**KUMARAGURU**
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**B.E DEGREE EXAMINATIONS: MAY 2017**

(Regulation 2014)

Sixth Semester

**ELECTRICAL AND ELECTRONICS ENGINEERING**

U14EET601**:** Electrical Machine Design

## COURSE OUTCOMES

**CO1:** Outline the concept and ability to analyze the magnetic materials and magnetic circuits in electrical machines, their characteristics and specifications of different electrical machines.

**CO2:** Design DC machine for the given specification.

**CO3:** Design induction motor, synchronous machines and transformers for the given specification.

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

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Match the $L/\tau$ ratio values with the operating characteristics of Induction Motor.     CO3  [K$_1$]

| $L/\tau$ ratio | Characteristics |
|---|---|
| A.  1.5 to 2 | i. Good Efficiency |
| B.  1.0 to 1.25 | ii. Minimum Cost |
| C.  1.5 | iii. Good Overall Design |
| D.  1 | iv. Good Power Factor |

|    | A | B | C | D |
|---|---|---|---|---|
| a) | ii | i | iii | iv |
| b) | iii | iv | ii | i |
| c) | ii | iv | i | iii |
| d) | iii | i | ii | iv |

2. The permeance per unit length of slot or depth of field is called as     CO1  [K$_1$]

   a) Specific Conductivity  b) Specific Reluctance

   c) Specific Permeance  d) Specific Resistivity

3. Which of the following statements belongs to Commutator Design of DC Machine ?     CO2  [K$_2$]
   1. Commutator Peripheral speed should be below 15 m/s
   2. Minimum Commutator Segment pitch is approximately 4 mm
   3. Commutator Diameter generally lies between 0.6 to 0.8 of Stator Diameter
   4. Number of segments is equal to the number of coils.

a)   1,2,3                                    b)   1,2,4

c)   1,2                                      d)   2,3

4.  The provision of cooling tubes in the transformer, improves heat dissipation due to      CO3  [K₂]

a)   Conduction                              b)   Radiation

c)   Convection                              d)   Induction

5.  Assertion (A): By designing induction motor with smaller air-gap, high power factor can be   CO3  [K₂]
    achieved.

    Reason (R): If air-gap is small, the mmf and magnetizing current will be high, which in turn
    increases the value of power factor.

a)   Both A and R are Individually true and  b)   Both A and R are Individually true but
     R is the correct explanation of A            R is not the correct explanation of A

c)   A is true but R is false                d)   A is false but R is true

6.  Which of the following coolant is used in direct cooling of turbo-alternators?            CO1  [K₁]

a)   Hydrogen                                b)   Oxygen

c)   Carbon-di-oxide                         d)   Oil

7.  For a 250 kVA Square Core type Transformer with an iron area of  0.0614 m², the diameter   CO3  [K₃]
    of the circumscribing circle is

a)   0.26 m                                  b)   0.37 m

c)   0.45 m                                  d)   0.56 m

8.  The limiting factor for diameter of synchronous machine is                                CO3  [K₁]

a)   Synchronous Reactance                   b)   Voltage Rating

c)   Air-gap length                          d)   Peripheral Speed

9.  Assertion (A): A high value of flux density should not be used in the air gap of dc machines,   CO2  [K₂]
    having a high frequency.

    Reason (R): When the dc machine rotates, the armature magnetic circuit alternately comes
    under the influence of north and south poles.

a)   Both A and R are Individually true and  b)   Both A and R are Individually true but
     R is the correct explanation of A            R is not the correct explanation of A

c)   A is true but R is false                d)   A is false but R is true

10. Total number of slots in the stator of an alternator having 12 poles, 3 phase, 8 slots per pole   CO3  [K₃]
    per phase is

a)   288                                     b)   96

c)   24                                      d)   120

## PART B (10 x 2 = 20 Marks)
### (Answer not more than 40 words)

11. What are the methods used for estimating the mmf for teeth (tapered teeth)?    CO1   [K$_1$]

12. List the advantages of hydrogen cooling system.    CO1   [K$_1$]

13. State the merits and demerits in choosing large number of poles for a dc machine.    CO2   [K$_1$]

14. What is the role of commutator and brushes in DC Machines ?    CO2   [K$_2$]

15. Draw the cruciform section of the transformer core and give the optimum dimensions in terms of circumscribing circle diameter d.    CO3   [K$_2$]

