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

III B.Tech II Semester Regular/Supplementary Examinations, May/June - 2015

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

*****

1 a) Explain in detail about the design factors of Electrical Machines. [8]

b) Explain in detail about the basic principles used in the design of electrical machines. [7]

2 a) With suitable examples, explain about full pitch coil, fractional pitch coil, concentrating winding and distributed winding. [8]

b) Draw the winding diagram for a 4 pole, 12 slot simplex lap connected DC generator with commutator having 18 segments. [7]

3 a) Explain in detail about the design of field systems of DC Machines. [7]

b) Find the armature voltage drop of a 300 kW, 500 volt, 6 pole lap connected DC generator having 150 slots with 8 conductors per slot. Area of each conductor is $20mm^2$ and length of mean turn is 2 m. The resistivity is 0.021 $\Omega\ m^{-1}\ mm^2$. [8]

4 a) Explain in detail about the factors that help in choosing different types of transformers. [8]

b) Explain in detail about the core design of the transformers. [7]

5 a) Derive the relationship between the current densities of primary and secondary windings of transformers. [7]

b) Determine the dimensions of core and yoke for a 200 kVA, 50 Hz single phase core type transformer. A cruciform core is used with distance between adjacent limbs equal to 1.6 times the width of core laminations. Assume voltage per turn 10 V, maximum flux density 1 Wb/m^2, window space factor 0.32, current density 4 A/mm^2, and stacking factor = 0.9. The net iron area is 0.56 d^2 in a cruciform core where d is the diameter of circumscribing circle. Also the width of the largest stamping is 0.85d. [8]

6 a) Explain in detail about the choice of specific electric and magnetic loadings for Induction Machines. [7]

b) A 15 kW, 440 V, 4 pole, 50 Hz, 3 phase induction motor is built with a stator bore 0.24 m and a core length of 0.15. The specific electric loading is 20000 ampere conductors per meter. Using the data of this machine, determine the core dimensions of a 11 kW, 460 V, 6 pole, 50 Hz three phase induction motor. Assume a full load efficiency of 85 % and power factor of 0.9 for each machine. The winding factor is 0.955. [8]

7 a) Explain the different factors that should be considered while estimating the length of air gap in induction machines. [7]

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 per slot. The slip ring voltage on open circuit is to be about 410V. Find number of slots, number of conductors per slot, coil span and slip ring voltage on open circuit. Assume efficiency = 0.85, power factor = 0.9. [8]

8 a) Explain in detail about the stator design of synchronous machines. [7]

b) Determine the main dimensions for a 1000 kVA, 50 Hz, 3 phase, 375 rpm alternator. The average air gap flux density is 0.5 Wb/m^2 and the ampere conductors per meter are 25000. Use rectangular poles and assume a suitable value for ratio of core length to pole pitch in order that bolted on core construction is used for which the maximum permissible peripheral speed is 60 m/s. The run-away speed is 1.8 times the synchronous speed. [8]

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

III B.Tech II Semester Regular/Supplementary Examinations, May/June - 2015

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

*****

1 a) Explain in detail about the major considerations to evolve a good design of Electrical Machines. [8]

b) Explain in detail about the cooling techniques used in electrical machines. [7]

2 a) With the neat sketch explain about simplex lap and simplex wave winding. [8]

b) Draw the winding diagram for a simplex lap wound 24 slot, 4 pole DC armature with 24 commutator segments. [7]

3 a) Explain in detail about the choice of armature windings in DC Machines. [7]

b) A 5 kW, 250 V, 4 pole, 1500 rpm shunt generator is designed to have a square pole face. The loadings are: [8]
Average flux density in the air gap = 0.3 Wb/m^2 and ampere conductors per meter = 10000. Assume full load efficiency = 0.9 and ratio of pole arc to pole pitch = 0.7. Find the main dimensions of the machine.

