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Question Paper Code: 55304

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2018

Fifth Semester

Electrical and Electronics Engineering

15UEE504 - ELECTRICAL MACHINE DESIGN

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

PART A - (10 x 1 = 10 Marks)

1. Which of the following is the major consideration to evolve a good design? CO1- R
   (a) Cost
   (b) Durability
   (c) Compliance with performance criteria as laid down in specifications
   (d) All the above

2. In large DC machines, if P is the kW rating of the machine and η is efficiency then the power developed in the armature of generator is ..... and that of motor is..... CO1- R
   (a) Pη and P (b) P/ η and P (c) η/P and P (d) P and P/η

3. In D.C. machines, in order to prevent excessive distortion of field form by the armature reaction, the field MMF must be made CO2- R
   (a) equal to that of armature MMF
   (b) less in comparison with the armature MMF
   (c) large in comparison with the armature MMF
   (d) none of the above

4. In D.C. machines the number of slots per pole usually lies CO2- R
   (a) between 2 to 4 (b) between 6 to 8 (c) between 9 to 16 (d) between 20 to 30

5. In transformers, the cylindrical winding with rectangular conductors is generally used for CO3 -R

(a) Low voltage winding (b) High voltage winding

(c) Tertiary voltage winding (d) Any of the above

6. The heat generated in the transformer is dissipated to the surroundings mainly by CO3- R

(a) Conduction (b) Convection (c) Radiation (d) All of the above

7. Larger values of air gap flux density can be adopted while designing induction motors of CO4- R

(a) Larger output (b) Larger diameter of rotor

(c) Both A and B (d) None of the above

8. In induction motor which of the following depends on the leakage reactance? CO4 -R

(a) Starting torque (b)Maximum torque (c) Starting current (d) All of the above

9. Damper windings are provided in synchronous machines to CO5- R

(a) Damp out rotor oscillations

(b) Reduce the over-voltages under abnormal conditions

(c) Facilitate starting

(d) All of the above.

10. In case a synchronous motor starts but fails to develop full torque, the probable cause could be CO5- R

(a) low excited voltage (b) reverse field winding

(c) open or short circuit (d) None of these

PART – B (5 x 2= 10Marks)

11. List the parameters to be mentioned in the rating plates of rotating machinery. CO1 -R

12. Summarize the factors which affect the proportions of the armature core in DC machine. CO2 -U

13. Why is the core of the transformer laminated? CO3 -R

14. Write the expression for the output equation and output coefficient of induction motor. CO4- R

15. Solve to find the total number of slots in the stator of an alternator having 4 poles, 3-phase, and 6 slots per pole for each phase. CO5 -R

PART – C (5 x 16= 80Marks)

16. (a) (i) A 500 kW, 500 V, 455 rpm, 6-pole, DC generator is built with an armature diameter of 0.84 m and core length of 0.35 m. The lap wound armature has 660 conductors. Calculate the specific electric and magnetic loadings. CO1 -App (8)

(ii) State and explain the various classes of insulating materials employed in electrical machines, according to temperature limits. CO1-U (8)

Or

(b) A 15 kW, 230 V, 4 – pole dc machine has the following data: armature diameter =0.25 m armature core length =0.125 m, length of air gap at pole =2.5 mm, flux per pole = 11.7×10^{-3} Wb, (pole arc / pole pitch) = 0.66 . Calculate the mmf required for air gap (i) if the armature surface is treated as smooth (ii) if armature is slotted and gap contraction factor is 1.18. CO- App (16)

17. (a) (i) Determine the no. of poles, main dimensions, pole pitch and armature mmf/pole of a 92 kW, 220 V, 1480 rpm DC motor whose full load efficiency is 89.76%, Specific magnetic loading is 0.545 T and specific electric loading is 32,750 AC/m. The pole arc to pole pitch ratio as 0.67. Assume square pole face. CO2- App (12)

Or

(b) Determine the diameter and length of the armature core for a 55 kW, 110 V, 1000 rpm, and 4 pole DC shunt generator. Assume Specific magnetic loading 0.5 T, Specific electric loading 26000 ampere–conductors/m, Pole arc should be about 70% of pole pitch and length of core about 1.1 times the pole arc, Allow 10 A for field current and a voltage drop of 4 V for the armature circuit. Specify the winding used and also determine the suitable values for the number of armature conductors and number of slots. CO2- App (16)

