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

Model Question Paper (CBCS - 18 Scheme)
Fifth Semester B.E. Degree Examination
Electrical Machine Design

TIME: 03 Hours **Max. Marks: 100**

Note: 1.Answer any FIVE full questions, choosing at least ONE question from each MODULE.
. 2. Design Data hand book is allowed if necessary

Q. No		MODULE 1	RBT Level	Marks
1	a.	Discuss the Design factors to be considered for designing Electrical Machine	L1,L2	10 marks
	b.	Briefly Discuss on any five limitations imposed during Electrical Machine Design.	L1, L2	10 marks
		OR		
2	a.	Mention any Five properties of Insulating and Conducting materials used in electrical machines.	L2	10 marks
	b.	Discuss the classification of insulating material based on heat resisting properties with 2 examples of each type.	L1, L2	10 marks
		MODULE 2		
3	a.	Derive the output equation of DC machine	L2, L3	6 marks
	b.	Define specific magnetic loading and electric loading for DC machine	L1	4 marks
	c.	Calculate the diameter and length of armature core of a 70KW, 240V, 900 rpm, 4 pole D.C shunt generator. The average flux density is 0.7 Wb/m^2 and ac/m is 34000. The ratio of core length to pole pitch is 0.8. Full load armature drop is 9.6 V and field current is 3A.	L2, L3,L4	10 marks
		OR		
4	a.	Discuss in detail the factors to be considered for selection of number of poles of DC machine.	L2, L3	10 marks
	b.	During the design of armature of a 1000KW, 500V, 10pole, 300rpm, DC compound generator following information has been obtained. External Diameter of the armature=1.4m, Gross core length=0.35m, Flux/pole=0.105Wb. Based on the above design information find out the following details regarding the design of field system. i) Axial length of the pole; ii) width of the pole; iii) Pole arc; iv) Depth of yoke	L2, L3,L4	10 marks

		MODULE 3		
5	a.	Starting from the basic EMF equation derivation, Obtain an expression for EMF per turn in terms of output of the transformer. Write a note on factor K.	L2, L3	10 marks
	b.	Calculate approximate overall dimensions for a 200 KVA, 6600/440 V, 50 Hz, 3 -ϕ core type transformer. The following data may be assumed: flux density B_m=1.3 Wb/m^2, Current density δ=2.5 A/mm^2, window space factor K_w=0.3, Overall height is equal to Overall width, Iron factor Ki= 0.9, EMF/turn=10V, Use 3 stepped core. For a 3 stepped core: Wd= 0.9d; Ai= 0.6 d^2 . Verify overall height is same as that of overall width of the transformer.	L2, L3,L4	10 marks
		OR		
6	a.	Derive an expression for leakage reactance of core type transformer. List the assumptions made for obtaining the expression.	L2, L3	10 marks
	b.	A 1000 KVA, 6600/440V, 3-phase core type transformer has the following design details. Distance between centres of adjacent limbs = 0.47 Outer dia of HV winding= 0.44 m Height of frame= 1.24 m Core loss= 3.7 kW I^2R Loss= 10.5 kW Design a suitable tank for transformer and number of cooling tubes. The average temperature rise is to be limited to 35° C. The diameter of tubes is 50mm and the average height of tubes is 1.4 m. Allow clearance along width as 14 cm, breadth as 18 cm, and height as 60 cm. Specific heat dissipation due to radiation and convection is 6 & 6.5 W/mt^2/◦C respectively**.** Assume that convection is improved by 35% due to provision of tubes	L2, L3,L4	10 marks
		MODULE 4		
7	a.	With usual notations, derive output equation for a three phase induction motor	L2, L3	6 marks
	b.	Discuss on choice of choosing higher specific loadings for induction motor	L1, l2	6 marks
	c.	Find the main dimension of a 15 KW, three phase , 400v, 50 Hz, 2810 rpm, squirrel cage IM having an efficiency of 0.88 and full load power factor of 0.9. Take the rotor peripheral speed as 20 m/sec at synchronous speed. Assume specific electric loading= 25000ac/m and specific magnetic loading= 0.5 Wb/m^2	L2, L3,L4	8 marks
		OR		