4 a) Give the detailed comparison of power and distribution transformers. [8]

b) Explain in detail about the yoke design of the transformers. [7]

5 a) Write the output equations of single and three phase transformers and explain different parameters. [7]

b) Calculate approximate overall dimensions for a 200 kVA, 6600/440 V, 50 Hz, 3 phase core type transformer. The following data may be assumed: EMF per turn = 9V; maximum flux density = 1 Wb/m^2; current density = 2 A/mm^2; window space factor = 0.3, overall height = overall width; stacking factor = 0.9; Use a 3 stepped core. [8]
For a three stepped core:
Width of largest stamping = 0.9 d and Net iron area = 0.6 d^2 where d is the diameter of the circumscribing circle.

6 a) Explain in detail about the stator design of three phase induction machine. [7]

b) Estimate the stator core dimensions and number of stator conductors for a 100 kW, 3300 V, 50 Hz, 12 pole star connected slip ring induction motor. [8]
Assume:
Average gap density = 0.45 Wb/m^2, ampere conductors per meter = 25000, efficiency = 0.89, power factor = 0.9 and winding factor = 0.95. The slot loading should not exceed 500 ampere conductors.

7 a) Explain in detail about different factors that should be considered while designing the rotor slots of squirrel cage rotor. [7]

b) A 3 phase, 2 pole, 50 Hz squirrel cage induction motor has a rotor diameter 0.17 m and core length 0.1 m. The peak density in the air gap is 0.45 Wb/m^2. The rotor has 33 bars, each of resistance 110 μΩ and a leakage inductance 2 μH. The slip is 5%. Calculate the rotor output and torque exerted. Neglect the resistance of end rings. [8]

8 a) Explain in detail about the choice of specific electric and magnetic loadings for Synchronous Machines. [7]

b) Find the main dimensions of a 2500 KVA, 187.5 rpm, 50 Hz, 3 phase, 3 kV, salient pole synchronous generator. The generator is to be a vertical, water wheel type. The specific magnetic loading is 0.65 Wb/m^2 and the specific electric loading is 35000 A/m. Use circular poles with ratio of core length to pole pitch = 0.65. Specify the type of pole construction used if the run-away speed is about 2 times the normal speed. [8]

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

III B.Tech II Semester Regular/Supplementary Examinations, May/June - 2015

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

*****

1 a) Explain in detail about the limitations in the design of Electrical Machines. [8]

b) Explain in detail about different causes for the temperature rise in the electrical machines. [7]

2 a) By taking a suitable example, define back pitch, front pitch, winding pitch and commutator pitch. [8]

b) Find out whether the following windings are symmetrical or not [7]
(i) 6 pole, 37 slot, 2 coil sides per slot, simplex wave winding
(ii) 8 pole, 126 slot, 6 coil sides per slot, duplex wave winding

3 a) Explain in detail about the choice of specific electric and magnetic loadings for DC Machines. [7]

b) A design is required for a 50 kW, 4 pole, 600 RPM, DC shunt generator, the full load terminal voltage being 200 V. If the maximum gap density is 0.8 Wb/m^2 and the ampere conductors per meter are 25000, calculate suitable dimensions of armature core to give a square pole face. Assume that the full load armature voltage drop is 3% of the rated terminal voltage, and the field current is 1% of the rated full load current. Ratio of pole arc to pole pitch is 0.7. [8]

4 a) Give the comparison of single phase and three phase transformers in detail. [8]

b) Explain in detail about different methods of cooling of transformers. [7]

5 a) Explain different steps in the design of transformers. [7]

b) The current densities in the primary and secondary windings of a transformer are 2.2 and 2.1 A/mm^2 respectively. The ratio of transformation is 10:1 and the length of the mean turn of the primary is 10% greater than that of secondary. Calculate the resistance of secondary winding referred to primary and secondary. Given that the primary winding resistance is 10Ω. [8]

6 a) Explain in detail about different factors that affect while designing the stator slots of induction machines. [7]

b) Find the main dimensions of a 15 kW, 3 phase, 400 V, 50 Hz, 2810 rpm, squirrel cage induction motor having efficiency of 0.92 and a full load power factor of 0.85. [8]
Assume:
Specific magnetic loading = 0.4 Wb/m^2; specific electric loading = 20000 A/m.
Take the rotor peripheral speed as approximately 20 m/s at synchronous speed.

