*Basavarajeswari Group of Institutions*
**BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT**
(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

**USN** | | | | | | | | | | |   **Course Code** 2 1 E E 5 4 1

Fifth Semester B.E. Degree Examinations, September/October 2024

# ELECTRICAL MACHINE DESIGN

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

***Note:*** ***1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
***2. Missing data, if any, may be suitably assumed.***

| Q. No | | Question | Marks | (RBTL:CO:PI) |
|---|---|---|---|---|
| | | **Module-1** | | |
| **1.** | **a.** | Explain the principle of electrical machine design. What are the limitations of the design? | **06** | (2 :1 : 1.3.1) |
| | **b.** | What are desirable properties of insulating materials? Explain the classification of insulating materials based on thermal consideration with example in each class. | **08** | (2 :1 : 1.3.1) |
| | **c.** | Explain in brief magnetic materials characteristics and application of sheet steels. | **06** | (2 :1 : 1.3.1) |
| | | **(OR)** | | |
| **2.** | **a.** | Write a short note on cold rolled grain oriented sheet. | **06** | (2 :1 : 1.3.1) |
| | **b.** | Discuss modern manufacturing techniques in the design of electrical machines. | **06** | (2 :1 : 1.3.1) |
| | **c.** | What are desirable properties of conducting materials? Distinguish between aluminium and copper wires. | **08** | (2 :1 : 1.3.1) |
| | | **Module-2** | | |
| **3.** | **a.** | What is meant by specific loading of the DC Machine? Derive the output equation of the DC machine. | **08** | (2 :2 : 1.3.1) |
| | **b.** | Discuss the factors to be considered for the selection of number of slots in a DC machine. | **06** | (2 :2 : 1.3.1) |
| | **c.** | Explain in brief the factors to be considered during the choice of specific magnetic loading and electric loading. | **06** | (2 :2 : 1.3.1) |
| | | **(OR)** | | |
| **4.** | **a.** | List the factors to be considered for the design of shunt field coils. | **06** | (2 :2 : 1.3.1) |
| | **b.** | Discuss the various factors which govern the choice of number of poles in DC machines. | **06** | (2 :2 : 1.3.1) |
| | **c.** | Justify the statement: The total weight of the iron part in the DC Machine decrease with an increase in the number of poles. | **08** | (2 :2 : 1.3.1) |
| | | **Module-3** | | |
| **5.** | **a.** | Obtain output equation for three phase transformer. | **06** | (2 :3 : 1.3.1) |
| | **b.** | Prove that emf per turn of a single phase transformer is equal to $K\sqrt{Q}$, where Q = per phase kVA output of transformer. | **08** | (2 :3 : 1.3.1) |
| | **c.** | The full load efficiency of a 300 kVA transformer is 98.2 % at upf. Design the number of cooling tubes necessary if the temperature rise is $35^0$C, the tank area may be assumed as 4.92 $m^2$, assume diameter of tube as 5 cm and average length as 1 m. | **06** | (2 :3 : 1.3.1) |

**Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)**

**(OR)**

**6.** **a.** Show that the ratio of gross core area to the area of circumscribing circle in a two stepped core of a transformer is 0.79. **06** (2 :3 : 1.3.1)

**b.** Obtain an expression for no load current of a transformer. **06** (2 :3 : 1.3.1)

**c.** Calculate approximate overall dimensions for a 200 kVA, 6600/400 volts 50 Hz, 3-phase core type transformer. The following data may be assumed: EMF per turn is equal to 10 volts, $B_m$ is equal to 1.3 Tesla, current density equal to 2.5 A/mm$^2$, window space factor is equal to 0.3 overall height is equal to overall width, stacking factor is equal to 0.9, use 3 stepped core. **08** (2 :3 : 1.3.1)

## Module-4

**7.** **a.** Explain the design of stator for three phase induction motor. **10** (2 :4 : 1.3.1)

**b.** Find the values of diameter and length of stator core with 7.5 kW, 220 V, 50 Hz, 4-pole, three phase induction motor for best Power factor. Given: specific magnetic loading is equal to 0.4 Weber per metre square, specific electric loading is equal to 22000 Ampere per metre, efficiency is equal to 0.86 and power factor is equal to 0.87. Also find the main dimensions if the ratio of core length to pole pitch is unity. **10** (2 :4 : 1.3.1)

**(OR)**

**8.** **a.** Explain crawling and cogging of induction motor. **10** (2 :4 : 1.3.1)

**b.** Select the dimension from the following range for 25 HP, 400 volts, 3 phase, 6-pole, 50 Hz, induction motor. The mean gap density is not exceeding 0.45 Weber per metre square and specific electric loading is not exceeding 25000 ampere per meter. Calculate turns per phase for stator winding, the product of efficiency and power factor may be taken as 0.72. **10** (2 :4 : 1.3.1)

| **Stator bore dia in m** | **025** | **036** | **03** |
|---|---|---|---|
| **Core length in m** | **0.10** | **0.19** | **0.14** |
| | **0.14** | **0.18** | **0.15** |

## Module-5

**9.** **a.** List out the factors that affect the length of air gap in induction motor. **08** (2 :5 : 1.3.1)

**b.** A 2500 kVA, 225 rpm, three phase, 60 Hz, 2400 volts, star connected alternator has the following design data. D= 2.5 m, core length = 0.44 m, q= 3, conductor per slot=4, circuit per phase =2, leakage factor =2, $B_{av}$ =1.5 T, depth of field winding is 30 mm, the ratio of armature mmf to full load mmf is 0.5, field winding space factor is 0.84 and field winding dissipates 1800 Watts per metre square. leave 3 mm for insulations, flange and height of pole shoe along the height of pole, find (i) total flux per pole (ii)width of pole (iii) height of field winding (iv) Pole height **12** (2 :5 : 1.3.1)

**(OR)**

**10** **a.** Explain the term short circuit ratio as applied in synchronous machine and explain the effect of SCR on machine performance. **10** (2 :5 : 1.3.1)

**b.** A 500 kVA, 3.3 kV, 50 Hz, 600 rpm, 3-phase, and salient pole alternator has a 180-turn phase. Estimate the length of the air gap if the average flux density is 0.54 Wb/m$^2$. The ratio of pole arc to pole pitch is equal to 0.66, the mmf required for the air gap is 80 % of no load field mmf and winding factor = 0.955. **10** (2 :5 : 1.3.1)

** ** **

**Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)**