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**Question Paper Code: 41362**

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2017

Sixth Semester

Electrical and Electronics Engineering

14UEE602 - ELECTRICAL MACHINE DESIGN

(Regulation 2014)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

- Sheet steels possessing higher silicon content are called
  - Dynamo grade steel
  - Transformer grade steel
  - Cold rolled steel
  - Stainless steel
- Magnetic materials with relative permeability slightly less than unity are called
  - Diamagnetic materials
  - Ferromagnetic materials
  - Paramagnetic materials
  - Soft magnetic materials
- \_\_\_\_\_ is defined as the ratio of actual length of iron in stacks of assembled core plates to total axial length of the stack.
  - Stacking factor
  - Gap contraction factor
  - Field form factor
  - Space factor
- \_\_\_\_\_ is defined as the distance between the starts of two consecutive coils measured in terms of coil sides.
  - Back pitch
  - Front pitch
  - Winding pitch
  - Commutator Pitch
- Which part of the transformer does not allow the oil to come in contact with the atmospheric air? Also which part of the transformer is used to maintain the oil level?
  - Bucholz relay
  - Conservator
  - LV winding
  - HV winding

6. In which type of transformer winding is surrounded by core?  
(a) Core type      (b) Berry type      (c) Shell type      (d) Scott type
7. What type of slots is preferred for Induction motors?  
(a) Open slots      (b) Closed slots  
(c) Semi Enclosed slots      (d) Skewed slots
8. Name the phenomenon in which the induction motor fails to start  
(a) Crawling      (b) Cogging      (c) Stalling      (d) Skewing
9. Name the winding in Synchronous generator that is used to reduce oscillations and increases stability.  
(a) Running winding      (b) Main winding  
(c) Damper winding      (d) Auxiliary winding
10. What is the range of SCR (Short Circuit Ratio) for turbo alternators?  
(a) 0.5 to 0.7      (b) 0.05 to 0.07  
(c) 0.15 to 0.17      (d) 0.25 to 0.27

PART - B (5 x 2 = 10 Marks)

11. Mention the different types of duties of a machine.
12. What is unbalanced magnetic pull?
13. What are the advantages of stepped core?
14. What is runaway speed?
15. Distinguish between cylindrical pole and salient pole construction.

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Describe the classification of insulating materials used for electrical machines. Also discuss the applications of insulating materials. (8)
- (ii) Discuss the choice of Specific magnetic loading. (8)
- Or
- (b) (i) What are the main groups of electrical conducting materials? Describe the properties and applications of those materials. (8)
- (ii) Discuss the choice of specific electric loading. (8)
17. (a) (i) Derive the output equation of a DC machine. (8)

- (ii) A 5 kW, 250 V, 4 pole, 1500 rpm, shunt generator is designed to have a square pole face. The design constraints are: Average flux density in the gap =  $0.42 \text{ wb/m}^2$ , Ampere conductors per metre = 15000 A/m, find the main dimension of the machine. Assume full load efficiency = 87% and ratio of pole arc to pole pitch = 0.66. (8)

Or

- (b) Determine the main dimensions, number of poles and the length of air gap of a 500 volt, 600 kW, 900 rpm DC machine. Assume average gap density as  $0.6 \text{ wb/m}^2$  and ampere conductors per metre as 35000 AC/m. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 91 percentage. The following are the design constraints: Peripheral speed should not be greater than 40 m/s, Frequency of flux reversals should not be greater than 50 Hz, Current per brush armature should not be greater than 400 A. The mmf required for air gap is 50 percent of armature mmf and gap contraction factor is 1.15. (16)

18. (a) (i) Derive the output equation of single phase transformer in terms of core and window area. (8)

- (ii) A 3 phase, 50 Hz, oil cooled core type transformer has the following dimensions: Distance between core centers = 0.2m, Height of window = 0.24m, Diameter of circumscribing circle = 0.14m. The flux density in the core =  $1.25 \text{ Wb/m}^2$ , the current density in the conductor =  $2.5 \text{ A/mm}^2$ . Assume a window space factor of 0.2 and the core area factor = 0.56. The core is 2 stepped. Estimate KVA rating of the transformer.  $K_C$  for two stepped core = 0.56. (8)

Or

- (b) A 250 KVA, 6600/400V, three phase core type transformer has a total loss of 4800 W on full load. The transformer tank is 1.25 m in height, 1m \* 0.5m in plan. Design a suitable scheme for cooling tubes, if the average temperature rise is to be limited to  $35^\circ\text{C}$ . The diameter of each tube is 50 mm and the tubes spaced 75 mm from each other. The average height of each tube is 1.05m. Specific heat dissipation is 6 and  $6.5 \text{ Watt/m}^2/^\circ\text{C}$ . Assume convection is improved by 35% due to provision of tubes. (16)

19. (a) (i) Distinguish between squirrel cage rotor and slip ring rotor with neat diagrams. (8)

- (ii) Discuss the effect of length of air gap on Induction machines. (8)

Or

(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 Average gap density =  $0.4 \text{ Wb/m}^2$ , Conductors per metre = 25000 A/m. Efficiency  $\eta = 0.9$ . Power factor = 0.9. Choose main dimensions to give best power factor. The slot loading should not exceed 500 ampere conductors. Also  $K_{ws} = 0.96$ . (16)

20. (a) (i) 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  $0.6 \text{ wb/m}^2$  and the specific electric loading is 34000 A/m. Use circular poles with ratio of core length to pole pitch = 0.65. Specify the type of pole construction of the runaway speed is about 2 times the normal speed. Assume a winding factor of 0.955. (8)

(ii) Discuss the effect of Short Circuit Ratio (SCR) on the performance of synchronous machine. (8)

Or

(b) (i) Write short notes on the design of turbo alternators. (8)

(ii) Compute the main dimensions of a 100 MVA, 11 kV, 50 Hz, 150 rpm three phase water wheel generator. The average gap flux density is 0.65 Tesla and ampere conductor per meter is 40000. The peripheral speed should not exceed 65 m/s at normal running speed. (8)