7 a) Explain in detail about different factors that should be considered while designing the rotor slots of wound rotor induction machines. [7]

b) A 3 phase, 2 pole, 50 Hz squirrel cage induction motor has a rotor diameter 0.15 m and core length 0.1 m. The peak density in the air gap is 0.5 Wb/m^2. The rotor has 33 bars, each of resistance 100 μΩ and a leakage inductance 2 μH. The slip is 6%. Calculate the peak value of current in each bar and rotor copper loss. Neglect the resistance of end rings. [8]

8 a) Write the output equation of Synchronous Machines and explain in detail about different parameters. [7]

b) Find the main dimensions of a 100 MVA, 11 kV, 50 Hz, 150 rpm, 3 phase water wheel generator. The average gap density is 0.6 Wb/m^2 and ampere conductors per meter are 35000. The peripheral speed should not exceed 60 m/s at normal running speed in order to limit the run-away peripheral speed. [8]

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

III B.Tech II Semester Regular/Supplementary Examinations, May/June - 2015

ELECTRICAL MACHINE DESIGN

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

*****

1 a) Explain in detail about the modern manufacturing techniques of Electrical Machines. [8]

b) Explain in detail about different ways of heat dissipation in electrical machines. [7]

2 a) Define the terms 'Coil', 'Turn', 'Conductor' and 'Coil side'. [5]

b) Draw the winding diagram in radial form for a 4 pole, 12 slot simplex lap connected DC generator with commutator having 12 segments. Indicate the position of brushes. [10]

3 a) Explain in detail about the constructional details of DC Machines [7]

b) Calculate diameter and length of armature for a 7.5 kW, 4 pole, 1000 rpm, 220 V shunt motor. Given: full load efficiency = 0.9, maximum gap flux density = 0.9 Wb/m^2, specific electric loading = 25000 ampere conductors 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 face is square. [8]

4 a) Give the comparison of core type and shell type transformers in detail. [7]

b) Give the detailed comparison of natural and forced cooling techniques of transformers by considering different mediums. [8]

5 a) Explain about different types of windings used in core type of transformers. [7]

b) A 300 kVA, 6600/400 V, 50 Hz, delta/star 3-phase core type transformer has the following data: [8]
Width of HV winding = 24 mm, width of LV winding = 15 mm; height of coils = 0.5 m, length of mean turn = 0.9 m, HV winding turns = 800, width of duct between LV and HV windings = 15 mm
Calculate the leakage reactance of the transformer referred to LV side and HV side separately.

6 a) Write the output equation of three phase induction machine and explain different factors that will determine the output. [7]

b) Determine the main dimensions of a 3.7 kW, 400 V, 3 phase, 4 pole, 50 Hz squirrel cage induction motor to be started by a star delta starter. [8]
Assume: Average flux density in the gap = 0.4 Wb/m^2, ampere conductors per meter = 20000, efficiency = 0.9, power factor = 0.9, winding factor = 0.955, stacking factor= 0.9.

7 a) Explain in detail about the procedure of calculating short circuit (blocked rotor) current in induction machines. [7]

b) A 11 kW, 3 phase, 6 pole, 50 Hz, 220 V, star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the values of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 0.9 and a power factor of 0.8. The rotor MMF may be assumed as 80 % of stator MMF. Also find the bar and end ring sections if the current density is 4 A/mm^2. [8]

8 a) Define short circuit ratio and explain the effects of short circuit ratio on Machine performance. [7]

b) Determine a suitable number of slots and conductors per slot, for the stator winding of a 3 phase 3300 V, 50 Hz, 300 rpm alternator. The diameter is 2.2 m and the axial length of core is 0.36 m. The maximum flux density in the air gap should be approximately 0.95 Wb/m^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. [8]