Faculty of Engineering & Technology

Fifth Semester B.E. (Electrical Engg.) (C.B.S.)

Examination

ELECTRICAL MACHINE DESIGN

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Assume suitable data wherever necessary.

(3) Illustrate your answers wherever necessary with the help of neat sketches.

(4) Use of non-programmable calculator is allowed.

1. (a) Derive the expression of temperature rise of the machine when it is heated. 7

(b) Transformer gave a temperature rise of 20°C after 1 hour and 32°C after 2 hours on continuous full load. What is the final steady temperature rise on this load ? Also find heating time constant. 6

OR

2. (a) Discuss different ratings of rotating machine. 6

(b) The heat run on a D.C. motor gave the following results :

Time (minutes)	Temperature (°C)
0	50
15	56.6
30	61.8
45	65.8
60	69
75	71.2

Calculate the final steady temperature rise and the time constant of the machine if the ambient temperature is 30°C. 7

3. (a) Calculate approximate overall dimensions for a 200 kVA; 6600/440 V; 50 Hz; 3 phase core type transformer. The following data may be assumed : 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; Overall height = Overall width; Stacking factor = 0.9. Use a 3 stepped core. 8

(b) What is ideal cross section of core ? 5

OR

4. (a) 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 flux density of 1 wb/m^2, a current density 1.4 A/mm^2 and a window space factor of 0.2. The height of window is 3 times its width. 7

(b) Develop the output equation for a single phase as well as a three phase transformer. 6

5. (a) A 250 kVA, 6600/400 V, 3-phase core type transformer has a total loss of 4800 W at full load. The transformer tank is 1.25 m in height and 1 m × 0.5 m in plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35°C. The diameter of tubes is 50 mm and are spaced 75 mm from each other. The average height of tubes is 1.05 m. Specific heat dissipation due to radiation and convection is respectively 6 and 6.5 W/m^2-°C. Assume that convection is improved by 35% due to provision of tubes. 8

(b) Explain different properties of transformer oil. 6

OR

6. (a) Explain the necessity and working of 'OFF load tap changer' for transformer. 6

(b) A 15000 kVA, 33/6.6 kV, 3-phase, star-delta, core type transformer has the following data :

Net Iron area of each limb = 150×10^{-3} m^2

Net area of yoke = 180×10^{-3} m^2

Mean length of flux path in each limb = 2.3 m

Mean length of flux path in each yoke = 1.6 m

Number of turns in H.V. winding = 450

Calculate the no load current. Use the following data :

Bm (wb/m^2)	**mmf (A/m)**	**Iron loss (W/kg)**
0.9	130	0.8
1.0	210	1.3
1.2	420	1.9
1.3	660	2.4
1.4	1300	2.9

8

7. (a) Determine the main dimensions, turns per phase, number of slots and conductor cross section area

of 250 HP, 3 phase, 50 Hz, 400 V, 1410 rpm slip ring induction motor. Assume B_{av} = 0.5 wb/m^2, ac = 30,000 A/m, efficiency = 0.9 and power factor 0.9, winding factor = 0.955, current density = 3.5 A/mm^2. The ratio of core length to role pitch is 1.2. The machine is delta connected. 7

(b) Derive the output equation of an Induction motor. 6

OR

8. Determine the main dimensions, number of radial ventilating ducts, number of stator slots and the 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 also.

Assume : average flux density in gap = 0.45 wb/m^2; ampere conductors per meter = 23,000; efficiency = 0.85; power factor = 0.84; winding factor = 0.955; stacking factor = 0.9.

Machines rated at 3.7 kW, 4 pole are sold at a competitive price and therefore choose the main dimensions to give a cheap design. 13

9. (a) Why the flux density at 60° from interpolar axis is considered for calculating magnetizing current of 3-phase induction motor ? 6

(b) A 15 kW, 400 V, 3-phase, 50 Hz, 6 pole induction motor has a diameter of 0.3 m and length of core is 0.12 m. The number of stator slots is 72 with 20 conductors per slot. The stator is delta connected. Calculate the value of magnetizing current per phase if the length of air-gap is 0.5 mm. The gap contraction factor is 1.2. Assume the mmf required for iron parts to be 35% of the air-gap mmf. Coil span = 11 slots. 8

OR

10. A 15 kW, 3-phase, 6-pole, 50 Hz squirrel cage induction motor has the following data :

Stator bore diameter = 0.32 m; axial length of stator core = 0.125 m; Number of stator slots = 54; Number of conductors per stator slot = 24; current in each stator conductor = 17.5 A; full load power factor = 0.85 lagging.

Design a suitable cage rotor giving number of rotor slots, section of each bar section of each ring The full load speed is to be about 950 rpm approximately. Use copper for the rotor bars and end rings. Also calculate speed of rotor. Resistivity of copper is 0.02 Ω/m and mm^2. 14

11. (a) Determine a suitable number of slots and conductor per slot for stator winding of 3-phase, 3300 V, 50 Hz, 300 rpm alternator. Diameter is 2.3 m and axial length of core is 0.35 m. The maximum flux density in air gap should be approximately 0.9 wb/m^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. 7

(b) What is the effect of SCR on synchronous machine ? 6

OR

12. Write short notes on :—

(i) Advantage of Hydrogen Cooling 5

(ii) Run-away speed 4

(iii) Distribution factor and pitch factor. 4