TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Chaitra

Exam.	Regular (New Course)		
Level	BE	Full Marks	60
Programme	BEL	Pass Marks	24
Year / Part	III / I	Time	3 hrs.

Subject: - Electric Machine Design (*ENEE 306*)

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Differentiate between soft magnetic materials and hard magnetic materials in brief with necessary diagrams. [4]

   b) What is ageing of core of electrical machine? What are the advantages and disadvantages of adding silicon with iron? [4]

2. a) Define hot spot in relation to electrical machine. Taking the example of a plate of thickness t derive the necessary expression of temperature of the hottest spot. [5]

   b) A 40 kVA, 11000/400 V, 3-phase transformer is working in an ambient temperature of 35°C on full load. Its oil temperature is recorded as follows: [4]

   - 59°C after 1.5 hours
   - 71°C after 3 hours

   Its full-load copper losses are 2 times the iron losses

   Calculate:
   i) Heating time constant
   ii) Final steady temperature rise
   iii) 1-hour rating

3. a) For a 500 kVA, 50Hz, 6600/400, single phase core type, oil immersed, natural cooled power transformer, the design parameters are: [16]

Constant for output voltage per turn (K)	= 0.8
Resistivity of copper	= 0.021 Ω-mm^2/m
Maximum flux density in core (Bm)	= 1.5 Wb/m^2
Current density	= 2.75 A/mm^2
Core type	= Cruciform
Window space factor (kW)	= 0.27
Stacking factor (K_i)	= 0.9
Ratio of height to width of windows (H_w/W_w)	= 2.5
Ratio of yoke height to width (Hy/Dy)	= 1
Axial depth of LV winding	= 402 mm
Axial depth of HV winding	= 377.5 mm
Inside diameter of LV winding	= 310 mm
Outside diameter of LV winding	= 348 mm
Inside diameter of HV winding	= 360 mm
Outside diameter of HV winding	= 418 mm
Taking iron loss	=1460 W,
Copper loss	=3865 W at full load,
Height of tank	= 1.6 m,
Length of tank	=1.05 m,
Width of tank	= 0.62 m, find the temperature rise. If the mean rise of oil is not to rise 35 °C, find the necessary number of tubes and show its arrangement.

   b) Compare power transformer with distribution transformer. [3]

4. a) What are the factors that must be considered while selecting the length of air gap in induction motor? [6]

b) For a 2.2 kW, 440 V, 3-phase, 50 Hz, 1430 rpm squirrel cage induction motor having efficiency of 0.8 and p.f. 0.85 designed for its best power factor. Given BAV = 0.44 Wb/m^2, A_c = 21,000 A/m, slot space factor = 0.4, ratio of slot depth to width = 4, stator slot pitch = 12 to 15 mm, $\delta_s = 4$ A/mm^2. Calculate: [8]

i) Main dimensions
ii) T_s (Turns per phase of stator conductor)
iii) A_s (Area of stator conductor)
iv) No. of stator slots
v) Area and dimension of each stator slot
vi) Minimum width of stator teeth
vii) Find stator slot loading.

Note: For best power factor, $\tau = \sqrt{(0.18\ L)}$

5. a) Explain the factors to be considered for the choice of ampere conductors per meter (AC) in DC machine. [5]

b) A design is required for a 30 kW, 4 pole, 900 rpm DC shunt generator, the full load terminal voltage being 240 V. Assume that the full load armature voltage is 3% of the terminal voltage. Calculate the main dimensions of the machine if the maximum gap density is 0.85 Wb/m^2, specific electrical loading of 20,000 ampere conductor/meter and field resistance is 120 Ω. The ratio of pole arc to pole pitch is 0.7. The pole face is square. [5]

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