CBCS SCHEME

USN | | | | | | | | | | 18EE55

Fifth Semester B.E. Degree Examination, June/July 2025
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: 1.Answer any FIVE full questions, choosing ONE full question from each module.
2.Assume any missing data.

Module-1

1 a. Explain the principles of design of electrical machines. What are the limitations in design? **(10 Marks)**

b. Mention any five properties of Insulating and conducting materials used in electrical machines. **(10 Marks)**

OR

2 a. Discuss the classification of insulating material based on heat resisting properties with two examples of each. **(10 Marks)**

b. What are the desirable properties of magnetic materials? Explain in brief magnetic materials and its classification. **(10 Marks)**

Module-2

3 a. Derive the output equation of DC machine with usual notations. **(06 Marks)**

b. Define specific magnetic and electric loading for DC machine. **(04 Marks)**

c. Calculate the diameter and length of armature for a 7.5 KW, 4pole, 1000 rpm, 220 V shunt motor. Given full load efficiency is 83%. Maximum gap flux density = 0.9 wb/ m^2, specific electric loading = 30000 ac/m ; Field form factor = 0.7 ; Assume that the maximum efficiency occurs at full load and the field current is 2.5% of rated current. The pole face is square. **(10 Marks)**

OR

4 a. Discuss in detail the factors to be considered for selection of number of poles of DC machine. **(10 Marks)**

b. Determine the main dimensions, number of poles and the length of air gap of a 600 kw, 500 v, 900 rpm, generator. Assume average gap density as 0.6 wb/m^2 and the ampere conductors per meter as 35000. The ratio of pole arc to the pole pitch is 0.75 and the efficiency is 91%. The following are the design constraints :

Peripheral speed 40 m/s

Frequency of flux reversals ≯ 50 Hz

Current per brush arm ≯ 400A and

Armature mmf per pole ≯ 7500 AT.

The mmf required for airgap is 50% of armature mmf and gap contraction factor is 1.5. **(10 Marks)**

Module-3

5 a. Derive the output equation of single phase and three phase transformer. **(10 Marks)**

b. Calculate the KVA output of single phase transformer from the following data.

Core light

Distance between core centers = 0.28

Diameter of circumscribing circle

Distance between core centers = 0.56

Net iron area

Area of circumscribing circle = 0.7

Current density = 2.3 A/mm^2 ; K_w = 0.27; f = 50 Hz Flux density in the core = 1.2 wb/m^2.

Distance between core centres = 0.4 m. **(10 Marks)**

OR

6 a. The tank of 1250 KVA, natural oil cooled transformer has the dimensions length, width and height 0.65 × 1.55 × 1.85 m respectively. The full load loss = 13.1 kw ; loss dissipation due to radiations = 6w/m^{2}c°; loss dissipation due to convections = 6.5 w/m^{2}c° : improvement in convection due to provision of tubes = 40%; temperature rise = 40°C ; length of each tube = 1 m diameter of the tube = 50 mm; Find the number of tubes for this transformer. Neglect the top and bottom surface of the tank as regards the cooling. **(10 Marks)**

b. Derive an expression for leakage reactance of core type transformer. **(10 Marks)**

Module-4

7 a. Discuss on choice of choosing higher specific loadings for Induction Motor. **(05 Marks)**

b. Write a note on choice of length of air gap. **(05 Marks)**

c. Find the main dimensions of 15 kw, 3 phase, 400 volts, 50 Hz, 2810 rpm squirrel cage induction motor having an efficiency of 88% and full load power factor of 0.9. Specific magnetic loading is 0.5 wb/m^2 and specific electric loading is 25000 ac/m. Take rotor peripheral speed as approximately 20 m/sec. at synchronous speed. **(10Marks)**

OR

8 a. With usual notations, derive output equation for a three phase induction motor. **(10 Marks)**

b. Determine the main dimensions of 70 hp, 415 v, 3 phase, 50 Hz, y-connected 6 pole induction motor for which Bav = 0.51 wb/m^2 ; ac = 30000 ac/m; Take η = 90%, power factor = 0.91. Assume τ = L. Estimate the number of stator conductors required for a winding in which the conductors are connected in 2 – parallel paths. Choose a suitable number of conductors per slot, so that slot loading does not exceed 750 AT. **(10 Marks)**

Module-5

9 a. Define short circuit ratio in connection with 3 phase synchronous generators. Explain their effects. **(10 Marks)**

b. Discuss any five factors to be considered in selection of number of slots in synchronous machine. **(10 Marks)**

OR

10 a. A 1250 KVA, 3 phase, 50 Hz, 3300 v, 300 rpm synchronous generator with a concentric winding has the following design data. Bav = 0.58 wb/m^2, ac = 33000 ac/m, lg = 5.5 mm, Field turns per pole = 60, SCR = 1.2. The effective gap area is 0.6 times the actual area. Peripheral speed is 30 m/s. Find the stator core length, stator bore, turns per phase, mmf for air gap, armature mmf per pole and field current for No load and rated voltage. **(10 Marks)**

b. The fixed coils of a salient pole alternator are wound with single layer winding of bare conductor or 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 AT with potential difference of 5V 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. **(10 Marks)**