16. Why cooling of transformer is necessary?    CO3   [K$_2$]

17. Write the expression for output equation and output coefficient of induction motor.    CO3   [K$_1$]

18. Mention the factors to be considered for choice of specific electric loading for induction motor.    CO3   [K$_1$]

19. Differentiate salient pole rotors from non-salient pole rotors.    CO3   [K$_2$]

20. What is runaway speed?    CO3   [K$_1$]

### Answer any FIVE Questions:-
### PART C (5 x 14 = 70 Marks)
### (Answer not more than 300 words)

**Q.No. 21 is Compulsory**

21. (i) Determine the apparent flux density in the teeth of a dc machine when the real flux density is 2.15 Wb/m$^2$; slot pitch 28 mm, slot width 10 mm and the gross core length 0.35 m. The number of ventilating ducts is 4, each 10 mm wide. The magnetizing force for a flux density of 2.15 Wb/m$^2$ is 55000 A/m. The iron stacking factor is 0.9.   (7)    CO1   [K$_3$]

    (ii) Explain the different classes of motor duty with necessary waveforms and examples.   (7)    CO1   [K$_1$]

22. A 250 kVA, 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 1 m x 0.5 m in plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35 ˚C. The diameter of tube is 50 mm and is spaced 75 mm from each other. The average height of tubes is 1.05 m.    CO3   [K$_3$]

    Specific heat dissipation due to radiation and convection is respectively 6 and 6.5 W/m$^2$ – ˚C. Assume that convection is improved by 35 per cent due to provision of tubes.

23. Estimate the stator core dimensions, number of stator slots and number of stator conductors per slot for a 100 kW, 3300 V, 50 Hz, 12 pole star connected slip ring induction motor. Assume

Average gap density = 0.4 Wb/m$^2$, Conductors per metre = 25,000 A/m,

Efficiency = 0.9, power factor = 0.9 and winding factor = 0.96.

Choose main dimensions to give best power factor. The slot loading should not exceed 500 Ampere Conductors.

CO3 [K$_3$]

24. Find the main dimensions of a 200 KW, 250V, 6 pole, 1000 rpm DC generator. The maximum value of flux density in the gap is 0.87Wb/m$^2$ and the ampere conductors per metre of armature periphery are 31000. The ratio of pole arc to pole pitch is 0.67 and the efficiency is 91 percent. Assume the ratio of length of core to pole pitch as 0.75.

CO2 [K$_3$]

25. (i) Derive the output equation of Single Phase Transformer. (6)

CO3 [K$_1$]

(ii) Determine the dimensions of core and yoke for a 200 KVA, 50 Hz single phase core type transformer. A cruciform core is to be used with distance between adjacent limbs = 1.6 times the width of core laminations. Assume voltage per turn is 14 V, maximum flux density is 1.1 Tesla, window space factor is 0.32, current density is 3 A/mm$^2$ and stacking factor is 0.9. The Net iron area is 0.56 d$^2$ in a cruciform core, where d is the diameter of circumscribing circle. Width of the largest stamping is 0.85d. (8)

CO3 [K$_3$]

26. (i) What is Short Circuit Ratio (SCR) of Synchronous Machines ? Explain its significance. (6)

CO3 [K$_2$]

(ii) 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 the specific electric loading is 34000 A/m. Use circular poles with ratio of core length to pole pitch = 0.65. Specify the type of pole construction used if the run-away speed is about 2 times the normal speed. (8)

CO3 [K$_3$]

27. Explain the various approaches used in Computer Aided Design of electrical machines

CO3 [K$_1$]

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