Code : PCC-EEE-03 (100307)

B.Tech 3rd Semester Special Exam., 2020

ELECTRICAL MACHINES—I

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Question No. 1 is compulsory.

1. Answer any *seven* of the following questions : 2×7=14

(a) State Biot-Savart law.

(b) State Ampere law.

(c) Draw magnetic lines of a magnate showing magnetic flux lines clearly.

(d) On the same platform, draw the *B-H* curve for soft as well as hard magnetic material.

(e) With the help of neat and labeled diagram, show energy and co-energy.

(f) What interpoles are used for in a DC motor?

(g) Define commutation in DC machine.

(h) Draw sample waveform of wave winding and lap winding.

(i) Why is laminated core used in transformers?

(j) What is the order of the efficiency of a general purpose transformer? State reason.

2. *(a)* Draw and discuss general representation of an electromechanical energy conversion device. Further, explain lossless electromechanical energy conversion. 6

(b) The self and mutual inductances of a doubly excited magnetic system are as follows :

$$L_s = 0{\cdot}65 + 0{\cdot}18\cos 2\theta_r \text{ henry}$$
$$L_r = 0{\cdot}78 + 0{\cdot}29\cos 2\theta_r \text{ henry}$$
$$M_s = 0{\cdot}86\cos\theta_r \text{ henry}$$

Considering the winding resistance as zero, find the magnitude and direction of torque when the currents are $i_s = 15$ A DC, and $i_r = 12$ A DC. When stationary rotor has an angular position of $\theta_r = 60°$, consider all notations in their standard representation. 8

3. (a) Derive the expression for the maximum efficiency of a single-phase transformer. 6

(b) Draw and explain the exact and approximate equivalent diagram of a single-phase transformer. Give the mathematical formulations to represent the impedances, voltage and current of a side, when referred to another side. 8

4. (a) Following test results are obtained from a 10 kVA, 2500/250, 1-ϕ transformer. Calculate the efficiency at the load at 0·8 p.f. : 6

OC test : 250 V, 0·8 A, 50 W
SC test : 60 V, 3·0 A, 45 W

(b) Why are OC/SC tests performed on a transformer? Discuss what side they are performed and why. Elaborate the procedure to perform the tests. 8

5. (a) Draw and discuss the important constructional details of a DC motor. List two applications of DC series motor depicting its characteristic. 6

(b) Differentiate lap and wave windings along with their roles in a DC motor. Given the number of conductors in the machine as 16, calculate the average pitch of a 4-pole DC machine for (i) lap and (ii) wave windings. 8

6. (a) What do you understand by armature reaction? Elaborate its effect on the working of a DC generator and suggest the remedies to remove it. 7

(b) What are the problems faced with regard to commutation in a DC machine? Suggest the constructional changes need to be performed in order to protect the machine from commutation failure. 7

7. (a) A 4-pole, 32-conductor, DC generator is lap wound and is running at a speed of 1500 r.p.m. Assuming per pole to be 10 Wb, find the EMF generated by the DC machine. 6

(b) Draw the open circuit and load characteristics of a separately excited DC generator. Also explain the curvature that is seen in an open circuit characteristic of a self-excited DC generator. 8

8. (a) Classify various types of braking used in a DC machine. Explain the type of braking demonstrating a train runs down a hill top. Support your answer with mathematical expressions. 7

(b) "A DC shunt motor can provide a wide range of speed control." Justify the statement theoretically and mathematically. Additionally, draw neat and labeled diagram of Ward Leonard method to control the speed of a DC shunt motor. 7

9. (a) Differentiate between a 1-ϕ transformer and an autotransformer. How is copper saving done in an autotransformer? What are additive and subtractive polarities in an autotransformer? 7

(b) Why is back-to-back test performed on a transformer? Write the steps to conduct the test. In back-to-back test, the wattmeter readings for primary and secondary are 25 W and 50 W, respectively. Calculate the copper loss of a transformer at half the rated load, if both the transformers used are identical. 7

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