A / mm^2 and a window space factor 0.2, the height of the window is 3 times its width. 12

6 a. Derive an expression for leakage reactance of a transformer with primary and secondary coils of equal lengths. State clearly the assumption made. 10

b. The ratio of flux to full load mmf in a 400 kVA, 50 Hz, 1-ϕ core type power transformer is $2.4x10^{-6}$. Calculate the net iron area and the window area of the transformer. Maximum flux density in the core is 1.3 wb/m^2, current density 2.7 A/mm^2 and window space factor 0.26. Also calculate full load mmf. 10

UNIT - IV

7 a. Derive the output equation of a 3-ϕ induction motor and explain the factors which influence the choice of magnetic and electric loading. 10

b. A 11 kW, 3-phase, 6- pole, 50 Hz, 220 V star connected induction motor has 54 stator slots, each containing 9 conductor. Calculate the values of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf may be assumed as 85% of stator mmf. Also find the bar and the end ring sections if the current density is 5 A/mm^2. 10

8 a. Describe the factors which are to be considered when estimating the length of airgap of a 3-ϕ induction motor. 8

b. A 3-phase, 2-pole, 50 Hz Squirrel cage induction motor has a rotor diameter 0.20 m and core length 0.12 m, the peak density in the airgap is 0.55 wb/m^2. The rotor has 33 bars, each of resistance 125 micro ohm and a leakage inductance 2 micro Henry. The slip is 6%.

Calculate; (i) The peak value of current in each bar (ii) Rotor I^2R loss

(iii) Rotor output (iv) Torque exerted. 12

Neglect the resistance of end rings.

UNIT - V

9 a. List the effects of SCR on the performance of synchronous machines. 8

b. Determine a suitable number of slots and conductors per slot, for the stator winding of a 3-phase, 3300 V, 50 Hz, 300 rpm alternator. The diameter is 2.3 m and the axial length of core is 0.35 m. The maximum flux density in the air gap should be approximately 0.9 wb/m^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. 12

10 a. Mention the different methods for eliminating harmonics from the generated voltage of a synchronous machine, Explain briefly. 8

b. The field coils of a salient pole alternator are wound with a single layer winding of bare copper strip 30 mm deep, with separating insulation 0.15 mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000 A with a potential difference of 5 V per coil and with a loss of 1200 W/m^2 of total coil surface. The mean length of turn is 1.2 m. The resistivity of copper is 0.021 Ω/m and mm^2. 12

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