***U.S.N*** | | | | | | | | | | |

# P.E.S. College of Engineering, Mandya - 571 401

***(An Autonomous Institution affiliated to VTU, Belagavi)***

**Sixth Semester, B.E. - Electrical and Electronics Engineering**

**Semester End Examination; July / Aug. - 2022**

**Electrical Machine Design**

*Time: 3 hrs* *Max. Marks: 100*

***Course Outcomes***

*The Students will be able to:*

*CO1: The students are familiarized with different types of conducting magnetic and insulating materials used in electrical machines.*

*CO2: The students will be able to Design different parts of D.C. Machines.*

*CO3: The students will be able to Design different parts of transformer.*

*CO4: The students will be able to Design.*

*CO5: The students are familiarized with Design of different parts of Synchronous machines.*

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for a Maximum of **18 marks** from each unit.*

| Q. No. | Questions | Marks | BLs | COs | POs |
|---|---|---|---|---|---|
| | **I : PART - A** | **10** | | | |
| I a. | List the types of insulting materials on the basis of thermal consideration. | 2 | L1 | CO1 | PO1 |
| b. | Explain any two factors which influence selection of number of slots. | 2 | L2 | CO2 | PO1 |
| c. | What are the specific loadings to be considered in the design of transformers and state its advantages of higher values? | 2 | L2 | CO4 | PO1 |
| d. | Write the procedure for the selection of number slots for squirrel cage rotor. | 2 | L2 | CO4 | PO1 |
| e. | Define SCR in synchronous machines. | 2 | L2 | CO5 | PO1 |
| | **II : PART - B** | **90** | | | |
| | **UNIT - I** | **18** | | | |
| 1 a. | Explain the limiting factors considered for the design of electrical machines. | 9 | L2 | CO1 | PO1 |
| b. | Derive an output equation of DC machine using fundamentals. | 9 | L2 | CO1 | PO1 |
| c. | A 5 kW, 250 V, 4 pole 1500 rpm, shunt generator is designed to have square pole phase. The loadings are average flux density is the air gap 0.42 Wb/$m^2$ and amperes conductors per conductors is 15000. Find the main dimensions of the machine. Assume full load $\eta$ = 0.87 and ratio of pole are to pole pitch 0.66. | 9 | L3 | CO1 | PO2 |
| | **UNIT - II** | **18** | | | |
| 2 a. | A 8 pole 500 V D.C shunt generator with all the field coils connected in series requires an mmf of 5000 AT/pole. The poles are of rectangular dimensions, 120 x 200 $mm^2$ and the available winding cross–section is 120 x 25 $mm^2$. Determine; | 9 | L2 | CO2 | PO2 |

Contd… 2

i) The cross section area of wire

ii) The no of turns

iii) The power dissipation in $W/m^2$ based upon the area of the outside surface and the two end surface of the coil.

Resistivity is 0.02 Ω/m and $mm^2$ insulation on the wires increases the dia 0.2 mm, voltage drop of 50 V.

b. Explain the design procedure for shunt and series field winding of D.C machine. 9 L2 CO2 PO2

c. A 50 HP, 4 pole, 480 V, 600 rpm shunt motor has a wave wound armature with 770 conductors. The leakage factor for the poles is 1.2. The poles are to be circular in cross section, the field coils are 70 mm thick and produce an mmf of 10,000 AT/pole. The flux density in the poles is 1.5 $Wb/m^2$, calculate the; 9 L3 CO2 PO2

i) Diameter of the pole

ii) Diameter of the field wire

iii) Length of the field coil

iv) Turns per pole and

v) Field current

**UNIT - III** **18**

3 a. Calculate the core and window area required for a 1000 kVA, 6600/400 V, 50 Hz, 1-ϕ core type transformer. Assume a maximum flux density of 1.25 $Wb/m^2$ and a current density of 2.5 $A/mm^2$, voltage per turn = 30 V. window space factor = 0.32. 9 L3 CO3 PO2

b. A 3 - ϕ, 50 Hz, oil cooled core type transformer has the following dimensions:

Distance between core centers = 0.2 m, height of window = 0.24m, diameter of circumscribing circle = 0.14 m. The flux density in the core = 1.25 $Wb/m^2$. The current density in the conductor = 2.5 $A/mm^2$. Assume window space factor = 0.2 core area factor = 0.56. The core is 2 stepped. Estimate kVA rating of the transformer. 9 L3 CO3 PO2

c. Derive the following design equations for a 3-ϕ transformer, relating the output to the specific loading and main dimensions:

i) EMF per turn

ii) Output equation 9 L2 CO3 PO2

Contd… 3

**UNIT - IV** **18**

| | | | | | |
|---|---|---|---|---|---|
| 4 a. | Explain the factors that affect the estimation of length of air gap in the design of induction motor. | 9 | L2 | CO4 | PO2 |
| b. | Determine the main dimension, turns per phase number of slots, conductor cross section and slot area of a 250 HP, 3-ϕ, 50 Hz, 400, 1410 rpm, slip – ring induction motor. Assume $B_{av}$ = 0.5 Wb/$m^2$, ac = 3000 A/m, η = 0.9 p.f = 0.9, winding factor = 0.955, current density = 3.5 A/$mm^2$, slot space factor is 0.4 and ratio core length to pole pitch = 1.2. Take 5 slots per pole per phase motor is delta connected. | 9 | L3 | CO4 | PO2 |
| c. | Derive;<br>i) End ring current ii) Crawling in a 3-ϕ induction motor | 9 | L2 | CO4 | PO2 |

**UNIT - V** **18**

| | | | | | |
|---|---|---|---|---|---|
| 5 a. | Derive the output equation of a synchronous machine that relates output to main dimensions. | 9 | L2 | CO5 | PO2 |
| b. | Determine the main dimensions number of stator slots, conductors per slot, and conductor area of a 75000 kVA, 13.8 kV, 50 Hz, 187.5 rpm, 3-ϕ, star connected synchronous alternator peripheral speed should be about 60 m/s. Assume winding factor kW = 0.955, number of slots per pole per phase = 2.5. | 9 | L3 | CO5 | PO2 |
| c. | Define Short Circuit Ratio (SCR) and explain its effect on machine performance. | 9 | L2 | CO5 | PO2 |

* * * *