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B.Tech DEGREE EXAMINATION, DECEMBER 2023

Fifth Semester

18EEE305T - DESIGN OF ELECTRICAL MACHINES

(For the candidates admitted during the academic year 2020 - 2021 & 2021 - 2022)

Note:

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

PART - A (20 × 1 = 20 Marks)

Answer **all** Questions

		Marks	BL	CO
1.	The mmf required for the air gap is calculated by (A) $I_z Z$ (B) Only Iz (C) Only Z (D) Iz P	1	1	1
2.	The Carter's coefficient depends upon the ratio of (A) gap length/ Slot width (B) slot width/gap length (C) No. of slots/No. of poles (D) No. of poles/No. of slots	1	1	1
3.	The effective gap length is given by $l_{gs} = K_g l_g$, where K_g is called (A) gap factor (B) gap leakage factor (C) gap expansion factor (D) gap smooth factor	1	2	1
4.	The apparent flux density is defined as the ratio between (A) tooth area and actual flux in a tooth (B) actual flux in a tooth and tooth area (C) tooth area and total flux in a slot pitch (D) total flux in a slot pitch and tooth area	1	2	1
5.	The interpoles are placed between main poles in DC machines for (A) Improving voltage (B) Improving flux (C) Improving armature reaction (D) Improving the commutation	1	1	2
6.	The output equation of the DC machine is related to (A) L^2D (B) DL (C) D^2L (D) D^3L	1	1	2
7.	The ratio of copper area and total winding area is defined as (A) winding factor (B) space factor (C) copper factor (D) net iron factor	1	2	2
8.	The 'size of the machine' in DC generator is the choice of (A) both gap density and armature conductor per meter (B) armature conductor per meter only (C) gap density only (D) stator conductor	1	2	2
9.	The high temperature in the winding of the rotating machine due to (A) higher value of ac (B) lower value of B_{av} (C) higher value of Bav (D) lower value of ac	1	1	3
10.	Voltage per turn (E_t) in a single phase transformer is given by (A) 3.33 f Φm (B) 4.44 f Φm (C) 1.11 f Φm (D) 2.22 f Φm	1	1	3
11.	The total conductor area in window of a single phase transformer is (A) 2AT x Φ (B) 4AT x Φ (C) 2AT/Φ (D) 4AT/Φ	1	1	3

12.	The window space factor is defined as the ratio of copper area in window to (A) the total area of winding (B) the total area of core (C) the total area of cooling tube (D) the total area of window	1	1	3
13.	The choice of average flux density in air gap of induction motor is (A) Temperature rise (B) Voltage (C) Copper loss (D) Power factor	1	1	4
14.	The ratio of core length to pole pitch for good overall design of induction motor is (A) 1.5 (B) 0.5 (C) 1.0 (D) 2	1	1	4
15.	The current density (A / mm^2) in the stator winding of the induction motor is usually between (A) 1.5 to 2 (B) 3 to 5 (C) 0.5 to 1 (D) 2.5 to 2.95	1	1	4
16.	The number of slots in three phase induction motor depends on (A) Leakage reactance (B) Overall capacity (C) Copper loss (D) Temperature rise	1	1	4
17.	The hydraulic turbine(s) used at water heads up to 50 m is (A) Kaplan turbine (B) Pelton wheel Turbine (C) Francis turbine (D) Wind turbine	1	1	5
18.	The values of allowable peripheral speed for bolted on pole construction is (A) 60 m/s (B) 50 m/s (C) 40 m/s (D) 45 m/s	1	1	5
19.	The synchronous machine performance which effected by the value of SCR is (A) voltage regulation only (B) Stability only (C) stability and voltage regulation (D) speed	1	1	5
20.	The choice of specific magnetic loading of synchronous machine design is (A) Power factor (B) Copper loss (C) Temperature rise (D) Voltage	1	1	5

PART - B (5 × 4 = 20 Marks)

