16 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Electric Machine Design *(EE603)*

- ✓ 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 transformer grade and dynamo grade steel. [4]
   b) What are the advantages and disadvantages of adding silicon with iron? [4]
2. a) An induction motor is heated to a temperature of 60°C and is shut down. Calculate the temperature at a time 20 minutes after the shut down if the cooling time constant is 60 minutes. The ambient temperature is 30°C. [8]
   b) Derive the expression for internal temperature (hot spot) of the core. [8]
3. a) Differentiate between power and distribution transformer. [4]
   b) For a 500kVA, 50Hz, 6600/400V, single phase core type, oil immersed, natural cooled power transformer, the design parameters are:

   Constant for output voltage per turn = 0.8
   Resistivity of copper = 0.021 Ω-mm^2/m
   Maximum flux density in the core = 1.5 Wb/m^2
   Current density = 2.75A/mm^2
   Core type = Cruciform
   Window space factor = 0.27
   Stacking factor = 0.9
   Ratio of window height to width = 2.5
   Ratio of yoke height to width = 1
   Axial depth of LV winding = 402mm
   Axial depth of HV winding = 377.5mm
   Inside diameter of LV winding = 310mm
   Outer diameter of LV winding = 348mm
   Inside diameter of HV winding = 360mm
   Outside diameter of HV winding = 418mm

   Calculate:

   i) Dimension of the core, window and yoke
   ii) Overall dimension of the frame
   iii) Per unit regulation at 0.8 pf lagging
   iv) Taking iron loss = 1460W, copper loss = 3865W at full load, height of tank = 1.6m, length of tank = 1.05m, width of tank = 0.62m, find the temperature rise. If the mean temperature rise of oil is not to rise 35°C, find the necessary number of tubes and also show its arrangement. [20]

4. a) Derive the output equation for three phase induction motor. [5]

   b) What are the factors affecting the choice of specific electrical loading in induction machine? [5]

   c) A 90kW, 500V, three phase, 8 pole slip ring induction motor having 0.9 efficiency and power factor of 0.86 has 63 stator slots with 6 conductors per slot. If the slip ring voltage on open circuit is to be about 400V, find the number of rotor slots, rotor turns per phase, number of conductors per slot and appropriate full load rotor current per phase. Both stator and rotor are star connected. [6]

5. a) What are the factors affecting the choice of number of poles in DC machine? [4]

   b) Derive the output equation for the design of dc machine. [4]

   c) Determine the main dimensions, number of poles and length of air gap of a 600kW, 500V, 900rpm generator. Assume average gap density as 0.6 Wb/m^2 and ampere conductors per meter as 35,000 A/m. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 91%.
   The following are the design constraints: peripheral speed ≤ 40m/s, frequency of flux reversal ≤ 50Hz, current per brush ≤ 400A, and armature mmf per pole ≤ 7500A. The mmf required for air gap is 50% of armature mmf and gap contraction factor is 1.15. [8]

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16 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Electric Machine Design *(EE603)*

- ✓ 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 hot rolled and cold rolled grain-oriented steel. [4]

   b) What are the different classes of insulation used in electrical machine? Mention their maximum working temperature and the types of material used in such classes. [4]

2. a) Derive the temperature rise-time curve of the machine under heating condition and also define heating time constant. [8]

   b) A 400 kVA transformer has its maximum efficiency at 80% of full load. During a short full load heat run, the temperature rise after one hour and two hours is observed to be 24°C and 34°C respectively. Find the thermal time constant and final steady temperature rise of the transformer. If, by use of a fan, the cooling is improved so that the rate of heat dissipation per unit area per degree rise in temperature is increased by 15%, find the new kVA rating possible

   (i) For the same final temperature rise as before
   (ii) If allowable temperature rise is taken as 50°C [8]

3. a) Differentiate between core and shell type transformer. [6]

   b) For a 4000 KVA, 3 phase, 50 Hz, 66 KV/11KV, 3 phase, 50 Hz, delta/delta, core type, oil immersed natural cooled power transformer are:

   Max flux density in core = 1.6 Wb/m^2
   Constant for output voltage per turn = 0.6
   Resistivity of Copper = 0.021 $\Omega mm^2/m$
   Core type = Cruciform
   Current density in conductors = 2.5 A/mm^2
   Window space factor = 0.22
   Stacking factor = 0.9
   Ratio of window height to width = 2.75
   Take hot rolled steel and area of yoke is 20% greater than area of core
   Width of duct between LV and core = 10mm
   Width of LV winding = 50mm
   Width of HV winding = 50 mm
   Width of duct between LV and HV = 20 mm

   Assuming all the other required parameters, calculate:

   (i) Overall core dimension
   (ii) Overall dimension of frame
   (iii) Per unit resistance and leakage reactance drop
   (iv) Per unit voltage regulation at 8.0 pf [18]

4. a) Determine the main dimension, turns per phase, number of slots and slot area of a 250HP, 400V, 4-pole, 50Hz slip ring induction motor. Assume, Bav = 0.5Wb/m^2, ac = 3000 Ampere conductor/m, efficiency (η) = 0.9, pf = 0.9, current density = 3.5A/mm^2. The slot space factor is 0.4 and ratio of core length to pole pitch is 1.2. The machine is delta connected. [8]

   b) Derive the expressions for output equation of three phase induction machine. Explain the separation of D and L. [8]