8	a.	Write a note on choice of length of air gap and Crawling	L1, L2	8 marks
	b.	Determine the main dimensions , number of radial ventilating ducts, number of stator slots and the number of staor slots and the number of turns per phase of a 3.7 kw, 400v, three phase, 4 pole 50 Hz squirrel cage induction motor to be started by star delta starter. Assume, average air gap densit= 0.45 Wb/m^2, ampere conductor/meter 23000, efficiency= 0.85, power factor= 0.84, Winding factor= 0.955, stacking factor= 0.9 and core length to pole pitch= 1.5	L2, L3,L4	12 marks
MODULE 5				
9	a.	Enumerate the advantage and Disadvantages of providing large airgap in synchronous machine.	L1, L2	6 marks
	b.	Define 'SCR' of a synchronous machine. Discuss the effect on performance of the machine	L2, L3	4 marks
	c.	Determine the main dimensions of 1000KVA, 50Hz, 3 phase, 375 rpm alternator. The average air gap density is 0.55 Wb/m^2, ampere conductor/meter 28000. Use rectangular poles, assume ratio of core length to pole pitch as 2. Max permissible peripheral speed is 50m/sec. The runaway speed=1.8 times the synchronous speed. Assume winding factor as 0.995.	L2, L3,L4	10 marks
OR				
10	a.	Discuss the factors which influences the selection of armature slots of synchronous machine	L1, L2	8 marks
	b.	A 2500KVA, 225rpm, 3phase, 60Hz, 2400V, star connected salient pole alternator has the following design data Stator bore=2.5m; corelength=0.44m; slot/pole/phase=3; Conductors/slot=4; circuits/phase=2; leakage factor=1.2; winding factor=0.95. The flux density in pole core is 1.5 Wb/m^2. The winding depth=30mm; the ratio of full load field mmf to armature mmf is 2; field winding space factor is 0.84 & field winding dissipates 1800w/ m^2 of inner & outer surface without the temperature rise exceeding the permissible limit. Leave 30mm for insulation, flanges & height of pole shoe along the height of pole. Find (a) The flux per pole (b) length & width of the pole (c) winding height (d) pole height	L2, L3,L4	12 marks

Model Question Paper-1 with effect from 2020-21 (CBCS Scheme)

USN | | | | | | | | | | |

Fifth Semester B.E. Degree Examination

Electrical Machine Design

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. Assume any missing data.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Explain the principles of design of electrical machines. What are the limitations in design?	L2	10
	b	What are the desirable properties of magnetic materials? Explain in brief magnetic materials and its classification.	L2	10
		OR		
Q.02	a	What are the desirable properties of insulating materials? Illustrate the classification of insulating materials based on thermal consideration as per IS 1271-1958.	L3	08
	b	What are the desirable properties of conducting materials? Compare aluminum and copper wire as conducting material for design of electrical machines.	L4	07
	c	Write brief note on Cold Rolled Grain Oriented (CRGO) steel used in electrical machines.	L2	05
		Module-2		
Q. 03	a	With usual notations, derive output equation of DC Machine.	L3	08
	b	Define "specific magnetic loading" and "specific electric loading". What are advantages and disadvantages of using higher specific loading?	L2	06
	c	A 5 KW, 250V, 4 pole 1500rpm shunt generator is designed to have a square pole face. The loadings are: average flux density B_{av}=0.42Wb/m^2 and ampere conductors per metre ac=15000A/m. Find the main dimensions of the machine. Assume full load efficiency = 0.87 and ratio of pole arc to pole picth=0.66	L3	08
		OR		
Q.04	a	Discuss the various factors which govern the choice of number of poles in a d.c. machine.	L3	10
	b	Determine the main dimensions, number of poles of a 600 KW, 500V, 900 r.p.m.generator. Assume average gap density as 0.6 wb/m^2 ampere conductors per metre as 35000. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 91%. The following are the design constraints. Peripheral speed > 40m/s, frequency of flux reversals > 50Hz, current per brush arm > 400A and armature mmf per pole > 7500A. The mmf required for air gap is 50% of armature mmf and gap contraction factor is 1.15.	L3	10

