Code No: R32021 **R10** **Set No: 1**

III B.Tech. II Semester Regular and Supplementary Examinations, May/June -2014

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Explain the classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability. Also give examples for each class.
   (b) Discuss the cooling techniques for electric machines in details. (8M+7M)

2. (a) Give main details of design of armature in a D.C machine. (7M)
   (b) The stator of a machine has smooth surface but its rotor has open type of slots with slot width is equal to width of tooth of (wt) 11mm, and the air gap length 'lg' is 2.2mm. Find the effective length of air gap if carter coefficient is $\frac{1}{1+5.\frac{lg}{ws}}$; No radial conductors are present. (8M)

3. (a) What are the guiding factors for selection of number of poles in a DC machine and list the advantages and disadvantages of higher number of poles. (7M)
   (b) Find the main dimensions of a 200 KW, 250 V, 6 pole 100rpm DC generator. The maximum value of flux density in the air gap 0.87 wb/mts^2 and the ampere conductor per meter of armature periphery are 31000. The ratio of pole are pole pitch = 0.67, $\eta = 91\%$, Assume the ratio of length of core to pole pitch = 0.75. (8M)

4. (a) Why current density in primary and secondary is taken as same in design of transformers. (5M)
   (b) Calculate the main dimensions of a 100 KVA, 2000/400V, 50Hz single phase shell type transformer.
   Volt per turn =10V
   Flux density of core = 1.1wb/mt^2
   Current density = 1.2 mm^2
   Window space factor = 0.33
   The ratio of window height to window width and ratio of core depth to width of central limb= 2.5. The stacking factor = 0.9 (10M)

5. (a) Derive the output equation of 3 phase transformer. (7M)
   (b) During temperature rise test at full load on 100KVA transformer, temperature recorded were 60^{0}C after 1hr and 72^{0}C after 2hrs Find the time for which the transformer could be safety loaded to 200KVA. Ambient temperature may be assumed to be 40^{0}C, Full load copper loss is twice the iron loss. (8M)

6. (a) Define and explain Specific magnetic loading and specific electric loading. (10M)
   (b) Derive the expression for the slot leakage reactance of poly phase machine. (5M)

7. (a) The following data refers to a 4-pole, 3-phase induction motor;
   No of stator conductors = 1080
   Full load current/ ph = 12.5A
   Stator winding factor= 0.96
   No of rotor slots = 43
   Resistance of rotor bar/slot = $0.31 \times 10^{-4}\ \Omega$
   Resistance of end ring bar/slot = $1.32 \times 10^{-4}\ \Omega$
   Calculate
   i) Total copper loss of rotor. ii) Rotor bar current and end ring current (10M)
   (b) Give the design specifications of wound rotor of induction motor. (5M)

8. (a) Derive the expression for length of air gap in salient pole synchronous machine
   (b) Discuss the selection of armature slots for synchronous machine.
   (c) What is short circuit ratio? Discuss In brief. (5M+5M+5M)

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Code No: R32021 **R10** **Set No: 2**

III B.Tech. II Semester Regular and Supplementary Examinations, May/June -2014

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) List the various types of magnetic and insulation materials used in electrical machines?
   (b) Explain the fundamental requirements to be met by high conductivity materials
   (c) Define Heating time constant. (8M+4M+3M)

2. (a) Define the following;
   (i) Pole pitch (ii) Full pitched coil (iii) Fractional pitch coil (iv) Concentrated winding.
   (b) Calculate the apparent flux density as a section of the tooth from the following data.
   Tooth width at the section = 1.2cm
   Slot width at parallel sides = 1cm
   Grass length of armature = 0.32m
   Number of ventilating ducts =4
   Width of each duct =1cm
   Stacking factor = 0.9
   Real flux density at the section = 2.15T
   Permeability of teeth corresponding to real flux density = 35.8×10^{-6} (8M+7M)

3. (a) What are the factors to be considered while selecting number of armature slots in a dc machine? (7M).
   (b) The field coils (cylindrical) of a 4 Pole 460V, DC motor are required to produce 5700 AT/P. The mean length of turn is 0.66 m, while the winding depth is 4cm. Heat is dissipated at the rate of 1000 W/sqm of the out side cylindrical surface of the coil Determine. (i) Dimension of the coil. (ii) Size of conductor. (iii) The number of turns.
   Assume the dia of conductor along with the insulation to be 0.175mm greater than dia of the bare conductor. (8M)

4. (a) Why tubes are provided on transformer tank and derive an expression for temperature rise of electrical machine from fundamentals. (7M)
   (b) Prove that the stepped cores of the transformers will give more utilization factor than square cores. (8M)

5. (a) Discuss various losses occurring in a transformer and define equivalent resistance and equivalent leakage reactance. (8M)
   (b) The iron and full load copper losses in a 40KVA single phase transformer are 450W and 850W respectively. Find the maximum efficiency. (7M)

6. (a) Find the main dimensions of a 15KW, 3 phase 400V, 50Hz, 2810rpm squirrel cage induction motor having an efficiency of 0.88 and a full load power factor of 0.9 Assume;
   Specific magnetic loading = 0.5 wb/m^2
   Specific electric loading = 2500 A/m
   Take rotor peripheral speed as approximately 20m/s at synchronous speed. (10M)
   (b) Derive the output equation of a 3 phase Induction motor. (5M)

7. (a) Give design specification of wound rotor of induction motor. (7M)
   (b) What are the parameters to be considered while choosing the length of air gap of an Induction motor? Discuss with relevant expressions (8M)

8. (a) What is the effect of Short Circuit Ratio on the Synchronous machine performance? Explain.
   (b) Explain design of field systems for a 3-phase synchronous machine. (7M+8M)

