

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

**Course Code: EE409****Course Name: Electrical Machine Design**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

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|---|---|-----|
| 1 | What considerations impose limitations in design of electrical machines?                                    | (5) |
| 2 | Distinguish between power transformers and distribution transformers.                                       | (5) |
| 3 | Explain the procedure for designing the shunt field winding for a DC machine.                               | (5) |
| 4 | What are the factors to be considered for the design of field winding in a synchronous machine?             | (5) |
| 5 | What are the guiding factors for the choice of number of armature slots in a three-phase induction machine? | (5) |
| 6 | What are the criteria for the choice of number of slots of an induction machine?                            | (5) |
| 7 | What are the advantages of FEM based methods over conventional design methods?                              | (5) |
| 8 | Compare the analysis method and synthesis method of machine design.   | (5) |

**PART B***Answer any two full questions, each carries 10 marks.*

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|----|---|------|
| 9  | The temperature rise of a transformer is 25°C after 1 hour and 37.5°C after 2 hours of starting from cold conditions. Calculate its final steady temperature rise and the heating time constant. If its temperature falls from the final steady state value to 40°C in 1.5 hours when disconnected, calculate the cooling time constant. The ambient temperature is 30°C.                               | (10) |
| 10 | a) What are the practical aspects of unbalanced magnetic pull that must be considered while designing electrical machines?  | (5)  |
|    | b) A 200 KVA, 6600/440 V 50Hz, 3 phase core type transformer has the following design data. Maximum flux density = 1.3 wb/m <sup>2</sup> , emf per turn = 10V, stacking factor = 0.9, window space factor = 0.3, current density = 2.5 A/mm <sup>2</sup> , overall width = overall height, 3 stepped core is used. Calculate the overall dimensions of the transformer.                                 | (5)  |
| 11 | A 250KVA, 6600/400 V, 3 phase core type transformer has a total loss of 4800 W at full load. The transformer tank is 1.25 m in height and 1m×0.5m in plan. Design a suitable scheme for the tubes if the average temperature rise is to be limited to 35°C. The diameter of the tube is 50mm and is spaced 75mm from each other. The average height of the tube is 1.05m. Specific heat dissipation due | (10) |

to radiation and convection is respectively 6 and  $6.5 \text{ W/m}^2\text{C}$ . Assume that the convection is improved by 35% due to provision of tubes.

**PART C**

*Answer any two full questions, each carries 10 marks.*

- 12 a) Explain the criterion for the selection of number of poles in a dc machine. (5)  
b) What are the design procedure of the field winding of a dc machine? (5)
- 13 A shunt field coil has to develop an mmf of 8000A. The voltage drop in the coil is 40 V and the resistivity of the round wire used is  $0.021 \Omega/\text{m}$  and  $\text{mm}^2$ . The depth of the winding is 35 mm approximately and the length of the mean turn is 1.8 m. Design a coil so that the power dissipated is  $800 \text{ W/m}^2$  of the total coil surface. Take the diameter of the insulated wire 0.2 mm greater than that of bare wire. (10)
- 14 a) Derive the output equation of a synchronous machine. (4)  
b) Estimate the diameter, core length, size, number of conductors and number of slots for stator of a 15MVA, 11KV, 50Hz, 2 pole star connected turboalternator with  $60^\circ$  phase spread. Assume  $B_{av}=0.55\text{Wb/m}^2$ ,  $a_c=36000\text{Amp/m}$ , current density= $5\text{A/mm}^2$ , peripheral speed= $160\text{m/sec}$ . The winding should be arranged to eliminate 5<sup>th</sup> harmonics. (6)

**PART D**

*Answer any two full questions, each carries 10 marks.*

- 15 a) What are the factors to be considered for the selection of air gap length of an induction motor? (5)  
b) Derive an expression for the end ring current of a squirrel cage induction motor. (5)
- 16 a) Describe about finite element methods. What are its advantages and applications? (6)  
b) What is computer aided design? How does it help in designing electrical machines? (4)
- 17 Estimate the stator core dimensions, number of stator slots and number of stator conductors per slot for a 100KW, 3300V, 50Hz, 12 pole star connected slip ring induction motor. Assume average gap density  $0.4\text{Wb/m}^2$ , ampere conductors/m= $25000\text{A/m}$ , efficiency=0.9, Power factor=0.96. Choose main dimensions to give best power factor. The slot loading should not exceed 500 Ampere conductors. (10)

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