Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- VIth SEMESTER–EXAMINATION – MAY- 2012

Subject code: 160804 **Date: 17/05/2012**

Subject Name: Electrical Machine Design

Time: 10:30 am – 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

<table>
<tr><td>Q.1</td><td>(a)</td><td>Deduce an expression for the m.m.f required for the air gap of an armature with slots and ducts.</td><td>07</td></tr>
<tr><td></td><td>(b)</td><td>Determine the apparent flux density in the teeth of a d.c.machine having the following data:
Real flux density = 1.95 Wb/m^2
Slot pitch = 2.8 cm
Slot width = 1.0 cm
Gross core length= 35 cm
Ventilating ducts = 5
Width of each duct= 1.0 cm
Stacking factor = 0.9

Use the following magnetization curve:

<table><tr><td>Flux-density: Wb/m^2</td><td>1.7</td><td>1.8</td><td>1.9</td><td>2.0</td></tr><tr><td>Mmf per metre (Amps).</td><td>10,000</td><td>19,000</td><td>34,000</td><td>100,00</td></tr></table></td><td>07</td></tr>
<tr><td>Q.2</td><td>(a)</td><td>Define heating time constant and explain how it can be evaluated from heating curve.</td><td>07</td></tr>
<tr><td></td><td>(b)</td><td>During a heat run test of a 100 KVA transformer the temperature rise after 1 hour and 2 hours is found to be 24^o C and 34 ^{o} C respectively. Calculate the heating time constant and final steady temperature rise.
If the cooling is improved by using an external fan so that the rate of heat dissipation is increased by 18%, find the new KVA rating for the same final temperature rise. Assume that the maximum efficiency occurs at 80% of full load and unity power factor.</td><td>07</td></tr>
<tr><td></td><td></td><td>OR</td><td></td></tr>
<tr><td></td><td>(b)</td><td>A 30 MVA alternator has a total loss of 1000 Kw.The temperature rise in the machine is limited to 30 ^{o}C.Assume
Inlet air temperature = 25 ^{o}C
Barometric height = 780 mm of mercury.
Pressure = 20 cm of water
Fan efficiency = 40%
Specific heat of air at constant pressure = 0.237 cal/gm- ^{o}C
Volume of 1kg of air at 0 ^{o}C and 760 mm of mercury=0.775 m^3.
Calculate the volume of cooling air required and also the fan power.</td><td>07</td></tr>
<tr><td>Q.3</td><td>(a)</td><td>Deduce an expression for the design of core for Square and cruciform sections also state the reason why circular coils are always preferred in comparison to rectangular coils.</td><td>07</td></tr>
<tr><td></td><td>(b)</td><td>Determine the dimensions of the core and yoke for a 100 KVA, 50 Hz, Single phase, core type transformer. A square core is used with distance</td><td>07</td></tr>
</table>

		between the adjacent limbs equal to 1.6 times the width of the laminations. Assume voltage per turn of 14 volts, maximum flux density 1.1 wbm^2, window space factor 0.32 and the current density 3A/mm^2. Take stacking factor = 0.9.Flux density in the yoke to be 80% of flux density in core.	
		OR	
Q.3	**(a)**	Show that for minimum total material cost of a 3-phase transformer the ratio (Weight of iron/Weight of copper) should be equal to the ratio (specific cost of Copper (Rs. /kg) / specific cost of iron ((Rs. /kg)).	**07**
	(b)	Determine the main dimensions of the core, the number of turns and the area of conductors for a 5 KVA, 50 Hz, 11000/400 V, Single phase, core type distribution transformer. The net conductor area in the window is 60% of the net cross-section (square) of the iron core. Assume a flux density of 1 wb/m^2, a current density of 1.4 A/mm^2 and a window space factor of 0.2.The window height is 3 times its width.	**07**
Q.4	**(a)**	Define specific magnetic loading (Bav) and specific electric loading (ac) and obtain an expression for the "output co-efficient for a d.c. machine.	**07**
	(b)	Calculate the main dimension of a 250 h.p., 3-ph., 50 Hz, 400V, 1410 rpm, delta connected slip-ring induction motor. The data given are: Bav= 0.5 Wb/m^2 , ac=30000 A/m Efficiency and power-factor, both = 90 %; Winding factor =0.955; current density = 3.5 A/mm^2 Slot space factor = 0.4 , ratio of core length to pole pitch =1.2	**07**
		OR	
Q.4	**(a)**	Discuss the factors that determine the choice of air-gap in induction motor.	**07**
	(b)	Find the main dimensions and numbers of poles of a 50 h.p., 230 V, 1400 rpm shunt motor so that a square pole face is obtained. Bav in the gap is 0.5 wb/m^2 and the amp-conductor per meter are 22,000.The ratio of pole arc to pole pitch is 0.7.Assume the efficiency of the machine as 90 percent.	**07**
Q.5	**(a)**	What are the important considerations in choosing number of poles in d.c. machine?	**07**
	(b)	List and explain briefly the limitations being imposed in the design of electrical machines also discuss the modern trends in the design.	**07**
		OR	
Q.5	**(a)**	What are the types of windings commonly used in transformer and on what basis are they selected?	**07**
	(b)	Explain the methods for the estimation of Mmf for the tapered teeth.	**07**

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