Register Number:……..

KUMARAGURU college of technology
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**B.E. DEGREE EXAMINATIONS: NOV/DEC 2022**

(Regulation 2018)

Fifth Semester

**ELECTRICAL AND ELECTRONICS ENGINEERING**

U18EET5004**:** Electrical Machine Design

**COURSE OUTCOMES**

**CO1: Understand the various design factors, magnetic circuit fundamentals and select suitable materials required for Construction of Electrical Machines and Transformers.**
**CO2: Design DC Machines for given specifications.**
**CO3: Design Single phase and Three phase Transformers along with cooling methodologies.**
**CO4: Design stator and rotor of 3 Phase Induction and Synchronous Machines.**
**CO5: Use software tools to design electrical machines.**

**Time: Three Hours** **Maximum Marks: 100**

**Answer all the Questions:-**
**PART A (10 x 2 = 20 Marks)**
**(Answer not more than 40 words)**

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|---|---|---|---|
| 1. | What are the major considerations to evolve a good design of electrical machine? | CO1 | [$K_1$] |
| 2. | Stator of a machine has a smooth surface, but its rotor has open type of slot with slot width = tooth width = 12 mm and length of air gap = 2 mm. Find the gap contraction for slots, if the Carter's Coefficient is $\frac{1}{1+\left(\frac{5lg}{w_s}\right)}$. There are no radial ducts. | CO1 | [$K_3$] |
| 3. | List the factors to be considered while selection of poles for a DC Machine. | CO2 | [$K_1$] |
| 4. | How is the Length of the Commutator computed? | CO2 | [$K_2$] |
| 5. | Draw the diagram of a Cruciform Core and state its advantages. | CO3 | [$K_2$] |
| 6. | Outline the need for cooling tubes used in Transformers. | CO3 | [$K_2$] |
| 7. | How the Induction Motor can be designed for best power factor? | CO4 | [$K_2$] |
| 8. | Summarize the effects of harmonics in Induction Motor? | CO4 | [$K_2$] |
| 9. | What is run away speed? | CO4 | [$K_1$] |
| 10. | Comment on the significance of using Computers in Electrical Machine Design. | CO5 | [$K_2$] |

**Answer any FIVE Questions:-**
**PART B (5 x 16 = 80 Marks)**
**(Answer not more than 400 words)**

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| 11. | a) | A 15 KW, 230 V, 4 pole DC machine has the following data : Armature Diameter = 0.25 m, Armature Core length = 0.125 m, Length of Air Gap at pole centre = 2.5 mm, flux/pole = 11.7 mWb, (pole arc/pole pitch) = 0.66. Calculate the MMF required for air gap, if the armature is slotted and having a gap contraction factor of 1.18. | 8 | CO1 | [$K_3$] |
| | b) | Find the MMF per metre across the tooth of a dc machine armature from the following data: slot pitch = 2.1 cm, tooth width at the root = 1.07 cm, gross length = 32 cm, stacking factor = 0.9, Real flux density at the root of the teeth = 2.25 Tesla, Apparent Flux Density at the root = 2.36 Tesla. | 8 | CO1 | [$K_3$] |
| 12. | a) | Calculate the diameter and length of armature core of a 70 KW, 240 V, 900 rpm, 4 pole D.C Shunt Generator. The average flux density is 0.7 Wb/$m^2$ and ac/m is 34000. The ratio of core length to pole pitch is 0.8. Full load armature drop is 9.6 V and field current is 3 A. | 8 | CO2 | [$K_3$] |
| | b) | Develop a C Programming code for the above problem. | 8 | CO5 | [$K_3$] |
| 13. | a) | A 250 KVA, 6600/400 V, 3 phase core type transformer has a total loss of 4800W on full load. The transformer tank is 1.25 m in height, 1 m x 0.5 m in plane. Design a suitable scheme for cooling tubes, if the average temperature rise is to be limited to 35° C. The diameter of the tube is 50 mm and are spaced 75 mm from each other. The average height of tube is 1.05 m. Specific heat dissipation due to radiation and convection are respectively 6 and 6.5 W/$m^2$ degree Celsius. Assume that the convection is improved by 35% due to provision of tubes. | 8 | CO3 | [$K_3$] |
| | b) | Obtain the expressions for Output Equation of Single Phase and Three Phase Transformers. | 8 | CO3 | [$K_2$] |
| 14. | | Estimate the main dimensions, number of stator slots, stator turns per phase and cross-sectional area of stator and rotor conductors for a 3 phase, 15 HP, 400 V, 6 pole, 50 Hz, 975 rpm Induction Motor. The motor is suitable for star delta starting. $B_{av}$ = 0.45 Wb/$m^2$, ac = 20000 amp-conductors/m, L/$\tau$=0.85, efficiency = 0.9, power factor = 0.85. | 16 | CO4 | [$K_3$] |

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| 15. | a) | 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 $Wb/m^2$ and specific electrical loading is 34000 A/m. Use circular poles with the ratio of core length to pole pitch as 0.65. Specify the type of pole construction used, if the run-away speed is about 2 times the normal speed. | 8 | CO4 | [$K_3$] |
| | b) | Derive the output equation of a Synchronous Machine in terms of main dimensions, specific magnetic and electric loadings, and synchronous speed. | 8 | CO4 | [$K_2$] |
| 16. | a) | Discuss the various cooling methods used for rotating electrical machines. | 8 | CO1 | [$K_2$] |
| | b) | List the desirable properties for Magnetic and Insulating Materials. | 8 | CO1 | [$K_2$] |

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