18. (a) (i) The window in the core if a 2200/400 V, 50 kVA, 50 Hz, 1-phase, core type transformer has a gross available area of 340 cm^2, space factor being 0.35, maximum core density is 1.0 Wb/m^2 and current density is 2.1 A/mm^2. Use a square section for which $A_i=0.45\ d^2$ and width of core is o.71d. Assume iron stacking factor as 0.9 CO3- App (10)

Estimate with neat diagram:

1) Sectional area of iron in the limb
2) Dimensions of window if the distance between the centres of the square section core is twice the core width.
3) No. of primary and secondary turns and conductor cross-section of the windings.

(ii) Calculate the value of no-load current of 220/110 V, 1 kVA, 50 Hz, 1-phase transformer having a net core area of 25 cm^2 and the length of mean flux path of magnetic core is 40 cm. The total iron used in the transformer core is 8 kg. The core is operating at a flux density of 1.2 Wb/m^2 for which MMF required per metre length is 200 amp-turns. The specific core loss is 1 watt/kg. CO3- App (6)

Or

(b) The tank of 1250 kVA, natural oil cooled transformer has the dimension length, width and height as 0.65 x 1.55 x 1.85 m respectively. The full load loss =13.1 kW, loss dissipation due to radiation and convection is 6 and 6.5 $W/m^2/^oC$, improvement in convection due to provision of tubes = 40%, temperature rise = 40^oC, length of each tube = 1m, diameter of tube =50 mm. Find the number of tubes for this transformer. Neglect the top and bottom surface of the tank as regards the cooling. CO3 -App (16)

19. (a) Determine the main dimensions, no. of stator slots and no. of stator conductors/slot of a 140 HP, 3300 V, 50 Hz, 12 pole, Y-connected slip ring induction motor with the following design data. CO4- App (16)

Average gap density = 0.4 Wb/m^2 ; Ampere conductors/m = 25000

Efficiency = 90 % ; Power factor = 0.9; Winding factor = 0.96

Maximum slot loading = 500 AC

Choose main dimensions for best power factor condition.

Or

(b) (i) A 3-phase, 11 kW, 440 volt, 50 Hz, 6 pole delta connected squirrel cage induction motor has 54 stator slots each containing 28 conductors. Calculate the value of bar and end ring currents. The no. of rotor bars is 67. The machine has an efficiency of 86% and a power factor of 0.85. The rotor mmf is 80% of stator mmf. CO4 -App (8)

(ii) Calculate the magnetizing current of a 450V, 4 pole, 3-phase, 50 Hz, Delta connected Induction motor having the following data. CO4- App (8)

No. of stator slots = 36; No. of stator conductors/slot= 30
Stator bore diameter = 13 cm; Axial length of stator = 13 cm
Effective air-gap length = 0.1 cm
Winding is full pitched, Phase spread angle is 60^o. Assume that the iron has infinite permeability.

20. (a) Determine for a 500 kVA, 6600 V, 50 Hz, 500 rpm, Y-connected 3-phase salient pole alternator. Assume ψ =0.68 CO5 -App (16)

i) The diameter at the air-gap
ii) Core length for square pole face
iii) No. of stator slots
iv) No. of stator conductors for double layer winding

Assume Specific magnetic loading = 0.6 Tesla; Specific electric loading = 30000 AC/m; Winding factor = 0.955

Or

(b) (i) The design data of a 1500 kVA, 3-phase, 50 Hz, 3300 V, Y-connected, 300 rpm, salient pole alternator are given below: CO5- App (10)

Stator bore = 2.0 m; Stator core length = 0.35 m; Pole arc to Pole pitch = 0.66; Turns/phase = 150; Single layer full pitched coil with 5 conductors/slot and SCR = 1.2. Calculate Specific magnetic loading, Armature mmf/pole, Gap density over the pole arc and Air-gap length.
Assume mmf required for air gaps 88% of the no load field mmf, Gap contraction factor is 1.15 and Phase spread angle is 60^o.

(ii) A 500 kVA, 3.3 kV, 50 Hz, 600 rpm, Star connected salient pole synchronous generator has 200 turns/phase. Given that no load field mmf of the generator is 5450 AT. Find the SCR of the generator. Assume winding factor as 0.955. CO5- App (6)

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