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 |
|---|---|---|
| 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$^{o}$C after 1 hour and 37.5$^{o}$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$^{o}$C in 1.5 hours when disconnected, calculate the cooling time constant. The ambient temperature is 30$^{o}$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 V50Hz,3 phase core type transformer has the following design data. Maximum flux density = 1.3 wb/m$^2$, emf per turn =10V, stacking factor=0.9, window space factor=0.3, current density= 2.5 A/mm$^2$, 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 35ºC. 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 W/m$^{2o}$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 Ω/m and 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 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 60º phase spread. Assume $B_{av}$=0.55Wb/m$^2$, ac=36000Amp/m, current density=5A/mm$^2$, peripheral speed=160m/sec. The winding should be arranged to eliminate 5$^{th}$ 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 0.4Wb/m$^2$, ampere conductors/m=25000A/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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