

CBCS SCHEME

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21EE744

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025 Industrial Drives and Applications

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Describe the modes of operation of an electrical drive. (10 Marks)
- b. A drive has the following parameters:
 $J = 10 \text{ kg-m}^2$, $T = 100 - 0.1 N$, N-m, passive load torque $T_l = 0.05 N$ N-m, where N is speed in rpm. Initially the drive is operating in steady state. Now it is to be reversed. For this motor characteristics is changed to $T = -100 - 0.1 N$ N-m. Calculate the time of reversal. (06 Marks)
- c. What are the factors affecting the choice of an electric drive? (04 Marks)

OR

- 2 a. Explain the speed torque conventions and multi-quadrant operation of motor driving hoist load. (07 Marks)
- b. What is the necessity of mounting flywheel on motor shaft in non-reversible drives? Obtain the equations to calculate moment of inertia of flywheel. (07 Marks)
- c. A motor equipped with flywheel is to supply a load torque of 1000 N-m for 10 sec followed by light load period of 200 N-m long enough for flywheel to regain its steady state speed. It is desired to limit the motor torque to 700 N-m. What should be moment of inertia of flywheel? Motor has an inertia of 10 kg-m^2 . It's no load speed is 500 rpm and slip at a torque of 500 N-m is 5%. Assume speed-torque characteristic of motor to be a straight line in region of interest. (06 Marks)

Module-2

- 3 a. A 200 V, 875 rpm, 150 A separately excited DC motor has an armature resistance of 0.06Ω . It is fed from a single phase fully controlled rectifier with an AC source voltage of 220 V, 50 Hz. Assuming continuous conduction. Calculate:
 - (i) Firing angle for rated motor torque and 750 rpm
 - (ii) Firing angle for rated motor torque and -500 rpm
 - (iii) Motor speed for $\alpha = 160^\circ$ and rated torque (06 Marks)
- b. Explain the operation of Chopper control of separately excited DC motor. (10 Marks)
- c. Discuss the operation of controlled rectifier fed DC drives. (04 Marks)

OR

- 4 a. A 230 V, 960 rpm and 200 A separately excited DC motor has an armature resistance of 0.02Ω . The motor is fed from a chopper which provides both motoring and braking operations. The source has a voltage of 230 V. Assuming continuous conduction:
 - (i) Calculate duty ratio of chopper for motoring operation at rated torque and 350 rpm.
 - (ii) Calculate duty ratio of chopper for braking operation at rated torque and 350 rpm.
 - (iii) If maximum duty ratio of chopper is limited to 0.95 and maximum permissible motor current is twice the rated. Calculate maximum permissible motor speed, obtainable without field weakening and power fed to source.
 - (iv) If motor field is also controlled in (iii) above, calculate field current as a fraction of its rated value for speed of 1200 rpm. (10 Marks)

- b. Describe the operation of single phase fully controlled rectifier control of separately excited DC motor. (10 Marks)

Module-3

- 5 a. Explain the analysis of induction motor fed from non-sinusoidal voltage supply. (10 Marks)
 b. A 2.8 KW, 400 V, 50 Hz, 4-pole, 1370 rpm, delta connected squirrel cage induction motor has following parameters referred to stator: $R_s = 2 \Omega$, $R'_r = 5 \Omega$, $X_s = X'_r = 5 \Omega$, $X_m = 80 \Omega$. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate:
 (i) Motor terminal voltage, current and torque at 1200 rpm.
 (ii) Motor speed, current and torque for terminal voltage of 300 V. (10 Marks)

OR

- 6 a. Describe the operation of three phase induction motor operating with unbalanced source voltages and single phasing. (08 Marks)
 b. Explain any two methods of starting an induction motor. (06 Marks)
 c. A 400 V, star connected, 3- ϕ , 6-pole, 50 Hz induction motor has following parameters referred to stator: $R_s = R'_r = 1 \Omega$, $X_s = X'_r = 2 \Omega$. For regenerative braking operation of motor, determine:
 (i) Maximum overhauling torque it can hold and range of speed for safe operation.
 (ii) Speed at which it will hold on overhauling load with a torque of 100 N-m.
 (iii) Maximum overhauling torque the motor can hold as a ratio of maximum overhauling torque without capacitor if a capacitive reactance of 2Ω is inserted in each phase of stator. (06 Marks)

Module-4

- 7 a. Describe the current regulated voltage source inverter control. (08 Marks)
 b. Explain the closed loop speed control and converter rating for Voltage Source Inverter (VSI) and cyclo-converter induction motor drives. (06 Marks)
 c. Write short notes on any one method of speed control of single phase induction motor. (06 Marks)

OR

- 8 a. Describe the operation of synchronous motor from fixed frequency supply, using the method of starting. (08 Marks)
 b. A 6 MW, 3-phase, 11 KV, Y-connected, 6-pole, 50 Hz, 0.9 p.f. (leading) synchronous motor has $X_s = 9 \Omega$ and $R_s = 0$. Rated field current is 50 A. Machine is controlled by variable frequency control at constant (V/f) ratio up to base speed and at constant V above base speed. Determine torque and field current for rated armature current, 750 rpm and 0.8 leading power factor. (06 Marks)
 c. Discuss the modes of variable frequency control of synchronous motor drives. (06 Marks)

Module-5

- 9 a. Describe the operation of self controlled synchronous motor drive employing load commutated thyristor inverter. (10 Marks)
 b. Explain the operation of brushless DC motor drives for servo applications with suitable waveforms. (10 Marks)

OR

- 10 a. Explain any one type of variable reluctance stepper motor. (08 Marks)
 b. Discuss the operation of textile mill drives. (08 Marks)
 c. Mention the important features of stepper motor. (04 Marks)

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