

GUJARAT TECHNOLOGICAL UNIVERSITY**B. E. - SEMESTER – VII • EXAMINATION – WINTER 2012****Subject code: 170902****Date: 31/12/2012****Subject Name: Electrical Machine Design - I****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

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

- Q.1 (a)** State the factors to be considered while selecting the number of poles in the design of DC machine. **07**
- (b)** Calculate approximate overall dimensions for a 200 kVA, 6600/440V, 50 Hz, 3 phase core type transformer. The following data may be assumed: emf per turn=10V; maximum flux density=1.3 Wb/m², current density=2.5 A/mm², window space factor=0.3, overall height=overall width, stacking factor=0.9. Use a 3 stepped core. **07**
- For a 3 stepped core,
Width of largest stamping=0.9d and
Net iron area= 0.6d², where d=diameter of circumscribing circle.

- Q.2 (a)** Derive the output equation of a D.C. machine and explain its significance. **07**
- (b)** Determine the main dimensions, number of poles and length of air gap of a 600 kW, 500 V, 900 r.p.m. generator. Assume average gap density as 0.6 Wb/m² and ampere conductors per metre as 35000. The ratio of pole arc to pole pitch is 0.75 and efficiency is 91 percent. **07**
- The following are the design constraints: peripheral speed: ≤ 40 m/s, frequency of flux reversals: ≤ 50 Hz, current per brush arm: ≤ 400 A and armature mmf per pole ≤ 7500 A.
- The mmf required for air gap is 50 percent of armature mmf and gap contraction factor is 1.15.

OR

- (b)** Design a permanent magnet to have minimum volume. The magnet is to produce a flux density of 0.3 Wb/m², in a parallel sided air gap 50 mm square and 6mm long. The demagnetization curve of the magnet material is given below: **07**

B Wb/m ²	0	0.2	0.4	0.6	0.8	1.0	1.1
H A/m	60,000	58,000	55,500	51,000	43,000	24,000	0

- Q.3 (a)** Define specific electric and specific magnetic loading. Also state advantages and disadvantages of these loadings. **07**
- (b)** Estimate the per unit regulation, at full load and 0.8 power factor lagging, for a 300 kVA, 50 Hz, 6600/400 V, 3 phase, delta/star, core type transformer. The data given is: **07**
- H.V. winding: outside diameter=0.36m, inside diameter=0.29m, area of conductor=5.4mm²
- L.V. winding: outside diameter=0.26m, inside diameter=0.22m, area of conductor=170mm²
- Length of coils=0.5 m, voltage per turn=8V, resistivity=0.21 Ω /m/ mm².

OR

- Q.3 (a)** List the various losses occurring in DC machine. Also derive the relationship between armature power developed (P_a) and the output power (P) for both- DC generator and DC motor. **07**
- (b)** A 40 Hz transformer is to be used on a 50 Hz system. Assuming the Steinmetz's coefficient as 1.6 and losses at lower frequency 1.2%, 0.7% and 0.5% for I^2R , hysteresis and eddy current respectively. Find (a) losses on 50 Hz for the same supply voltage and current (b) Output at 50 Hz for the same total losses as on 40 Hz. **07**

- Q.4 (a)** Estimate the leakage reactance of concentric winding in core type transformers clearly stating the assumptions used. **07**
- (b)** Calculate the diameter and length of armature for a 7.5 kW, 4 pole, 1000 r.p.m. 220 V shunt motor. Given: full load efficiency=0.83; maximum gap flux density=0.9 Wb/m²; specific electric loading=30,000 ampere conductors per meter; field form factor=0.7. Assume that the maximum efficiency occurs at full load and field current is 2.5% of rated current. The pole face is square. **07**

OR

- Q.4 (a)** With the help of neat sketch, explain the effect of armature reaction on air gap flux in case of DC machine. **07**
- Q.4 (b)** A 4 pole generator supplies a current of 140 A. It has 480 armature conductors (a) wave connected, (b) lap connected. The brushes are given an actual lead of 10°. Calculate the cross and demagnetizing mmf per pole in each case. The field winding is shunt connected and takes a current of 10 A, find the number of extra shunt field turns to neutralize the demagnetization. **07**

- Q.5 (a)** Describe the different methods adopted to reduce the effect of armature reaction in DC machine. **07**
- (b)** The following particulars refer to the shunt field coil for a 440 V, 6 pole, DC generator: **07**
Mmf per pole=7000 A; depth of winding=50mm; length of inner turn=1.1m; length of outer turn=1.4m; loss radiated from outer surface excluding ends = 1400 W/m²; space factor=0.62; resistivity= 0.02 Ω/m and mm². Calculate (a) the diameter of wire (b) length of coil (c) number of turns and (d) exciting current. Assume a voltage drop of 20 % of terminal voltage across the field regulator.

OR

- Q.5 (a)** State the guiding factors while selecting the no. of armature slots in DC machine. **07**
- (b)** An 11 kV, 25 Hz transformer has I^2R , hysteresis and eddy current losses 1.6, 0.6 and 0.4 percent of the output. What will be the percentage losses if the transformer is connected to 22 kV, 50 Hz supply assuming the full load current to remain the same? **07**