5. a) For a dc machine, derive the expression for calculating the minimum number of commutator segments. Note the number of commutator segment = number of coils in armature. [8]

   b) Calculate the diameter and length of armature of 7.5 kW, 4 pole, 1800 rpm, and 220V shunt motor. Given: full load efficiency = 0.83, maximum gap flux density = 0.9 Wb/m^2, specific electric loading = 30,000 ampere conductor per meter, field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the field current is 2.5% of rated current. The pole is square face and consider all the possible losses in the machine. [8]

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26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Electrical Machine Design *(EE603)*

- ✓ 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) Compare the characteristics of conducting and insulating materials used in DC machine. [5]
   b) What is meant by "ageing" in magnetic material? Enlist the merits and demerits of addition of Silicon with Iron. [5]
   c) Differentiate between core type and shell type transformer on the basis of construction, Mechanical design, Leakage reactance and Cooling. [6]
2. a) Derive the expression for calculation of internal temperature of a homogenous material of thickness 't' length 'l' and width 'w'. Other necessary data's can be assumed. [8]
   b) A 250 volt 1 kilowatt single elemental resistor is made from 0.2mm thick nickel chromium strip. The temperature raised of the strip is not exceed 300°C. Calculate the length and width of the strip. Assume e = 0.9 , Radiating efficiency = 0.75. Resistivity of nichrome = $1\times10^{-6}\Omega$-m. [8]
3. a) Derive an expression for KVA output of a single phase transformer from design point of view. [6]
   b) Design a 25kVA, 11000/433 V, 50 Hz, 3 phase, delta/star core type distribution transformer. [14]

   The required data for design are given below:
   Maximum flux density in core= 1 Wb/m^2
   Current density in conductor= 2.3 A/mm^2
   Constant for output volt per turn, K=0.45
   Core type= cruciform
   Window space factor, Kw= 8/(30+kV)
   Staking factor =0.9
   Ratio of window height to width= 2.5
   Take area of yoke 20% more than area of limb.
   Width of LV winding=9.1 mm
   Width of HV winding=26.22 mm
   Total losses at full load =901 W

   Calculate:
   i) Dimensions of core, window and yoke
   ii) Overall dimensions of the frame
   iii) Per unit resistance and leakage reactance drop
   iv) Per unit voltage regulation at 0.8 pf
   v) Full load efficiency at 0.8 pf
4. a) Discuss the factors to be considered for the selection of stator slots in an induction machine. [6]
   b) Determine the main dimensions of a 15kW, 3 phase, 400 V, 50 Hz, 2810 rpm squirrel cage induction motor having efficiency of 0.88 and a full load power factor of 0.9. Assume specific magnetic loading = 0.5 Wb/m^2 and specific electric loading = 25000 A/m. Take rotor peripheral speed as approximately 20 m/s at synchronous speed. [8]
5. a) Explain the factors to be considered when selecting the number of armature slots in dc machine. [6]
   b) Calculate the main dimensions of a 5 kW, 250 V, 4 pole, 1500 rpm dc shunt generator having full load efficiency of 0.87 and designed to have a square pole face. Assume average flux

27 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Electrical Machine Design *(EE603)*

- ✓ 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. What are the fundamental requirements of high conducting materials? Classify and explain the electrical conducting materials in brief. [8]
2. Differentiate between soft magnetic material and hard magnetic material. [4]
3. Differentiate between natural and artificial convections in brief. Also derive an expression for the temperature rise-time curve for an electrical machine. [12]
4. Determine the main dimensions of the core, the number of turns and the cross sections of the conductors for a 5kVA, 11000/400 V, 50Hz, single phase core type distribution transformer. The net conductor area in the window is 0.6 times the net cross section of iron in the core. Assume a square cross-section for core, a flux density 1 Wb/m^2, a current density 1.4 A/mm^2, and window space factor 0.2. The height of window is 3 times its width. [12]
5. How is the flux density in the design of transformer is chosen? [4]
6. Derive the expressions for per unit resistance drop of a core type transformer. [8]
7. The following design data are provided for an induction motor. [12]

   Diameter of stator bore (D) =16cm, Length of stator core (L)= 8.5cm,Average flux density (Bav) = 0.44 wb/m^2,Power factor = 0.85,Efficiency = 86%,Frequency = 50 Hz ,Current density = $5A/mm^2$,Stator slots = 36,Rotor Slots = 30, Length of rotor bar = 15cm,Mean diameter of end ring = 12 cm, Resistivity of bar conductor = 0.020 Ohm-metre, Power out of 3-phase,4-pole, 400V,delta connected = 10kW,
   Calculate No-load maximum flux, Length of air gap, No. of turns per phase, Rotor bar current and area, End ring current and area, Losses in bars and end rings.
8. Derive the expressions for output equation of three phase induction machine. [8]
9. Calculate the main dimensions and the number of poles of a 37kW, 230V, 1400 RPM dc shunt motor so that a square pole face is obtained. The average gap density is 0.5 Wb/m^2 and ampere conductors per meter are 22,000. Take full load efficiency of 90% and the ratio of pole arc to pole pitch of 0.7. [8]
10. What are the factors for the selection of no. of poles in DC machine? [4]

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