Module-3				
Q. 05	a	Derive the output equation of a three phase core type transformer and also prove that EMF/turn of a single phase transformer is $K\sqrt{Q}$ where Q=output KVA rating of transformer per phase.	L4	10
	b	Determine the dimensions of core, the number of turns, the cross section area of conductors of primary and secondary windings of a 100KVA, 2200V/480V single phase core type of transformer to operate at a frequency of 50Hz by assuming the following data: Approximate volts per turn =7.5V, maximum flux density of 1.2 Weber/m^2. Ratio of effective cross section area of core to the square of the diameter of circumscribing circle is 0.6, Ratio of height to width of window is 2.0, window space factor K_w =0.28, current density δ=2.5A/mm^2.	L3	10
OR				
Q. 06	a	What is window space factor? Find the width of the window for the optimum output of a transformer.	L3	06
	b	Explain the procedure to calculate No-load Current (Io) of single phase transformer.	L3	06
	c	Design a suitable transformer tank with cooling tubes for a 1000 KVA, 6600/440V, 50 Hz, 3phase transformer with the following data: Distance between centre of adjacent limbs = 0.47m Outer diameter of HV winding = 0.44m Height of frame = 1.24m Core loss = 3.7 KW I^2R loss = 10.5 KW. Temperature rise of oil should not exceed 35^0C. Take diameter of tube as 50mm and length 1.4m. The specific heat dissipation from the tank wall is 6 W/m^2 ^{0}C and is 6.5 W/m^2 ^{0}C due to radiation and convection respectively. Assume that the dissipation is improved by 35% due to convection.	L5	08
Module-4				
Q. 07	a	With usual notations derive the output equations of 3-ϕ induction machine.	L5	10
	b	Estimate the stator dimensions, number of stator slots and number of stator conductor per slot for a 100kW, 3300V, 50Hz, 12 pole, star connected slip ring induction motor. Assume an average flux density of 0.4 webers/m^2 in the air gap, ampere conductors per meter as 25,000, efficiency is 90%, power factor=0.9 and winding factor =0.96. Choose main dimensions to give best power factor. The slot loading must not exceed 500 ampere conductors.	L5	10
OR				
Q. 08	a	Discus the factors to be considered while deciding the length of air gap, number of stator and rotor slots in an Induction motor.	L2	10
	b	A 15KW, 3 phases, 6 poles, 50Hz squirrel cage induction motor has the following data: Stator bore diameter = 0.32m, axial length of stator core = 0.125m, number of stator slots = 54, number of conductors per stator slots = 24, current in each stator conductor = 17.5A, full load power factor = 0.85 lagging. Design a suitable cage rotor giving number of rotor slots, section of each bar and section of each end ring. The full load speed is to be about 950 r.p.m. approximately. Use copper for the rotor bars and end rings. Resistivity of copper is 0.02Ω/m and $mm^{2.}$ Assume current density = 7 A/mm^2.	L5	10

Module-5				
Q. 09	a	Define short circuit ratio in connection with 3 phase synchronous generators. Discuss its effects on the machine performance.	L3	10
	b	Determine the main dimensions for a 1000KVA, 50 Hz, 3 phase 375 r.p.m. alternator. The average air gap flux density is 0.55 Wb/mm^2 and the ampere conductors per metre 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 is 1.8 times the synchronous speed.	L3	10
OR				
Q. 10	a	Discuss any five factors to be considered in selection of number of slots in synchronous machine.	L3	10
	b	Determine a suitable number of slots and conductors per slot, for the stator winding of a 3 phase 3300 V, 50 Hz, 300 rpm alternator. The diameter is 2.3 m and the axial length of core is 0.35m. The maximum flux density in the air gap should be approximately 0.9 wb/m^2 .Assume sinusoidal flux distribution. Use single layer winding and star connection for stator.	L3	10