

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (OLD) EXAMINATION – WINTER 2023****Subject Code:2170909****Date:01-12-2023****Subject Name: Design of AC Machines****Time:10:30 AM TO 01:30 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Write the output equation of 3-phase induction motor in usual notation with meaning of each notation.	03
	(b) Explain the terms “critical speed” and “run-away speed” with reference to synchronous machine.	04
	(c) Determine the main dimensions, no. of stator slots and the no. of turns per phase of a 3.7 kW, 400 volt, 3- ϕ , 4 pole, 50 Hz, squirrel cage IM to be started by a star delta starter. Work out the winding details. Assume: Avg. flux density in the gap = 0.45 Wb/m ² , ampere conductors per meter = 23000, efficiency = 0.85 and power factor 0.84. 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. Assume winding factor = 0.955, staking factor = 0.9.	07
Q.2	(a) Write a brief note on overall design of 1- ϕ induction motor.	03
	(b) Derive D^2L in single phase induction motor is 1.5 times of three phase induction motor for same output and speed.	04
	(c) Explain with net diagram current distribution in squirrel cage induction motor.	07
OR		
Q.3	(c) Compare the output equation of both 1- ϕ and 3- ϕ IM.	07
	(a) Define terms a) Crawling, b) Cogging, and c) Skewed rotor slots.	03
	(b) What is dispersion coefficient? What is its effect on max. power factor.	04
	(c) A 11 kW, 3- ϕ , 4 pole, 50 Hz, 220 V, star connected IM has 54 stator slots, each containing 9 conductors. Calculate the values of bar and end ring currents. The no. 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 per cent of stator mmf.	07
OR		
Q.3	(a) Define ‘electric loading’ and ‘magnetic loading’ in connection with 3- ϕ induction motor.	03
	(b) Prove that torque produce by 5 TH harmonics is in backward direction & 7 TH harmonics is in forward direction.	04
	(c) Estimate the stator core dimensions, no. of stator slots and no. of stator conductors per slot for a 100 kW 3300V, 50 Hz, 12 pole star connected slip ring induction motor. Assume: Average gap density = 0.4 Wb/m ² ,	07

Conductors per meter = 25,000 A/m,
 Efficiency = 0.9, power factor = 0.9 and winding factor = 0.96.
 Choose main dimensions to give best power factor. The slot loading should not exceed 500 ampere conductors.

- Q.4** (a) Explain the difference between turbo and hydro alternator in a point of view of design. **03**
- (b) What is the role of damper winding in (i) synchronous generator and (ii) synchronous motor? **04**
- (c) Determine the main dimensions for a 1000 kVA, 50 Hz, 3 phase, 375 r.p.m. alternator. The average air gap flux density is 0.55 Wb/m² and the ampere conductors per meter are 28000. Use rectangular poles and assume a suitable value for ratio of core length to pole pitch in order that bolted on pole construction is used for which the maximum permissible peripheral speed is 50 m/s. The runaway speed 1.8 times the synchronous speed. **07**

OR

- Q.4** (a) Define SCR and its importance in designing of synchronous machine. **03**
- (b) State why a turbo alternator has smaller diameter and large length, but hydro alternator has larger diameter and small length **04**
- (c) A 500 kVA, 33 kV, 50 Hz, 600 r.p.m. 3 phase salient pole alternator has 180 turns per phase. Estimate the length of airgap if the average flux density is 0.54 Wb/m²; the ratio pole arc to pole pitch, 0.65; the short circuit ratio, 1.2; the gap contraction factor, 1.15, and the winding factor, 0.955. The mmf required for gap is 80% of no load field mmf and the winding factor, 0.955. **07**

- Q.5** (a) Derive the equation of MMF of damper winding. **03**
- (b) Briefly explain the methods for improving e.m.f. wave form of an alternator. **04**
- (c) Explain significance of FEM in design problem **07**

OR

- Q.5** (a) Explain the advantages of finite element method. **03**
- (b) Explain application of FEM technique for design problems **04**
- (c) Write the steps and necessary equations for rotor design of a synchronous machine **07**