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Code No: R32021 **R10** **Set No: 3**

III B.Tech. II Semester Regular and Supplementary Examinations, May/June -2014

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) What is super conductivity? What is the advantage of using super conductors in electrical machines? (7M)
   (b) Derive an expression for the quantity of cool and required to cool the electrical machine given its total losses. (8M)

2. (a) Show that a balanced fractional slot winding is possible with the following data;
   84 slots, 16 poles, 3-phase
   Draw a layout of such winding over a unit of repeatable poles. (8M)
   (b) Give the details of design of Armature in a AC machine. (7M)

3. (a) Find the main dimensions of a 200 KW, 250 V, 6 pole 100rpm DC generator. The maximum value of flux density in the air gap 0.87 wb/mts^2 and the ampere conductor per meter of armature periphery are 31000. The ratio of pole to pole pitch = 0.67, $\eta = 91\%$, Assume the ratio of length of core to pole pitch = 0.75. (8M)
   (b) Derive the output equation of a DC machine from fundamentals. (7M)

4. (a) What are the desirable characteristics of transformer oil? Explain. (7M)
   (b) Calculate approximate over all dimensions for a 200KVA, 6600V/440V, 50Hz,3-phase core type transformer. The following data may be assumed.
   Emf/turn = 9V
   Maximum flux density = 1.3T
   Current density = 2.5 A/mm^2
   Winding space factor = 0.3
   Over all height =over all width. (8M)

5. (a) Derive the output equation of 3-phase transformer & List the various losses. (7M)
   (b) A single pluse, 400V, 50Hz transformer is built from stampings having a relative permeability of 1000. The length of flux path is 2.5m, the area of cross section of the core is 2.5x10^{-3} m^2 and the primary winding has 800 turns, estimate the maximum flux and no-load current of the transformer. The iron loss at the working flux density is 2.6 W/kg. Iron weighs 7.8x10^{3}kg/m^3. (8M)

6. (a) What is the effect of harmonic components of stator flux on the torque produced by motor in induction motor? Explain how the effect of harmonics is minimized. (8M)
   (b) Discuss the factors effecting the choice of specific magnetic loading and specific electric loading in design of induction motor Indicate there values for $3-\phi$ induction motor. (7M)

7. Estimate the main dimensions, air gap length, stator slots, stator turns/ phase and cross sectional area of stator and rotor conductors for a $3-\phi$, 15HP, 400V,6-pole, 50Hz, 975rpm, Induction motor, The motor is suitable for star delta starting, B_{av}=0.45 wb/m^2,ac= 20222 amp/m, $\frac{L}{\gamma}=0.85$, efficiency =0.9, power factor = 0.85. (15M)

8. (a) Derive the expression for length of air gap in salient pole synchronous machine.
   (b) Discuss the constructional features of a synchronous machine. (7M+8M)

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Code No: R32021 **R10** **Set No: 4**

III B.Tech. II Semester Regular and Supplementary Examinations, May/June -2014

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Give is the classification of various magnetic materials used in design of electric machines? Explain the use of each type.
   (b) What are the properties of conducting materials used in electric machine design?
   (c) Define Heating time constant? (6M+6M+3M)

2. (a) Derive an expression for calculation of reluctance of flux path in a tapered tooth of stator of ac machine. (8M+7M)
   (b) Calculate the MMF required for the air gap of a machine having core length = 0.32m including 4 ducts of 10 mm each, pole are H ducts of 10mm each, pole are = 0.19m, slot pitch = 65.4 mm, slot opening = 5mm, air gap length =5 mm, flux per pole = 52m Wb..Given carter's coefficient is 0.18 for opening/ gap =1, and is 0.28 for opening/gap=2.

3. (a) Calculate the net iron length of a DC machine having gross core length of 0.32m, the number of ventilating ducts is 4, each 10mm wide the iron stacking factor is 0.92.
   (b) Explain in brief the design of field system in dc machines. (7M+8M)

4. (a) What are the factors on which design of insulation of a transformer depend and explain how cooling is provided in it. (7M)
   (b) Determine the main dimensions of the core for a 250KVA, 6600/415 V, 50Hz, 3-phase transformer with star connected windings Assume the following data:
   Volt/turn =9V
   Maximum flux density = 1.25 T
   A_1=0.62 d^2,window space factor = 0.3
   $\frac{Height\ of\ window}{Width\ of\ window} = 2$
   Current density = 250 A/mm^2. (8M)

5. (a) Derive output equation of a 3-phase transformer from basics and give the condition to design for minimum cost of transformer. (8M)
   (b) The iron and full load copper losses in a 40KVA single phase transformer are 450W and 850W respectively. Find the maximum efficiency. (7M)

6. A 90 KW, 500V, 50H_2, 3 phase, 8 pole induction motor has a star connected stator winding accommodated in 63 slots with 6 conductors per slot. It the slip ring voltage on open circuit is to be about 400V, Find a suitable rotor winding, stating (a) No of poles (b) Conductors per slot (c) Coil span (d) Slip ring voltage on open circuit (e) approximate full load current per phase in rotor Assume efficiency = 0.9 ; power factor = 0.86 (15M)

7. (a) Explain in brief the design of squirrel cage rotor of a 3-phase induction motor. (7M)
   (b) A 10hp, 220V, 4 pole, 50Hz delta connected 3-phase induction motor with a stator bore of 18cm and core length of 13.5 cm; to have average flux density 0.4T. Find Particulars of stator winding number of slots, Conductors/Slot, Coil pitch; fulx/pole. (8M)

8. (a) How armature slots are selected for synchronous machine. Explain. (8M+7M)
   (b) What is the effect of Short Circuit Ratio on the synchronous machine performance?

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