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# Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
## Electrical Machine Design

Time: 3 hrs. Max. Marks:100

**Note :1.** ***Answer any FIVE full questions.***
**2.** ***Suitable values may be assumed for any missing data.***
**3.** ***Draw figures wherever necessary.***

1 a. Show that the output of a dc generator with single turn coils is given by the expression $S = \frac{0.03E'\upsilon qA}{PN}$
Where $E'$ = average voltage between adjacent commutator segments.
$\upsilon$ = Peripheral velocity of the rotar in meters/sec
P = Number of poles, N = Speed in rpm and
q = Specific electric loading. **(08 Marks)**

b. Design a 50 KW, 4 pole, 600 rpm dc shunt generator, the full load terminal voltage being 220 V. If the maximum gap density is 0.83 webers/$m^2$ and the armature ampere conductors per metre are 30000 calculate the suitable dimensions of armature core to give a square pole face. Assume that the full load armature drop is 3% of the rated terminal voltage and that the field current is 1% of the full load current. Ratio of pole arc to pole pitch is 0.67. **(12 Marks)**

2 a. Calculate the main dimensions of a 20 HP, 1000 rpm, 400 V, dc motor Bar = 0.37 Wb/$m^2$, Specific electric loading = 16000 ac/m. Assume an efficiency of 90%. **(10 Marks)**

b. A shunt field coil has to develop an mmf of 9000 AT, the voltage drop in the field coil is 40 V and the resistivity of round wire is 0.021 $\Omega m/mm^2$. The depth of winding is 35 mm and length of mean turn is 1.4 m. Design a coil so that the power dissipated is 700 watts/$m^2$ of the total coil surface. Take the diameter of insulated wire to be 0.2 mm greater than bare wire. **(10 Marks)**

3 a. Prove that EMF/turn of a three phase transformer is given by $K\sqrt{Q}$ where Q is the output/phase of the transformer. **(05 Marks)**

b. Show that the losses in a transformer are proportional to the cube of its linear dimensions. **(05 Marks)**

c. A single phase 400 V, 50 Hz transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5 m. Area of cross section of the core is $2.5 \times 10^{-3}$ $m^2$ and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. Iron loss at the working flux density is 2.6 W/kg. Iron weighs $7.8 \times 10^3$ kg/$m^3$. Stacking factor = 0.9 **(10 Marks)**

4 a. Derive an expression for the leakage reactance of a transformer with primary and secondary coils of equal length. **(08 Marks)**

4 b. Calculate the overall dimensions for a 200 kVA, 6600/440 V, 50 Hz, 3 phase core type transformer assuming the following data:
EMF / turn = 10 volts
Maximum flux density = 1.3 $Wb/m^2$,
Current density = 2.5 $A/m^2$,
Window space factor = 0.3
Overall height = Overall width
Stacking factor = 0.9
Use a 3 stepped core,
Net core area = 0.6 $d^2$
Where d is the diameter of the circumscribing circle.
Width of largest stamping = 0.9 d **(12 Marks)**

5 a. Discuss the factors to be considered while deciding the length of air gap, number of stator and rotor slots. **(08 Marks)**

b. Estimate the stator core dimensions, number of stator slots and number of stator conductors per slot for a 100 kw, 3300 V, 50 Hz, 12 pole, star connected slip-ring induction motor. Assume an average gap density of 0.4 $w/m^2$ ampere conductors/metre = 25000. Efficiency = 90%, Power factor = 0.9 and the winding factor = 0.96. Choose the main dimensions to give best p.f. The slot loading must not exceed 500 ac. **(12 Marks)**

6 a. A 3 phase, 4 pole, 50 Hz induction motor has 24 stator slots and 28 rotor slots. Prove that it has a tendency to run as a synchronous motor at 214.3 rpm. **(08 Marks)**

b. A 90 kW, 500 V, 50 Hz, 3 phase 8 pole induction motor has a star connected stator winding accommodated in 63 slots with 6 conductors/slot. If the slip ring voltage on open circuit is to be above 400 V, find a suitable rotor winding stating
i) Number of slots.
ii) Number of conductors/slot
iii) Coil span
iv) Approximate full load current/phase in rotor.
Assume efficiency = 0.9, p.f = 0.86 **(12 Marks)**

7 A 1000 KVA, 3300 V, 300 rpm, 3 phase alternator has 180 volts with 5 conductors/slot, single layer winding with full pitch coils. The winding is star connected with one circuit per phase. Determine the specific electric and magnetic loadings if the stator bore is 2.0 meters and the core length is 0.4 meters. Using the same loadings determine the corresponding data for a 1250 kVA, 3300 V, 50 Hz, 250 rpm, 3 phase star connected alternator having 2 circuits per phase. The machine has 60° phase spread. **(20 Marks)**

8 Write short notes on any four:
a. Slot insulation in d.c. machines.
b. Cooling of transformers.
c. Crauling and cogging in induction motor.
d. Choice of air gap for d.c. machines.
e. Design of end rings for squirrel cage machines.
f. Stator design for single-phase induction motor. **(20 Marks)**

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