Hall Ticket No | | | | | | | | | | | Question Paper Code: AEEC23

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.Tech VI SEMESTER END EXAMINATIONS (REGULAR) - JULY 2023
Regulation: UG-20
ELECTRIC DRIVES AND STATIC CONTROL
Time: 3 Hours (ELECTRICAL AND ELECTRONICS ENGINEERING) Max Marks: 70

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Describe the construction and principle of single-phase fully controlled converter control of separately excited DC motor. [BL: Understand| CO: 1|Marks: 7]

   (b) A single-phase semi-converter is used for controlling the speed of a 10 HP, 220 V, 900 RPM DC series motor. The total resistance of the field and armature circuit is 0.9Ω. Assuming continuous current and speed of 900 RPM, obtain for an input voltage of 240 V, the motor current and torque for a firing of 45°. Assume motor constant = 0.035 n-m/A^2. [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Explain the four-quadrant operation of DC motor including the motoring and breaking operation with neat characteristics. [BL: Understand| CO: 2|Marks: 7]

   (b) A DC shunt motor takes a current of 50 A on a 440 V supply, runs at speed of 1000 RPM, with an armature resistance of 0.5 Ω and a field resistance of 100Ω. A chopper is used to control the speed of the motor in the range of 400-800 rpm having a constant torque. The on-period of the chopper is 2 ms, with its field supply voltage from 440 V. Determine the range of frequencies of the chopper. [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) Elaborate the working principle of control variable voltage characteristics of induction motor by AC voltage controllers with neat sketch. [BL: Understand| CO: 3|Marks: 7]

   (b) A 3-phase, 400 V, 15 kW, 1440 RPM, 50 Hz, star- connected induction motor has rotor leakage impedance of 0.4 +j1.6Ω, stator leakage impedance and rotational losses are assumed negligible. If this motor is energised from 120 Hz, 400V, 3-phase source, then calculate

   i) The motor speed at rated load

   ii) The slip at which maximum torque occurs and

   iii) The maximum torque. [BL: Apply| CO: 3|Marks: 7]

4. (a) Demonstrate the construction and operation of variable frequency control of induction motor by voltage source inverter with output waveforms. [BL: Understand| CO: 4|Marks: 7]

   (b) A three-phase, star-connected 400 V, 50 Hz, 4-pole induction motor has the following per phase parameters referred to the stators: R_1 =0.15 Ω, X_1 = 0.45 Ω, R'2 = 0.12 Ω,X'2 = 0.45 Ω and Xm = 28.5 Ω. Compute the stator current and power factor when the motor is operated at rated voltage and frequency with S = 0.04. [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Outline the operating principle of static Kramer-drive type slip power recovery scheme with necessary diagrams. [BL: Understand| CO: 5|Marks: 7]

   (b) A 3-phase, 420 V, 4-pole, 50 Hz, star-connected induction motor has its speed controlled by means of static Kramer drive. The effective phase turns ratio from rotor to stator is 0.8 and transformer has phase turns ratio from low voltage to high voltage as 0.4. The inductor current is ripple free. Losses in diode rectifier, inductor, inverter and transformer are neglected. The load torque is proportional to speed squared and its value at 1200 rpm is 450 Nm. For a motor operating speed of 1000 RPM, calculate.

   i) Rotor rectified voltage ii) Inductor current iii) Delay angle of the inverter

   iv) Efficiency, in case inductor resistance is 0.01 Ω and per-phase resistances for stator and rotor are 0.015 Ω and 0.02 Ω respectively. [BL: Apply| CO: 5|Marks: 7]

6. (a) What is the problem in control of inverter fed induction motors? Elucidate the basic principle of vector control of induction motor drive. [BL: Understand| CO: 5|Marks: 7]

   (b) A 400 V, 50 Hz, 950 RPM, 6-pole, Y-connected, three-phase wound rotor induction motor has the following parameters referred to the stator: Rs = 0.2 Ω, R'r = 0.07 Ω, Xs =0.4 Ω, X'r = 0.4Ω. The stator to rotor turns ratio is 2. Motor speed is controlled by static Scherbius drive. The drive is designed for a speed range of 25% below the synchronous speed. The maximum value of firing angle is 150°. Calculate the following:

   i) The transformer turns ratio ii) The torque for a speed of 750 rpm and $\alpha = 130°$

   iii) The firing angle for half the rated motor torque and speed of 850 RPM (DC link inductor has a resistance of 0.02 Ω). [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Describe the construction and principle of voltage source inverter fed synchronous motor drive with neat sketch. [BL: Understand| CO: 6|Marks: 7]

   (b) A 500 kW, three-phase, 6.6 kV. 60 Hz, 6-pole, Y-connected wound field synchronous motor has the following parameters: Xm = 78 Ω, Xsr = 3 Ω, pf = 1, k = 5, Rs = 0 (negligible). The motor speed is controlled by variable frequency control with a constant V/f ratio up to base speed and rated terminal voltage above base speed. Calculate T, P_m, I_m and I_f for the motor operation at rated armature current and UPF. What is the range of constant power operation? Neglect friction, windage and core loss. [BL: Apply| CO: 6|Marks: 7]

8. (a) Summarize the working principle of closed loop speed control of induction motor drives with block diagram. [BL: Understand| CO: 6|Marks: 7]

   (b) A 5MW, three-phase, 11kV, star-connected, 6-pole, 50Hz, 0.9 leading PF synchronous motor has Xs = 10 Ω and Rs = 0Ω. The rate field current is 50 A. Assume that stator resistance is to be neglected. The machine is controlled by variable frequency control at constant v/f ratio up to base speed and constant V above base speed. Determine

   i) The torque and the field current for the rated armature current of 750 RPM and 0.8 pf leading.

   ii) The armature current and pf for half the rated motor torque, 1500 RPM and rated field current. [BL: Apply| CO: 6|Marks: 7]