Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN										Course Code	2	1	E	E	5	4	1

Fifth Semester B.E. Degree Examinations, April/May 2024

ELECTRICAL MACHINE DESIGN

Duration: 3 hrs **Max. Marks: 100**

Note: ***1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
2. Missing data, if any, may be suitably assumed.

Q. No		Question	Marks	(RBTL:CO:PI)
		Module-1		
1.	**a.**	Explain the principle of electrical machine design. What are the limitations of the design?	**06**	(2 :1 : 1.3.1)
	b.	List the desirable properties of insulating materials? Explain the classification of insulating materials based on Thermal consideration with examples in each class.	**06**	(2 :1 : 1.3.1)
	c.	Explain in brief magnetic materials, characteristics and application of Sheet Steels.	**08**	(2 :1 : 1.3.1)
		(OR)		
2.	**a.**	Discus modern manufacturing techniques in the design of electrical machines.	**06**	(2 :1 : 1.3.1)
	b.	Write a note on cold rolled-grain oriented sheet steels.	**06**	(2 :1 : 1.3.1)
	c.	List the desirable properties of conducting materials? Distinguish between aluminium and copper wires.	**08**	(2 :1 : 1.3.1)
		Module-2		
3.	**a.**	Explain specific loadings of the DC machine. Derive the output equation of the DC machine.	**06**	(2 :2 : 1.3.1)
	b.	Justify this statement inverted, the total weight of the iron part in the DC machine decreases with increase in the number of poles.	**06**	(2 :2 : 1.3.1)
	c.	Find the main dimension of 200 kW, 250 V, 6 poles, 1000 rpm generator the max value of gap density is 0.87 T, and the ampere conductors per meter of armature periphery are 31000. The ratio of pole arc to pole pitch is 0.67 and the efficiency is 91%. Assume the ratio of the length of the core to pole pitch = 0.75	**08**	(3 :2 : 2.1.2)
		(OR)		
4.	**a.**	Specify the factors that influence the choice of specific loading.	**06**	(2 :2 : 1.3.1)
	b.	List the factors that govern the choice of several armature slots in a DC machine.	**06**	(2 :2 : 1.3.1)
	c.	The rectangular field coil is required to produce an mmf of 8000 A when the power dissipated is 250 W the temperature rises 40^{o} C and the specific dissipation is 30 W/m^2/ ^{o} C from the outer surface neglecting the top and bottom of the coil the length of the turn on the innermost layer is 0.68 m and the coil is 0.15m high. The resistivity of conductors is 0.02 Ω /m/mm^2. Find the current density in the field conductors.	**08**	(3 :2 : 2.1.2)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

Module-3

5. **a.** Prove that emf per turn of a single phase transformer is equal to $K\sqrt{Q}$, where Q = per phase KVA output of the transformer. What are the factors on which the value of K depends? **06** (21 :3 :1.3.1)

b. Show that the ratio of the net core area of a circumscribing circle in a two-stepped core of a transformer is 0.71 **06** (2 :3 : 1.3.1)

c. Calculate approximate overall dimensions for a 200 kVA, 6600/400 volts, 50 Hz, three-phase core type transformer. The following data may be assumed EMF per turn is equal to 10 volts, B_m is equal to 1.3T, current density is equal to 2.5 A/mm^2, window space factor is equal to 0.3, overall height is equal to overall width, and stacking factor is equal to 0.9, use 3 steps Core. **08** (3 :3 : 2.1.2)

(OR)

6. **a.** Obtain an expression for leakage reactance of a transformer with primary and secondary cylindrical coils of equal length stating clearly the assumptions made. **06** (2 :3 : 1.3.1)

b. The full load efficiency of a 300 kVA transformer is 98.2% at upf. Design the number of cooling tubes necessary if the temperature rise is 35^0 C, the tank area may be assumed as 4.92 m^2, assume diameter of tube as 5 cm and average length of tube as 1 m. **06** (2 :3 : 1.3.1)

c. Calculate the no load current of 400 volt, 50 Hz, single phase transformer having the following particulars: Core of Transformer Steel: Stacking factor is equal to 0.9, iron density is equal to 7.8 Kg per metre cube, length of mean flux path is equal to 2.2 m, gross iron area is equal to 10×10^{-3} metre square, primary winding turns equal to 200, joint equivalent to 0.2 mm air gap use following data for calculation : **08** (3 :3 : 2.1.2)

B_m (Wb/m^2)	**0.9**	**1.0**	**1.2**	**1.3**	**1.4**
Mmf/ AT/m	**130**	**210**	**420**	**660**	**1300**
Iron loss (W/kg)	**0.8**	**1.3**	**1.9**	**2.4**	**2.9**

Module-4

7. **a.** How will you find out kVA output if the machine rating is in (i) KW (ii) in hp? Mention the range of values for B_{av} and ac for an induction motor. **06** (2 :4 : 1.3.1)

b. Mention the factors that influence the choice of the specific loadings. **06** (2 :4 : 1.3.1)

c. Find the diameter and length of the stator core of a 7.5 kW, 220 V, 50 Hz, 4 pole, 3-phase induction motor for best power factor. Given that specific magnetic loading = 0.4wb/m^2 specific electric loading=22000 ac/ m, efficiency = 0.86 and power factor = 0.87. Also find the main dimensions if the ratio of core length to pole pitch is unity. **08** (3 :4 : 2.1.2)

(OR)

8. **a.** Discuss the various factors which influence the selection of air gap of an induction motor. **06** (2 :4 : 1.3.1)

b. Explain the crawling and cogging of the induction motor. **06** (2 :4 : 1.3.1)

c. A 415 V, 3-phase, 50 Hz, 6 pole delta connected induction motor has a specific magnetic loading of 5.0 Wb/m^2 and specific electric loading of 24000 ac/m the stator core diameter and length are 0.275 m and 0.15 m respectively. Find the output of the machine if the full load efficiency and power factor are 0.88 and 0.89 respectively. Determine the member of stator slot conductors per slot and the length of the air gap. **08** (3 :4 : 2.1.2)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

Module-5

9.	**a.**	From the first principle obtain the output equation of the phase alternator in terms of specific loadings, diameter, length, and speed in rps of the stator.	**06**	(2 :5 : 1.3.1)
	b.	Explain the term short circuit ratio as applied in synchronous machines. Explain the effect of SCR on machine performance.	**06**	(2 :5 : 1.3.1)
	c.	During the choice of stator of 3-phase, 7.5 mVA, 6.6 kV, 50 Hz 3000 rpm, turbo generator following information have been obtained internal diameter of stator = 075 m gross length of core = 0.9 m number of stator slots /pole /phase = 7, sectional area of stator concoctor =190 m^2 number of conductor/slot = 4 based upon the above date calculate (i) flux per pole (ii) specific magnetic loading (iii) specific electric loading (iv) current density for stator winding	**08**	(3 :5 : 2.1.2)

(OR)

10	**a.**	Explain various factors to be considered while selecting the number armature slots of synchronous machines.	**06**	(2 :5 : 1.3.1)
	b.	Enumerate the advantages of providing a large air gap in synchronous machines.	**06**	(2 :5 : 1.3.1)
	c.	A 500 kVA, 3.3 kV, 50 Hz, 600 rpm, 3-phase, and salient pole alternator has a 180-turn phase. Estimate the length of the air gap if the average flux density is 0.54 Wb/m^2. The ratio of pole arc to pole pitch is equal to 0.66, the mmf required for the air gap is 80 % of no load field mmf and winding factor = 0.955.	**08**	(3 :5 : 2.1.2)

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