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## Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Electric Motors

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. Derive the torque equation of a d.c. motor. (06 Marks)  
b. Explain the characteristics of DC series motor. (06 Marks)  
c. A 200 V, d.c. shunt motor takes 22A and runs at 1000 rpm. Its field and armature resistance are  $100 \Omega$  and  $0.1 \Omega$  respectively. Determine the value of additional resistance required in the armature circuit to reduce the speed to 800 rpm, when:  
(i) The torque proportional to the speed  
(ii) The torque varies as the square of the speed (08 Marks)

### OR

- 2 a. What is the necessity of starter for a d.c. motor? With a neat sketch, describe the working of three-point starter. What are its limitations? (10 Marks)  
b. With neat sketches, explain the Ward-Leonard method of speed control of DC motor. (06 Marks)  
c. Derive the condition for maximum efficiency of a DC machine. (04 Marks)

### Module-2

- 3 a. The Hopkinsons test on two shunt machines gave the following test results for full load:  
Line voltage = 250 V  
Current taken from supply excluding field current = 50 A  
Motor armature current = 380 A  
Field currents = 5 A and 4.2 A.  
Calculate the efficiency of the motor and generator. Assume resistance of each machine is  $0.02 \Omega$  ( $R_a$ ). (10 Marks)  
b. Discuss the torque-slip characteristics of a 3- $\phi$  induction motor indicating motoring, generating and braking regions on diagram. (10 Marks)

### OR

- 4 a. Describe the field test applied to two similar DC series motors. (06 Marks)  
b. Derive an expression for running torque of an induction motor and obtain the condition for maximum torque while running. (08 Marks)  
c. A 4-pole, 50 Hz, induction motor at rated voltage and frequency has a starting torque of 160% and maximum torque of 200 % of full load torque. Determine:  
(i) Full load speed  
(ii) Speed at maximum torque (06 Marks)

### Module-3

- 5 a. Starting from fundamentals, develop the equivalent circuit of a 3- $\phi$  induction motor. (06 Marks)

- b. The power input to a 500 V, 50 Hz, 6 pole, 3- $\phi$  induction motor at 975 rpm is 40 KW. The stator losses total 1 KW and the friction and windage losses total is 2 KW. Calculate:
- (i) The slip (ii) The rotor copper loss  
(iii) Mechanical power developed in the rotor (iv) Efficiency (08 Marks)
- c. Explain cogging and crawling phenomenon in 3- $\phi$  induction motor. (06 Marks)

OR

- 6 a. Draw the circle diagram from no load and short circuit test of a 3- $\phi$ , 14.92 KW, 400 V, 6 pole induction motor with the following test data:  
No load : 400 V, 11 A,  $\cos \phi = 0.2$   
S.C. test : 100 V, 25 A,  $\cos \phi = 0.4$   
The stator and rotor copper losses are equal. Determine from circle diagram:
- (i) The line current (ii) Slip (iii) Power factor  
(iv) Maximum output (v) Efficiency (10 Marks)
- b. Write a short note on induction generator. (04 Marks)
- c. Explain the construction of deep bar rotor induction motor. (06 Marks)

**Module-4**

- 7 a. What is the necessity of starter for a 3- $\phi$  induction motor? With a neat diagram, explain the operation of a star-delta starter. (08 Marks)
- b. Explain any two speed control methods of a 3- $\phi$  induction motor from stator side. (06 Marks)
- c. With a neat diagram, explain the construction and operation of capacitor start 1- $\phi$  induction motor. (06 Marks)

OR

- 8 a. Why single phase induction motor is not self starting? Explain double revolving field theory as applied to a single phase induction motor along with torque-speed characteristics. (10 Marks)
- b. With neat sketches, explain the construction, working and applications of split phase induction motor. (06 Marks)
- c. Explain rotor resistance method of speed control for a 3- $\phi$  induction motor. (04 Marks)

**Module-5**

- 9 a. Describe the different starting methods of a synchronous motor. (08 Marks)
- b. Write a short note on V and inverted V-curves of synchronous motor. (06 Marks)
- c. Describe the operation of linear induction motor. List the applications. (06 Marks)

OR

- 10 a. Explain the operation of synchronous motor at constant load and variable excitation with phasor diagrams. (08 Marks)
- b. Explain the construction and working of universal motor. (06 Marks)
- c. Write a short note on stepper motors. (06 Marks)

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