Answer **any 5** Questions

		Marks	BL	CO
21.	Define gap contraction factor for slots and field form factor.	4	2	1
22.	Derive the output equation of DC machine.	4	2	2
23.	Define window space factor and core area factor.	4	2	3
24.	Explain the procedure of selection of number of poles in DC machine.	4	2	2
25.	Deduce the relation between emf per turn and kVA rating of a single phase transformer.	4	2	3
26.	Discuss the factors affecting on the selection of air gap length in three phase induction motor	4	2	4
27.	Explain the effect of SCR on synchronous machine performance.	4	2	5

PART - C (5 × 12 = 60 Marks)

Answer **all** Questions

		Marks	BL	CO

28.	(a) Derive the expressions for real and apparent flux densities and also deduce the relation between them.	12	2	1
	(OR)			
	(b) (i) Derive the expression for Thermal Resistivity of winding. (ii) A field coil has a cross section of 100×50 mm^2 and its length of mean turn is 1 m. Estimate the hot spot temperature above that of the outer surface of the coil if the total loss in the coil is 120 W. Assume S_f=0.56 and Thermal Resistivity of insulating material is 8 Ω-m.			
29.	(a) Determine the diameter and length of armature core for a 55 kW, 110 V, 1000 rpm, 4 pole shunt generator assuming specific electric and magnetic loadings of 26000 amp.cond./m and 0.5 Wb/m^2 respectively. The pole arc should be 70% pole pitch and length of core about 1.1.times the pole arc. Allow 10A for field current and take voltage drop of 4 volt for armature circuit. Design a suitable armature windings.	12	3	2
	(OR)			
	(b) Determine the total commutator losses for an 800 kW, 400 V, 300 rpm, 10 pole generator having commutator diameter 1 m, current density in brushes 0.075 A/mm^2, brush pressure 14.7 kN/m^2, co-efficient of friction 0.23 and total brush contact drop 2.2 V.			
30.	(a) Estimate the main dimensions including winding conductor area of 3 phase delta-star core type transformer rated at 300 kVA, 6600/440 V, 50 Hz. A suitable core with three steps having a circumscribing circle of 0.25m diameter and a leg spacing of 0.45m is available. Assume E_t =8.5 V, current density = 2.5 A/mm^2, K_W = 0.28 and S_f= 0.9.	12	3	3
	(OR)			
	(b) Design a suitable cooling tank with cooling tubes for a 1250 kVA, natural oil cooled transformer having following dimension's length x width x height as 0.65 x 1.55 x1.85 m respectively. The full load loss =13.1 kW improvement in conduction due to provision of tubes = 35%, temperature rise = 35° c, length of the each tube = 1 m, diameter of the tube = 50mm. Find the number of cooling tubes for this transformer.			
31.	(a) (i) Discuss the factors which are considered for choice of specific magnetic loading in induction motor. (ii) Explain the step wise procedure to design squirrel cage rotor for an induction with necessary equations.	12	3	4
	(OR)			
	(b) Estimate the stator core dimensions, number of stator slots and number of stator conductors per slot for a 100 kW, 3300V, 50 Hz, 12 pole, star connected slip ring induction motor. B_{av} =0.4 Wb/m^2 , ac =25000 amp.cond./m, efficiency =0.9, pf=0.9. Choose main dimensions to give best power factor. The slot loading should not exceed 500 amp. conductors.			
32.	(a) (i) Derive a relation between output kVA of an alternator to its main dimensions, specific loading and speed. (ii) Describe the the procedure to find the length of air-gap in synchronous machine.	12	3	5
	(OR)			
	(b) Determine the main dimensions of a 75000 kVA, 13.8 kV, 50 Hz, 62.5 r.p.m., 3 phase, star-connected alternator. Also find the number of stator slots, conductors per slot, conductor area and work out the winding details. The peripheral speed should be about 40 m /s. Assume, average gap density =0.65 Wb/m^2 , ampere conductors per meter =40,000 and current density 4A/mm^2 .			

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