Dr. K. Latha

ADDITIONAL CONTROLLER OF EXAMINATIONS AU CHENNAI 600 025

Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)
END SEMESTER EXAMINATIONS – DECEMBER 2024
B.E (Full Time) - ELECTRICAL AND ELECTRONICS ENGINEERING
Semester VII
EE5701 – ELECTRICAL DRIVES
(Regulation 2019)

Time: 3hrs

Max. Marks: 100

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|---|---|
| CO 1 | Understand the basic requirements of motor selection for different load profiles. |
| CO 2 | Analyse the steady state behavior and stability aspects of drive systems. |
| CO 3 | Simulate the DC drive using converter and chopper control. |
| CO 4 | Simulate the AC drive |
| CO 5 | Design the controller for electrical drives |

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analyzing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

| Q. No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 1 | What is the dynamic equation of motor load system? | 2 | CO1 | L1 |
| 2 | Draw the torque and temperature rise characteristics w.r.t time for continuous duty and short time duty | 2 | CO1 | L1 |
| 3 | Explain how regenerative braking is achieved using chopper circuit for dc drive. | 2 | CO3 | L2 |
| 4 | For a semi converter fed separately excited dc motor draw the load voltage and load current waveform for discontinuous current conduction. | 2 | CO3 | L2 |
| 5 | Draw the rotor structures of permanent magnet synchronous motor for inset, interior and surface mounted types. | 2 | CO3 | L1 |
| 6 | What is the advantage of leading powerfactor operation for synchronous motor drive. | 2 | CO4 | L3 |
| 7 | Explain why V/f must be maintained constant in variable frequency operation of drive for constant torque mode of operation. | 2 | CO4 | L3 |
| 8 | Explain derating of the induction motor using stator voltage control | 2 | CO4 | L1 |
| 9 | Explain what happens when closed loop control is implemented without current feedback | 2 | CO5 | L4 |
| 10 | Explain how current can be sensed using Hall sensor | 2 | CO5 | L3 |

PART- B (5 x 13 = 65 Marks)

| Q. No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 11 (a) (i) | Derive the overload capacity for short time duty of a motor | 6 | CO2 | L3 |
| (ii) | Explain the different methods of speed control of DC motor with modes to obtain (i) $N>N_r$ and (ii) $N<N_r$ with N-T characteristics. | 7 | | |
| | OR | | | |

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|---|---|---|---|---|
| 11 (b)(i) | What is steady state stability of a drive? Derive the condition of steady state stability of a drive. | 7 | CO2 | |
| (ii) | What are the electrical factors taken into account for selecting a motor for a drive? | 6 | | |
| 12 (a) (i) | For a single phase fully controlled converter fed dc drive drive an expression for critical speed for $\alpha > \gamma$ where $\gamma$ is the angle when E=v . | 7 | CO3 | L5 |
| (ii) | Explain speed control of chopper fed separately excited DC motor. Derive an expression of ω-T in terms of δ. Draw the ω-T characteristics for different δ. | 6 | | |
| | OR | | | |
| 12 (b) | A 200 V, 875 rpm ,150 A separately excited dc motor has an armature resistance of 0.06 ohm. It is fed from a 1 phase fully controlled rectifier with an ac source voltage of 220 V, 50 Hz . Assuming a continuous conduction calculate<br>i)firing angle for rated motor torque and 750 rpm<br>ii) firing angle for rated motor torque and (-500) rpm<br>iii)motor speed for α=160 and rated torque | 13 | CO3 | L5 |
| 13 (a) (i) | Derive the torque equation of induction motor drive for the field weakening mode and prove that the breakdown torque is inversely proportional to the square of the stator frequency. Draw the s-T characteristics for the above control. | 6 | CO4 | L4 |
| (ii) | A 3 kW, 440 V, 50 Hz, 4 pole, 1370 rpm, delta connected squirrel-cage induction motor has following parameters referred to the stator: $R_s = 2\ \Omega$, $R'_r = 5\Omega$, $X_S = X'_r = 5\Omega$, $X_m = 90\ \Omega$. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate motor speed and torque for a stator voltage of 350 V. | 7 | | |
| | OR | | | |
| 13 b) (i) | Explain stator voltage control of induction motor drive with s-T characteristics. Explain why this method is best suited for pump drives. | 7 | CO4 | L4 |
| (ii) | Prove that the rotor current is maximum when motor runs at a slip s=1/3 for pump drive. Derive an expression for ratio of maximum current to full load current. For a speed of 1350 rpm calculate the ratio of maximum to full load current. | 6 | | |
| 14 (a) (i) | Explain constant torque and constant HP mode of operation for stator frequency control of synchronous motor with speed torque characteristics .Derive the torque equation. | 7 | CO4 | L4 |
| (ii) | Explain V/f control of a synchronous motor in true synchronous mode with the help of a block diagram. What are the disadvantages of this method of speed control? | 6 | | |
| | OR | | | |
| 14 (b) | What is meant by margin angle ? Explain the self controlled synchronous motor drive with constant margin angle control. Prove that damper windings can be avoided by this control strategy | 13 | CO4 | L4 |

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|---|---|---|---|---|
| 15 (a) (i) | Explain with block diagram the closed loop control of separately excited dc motor with current limiting and inner current control. | 8 | CO5 | L4 |
| (ii) | Compare the time constants of speed controller and current controller used in closed loop speed control of dc drive. Explain why it has to be chosen that way. | 5 | | |
| | OR | | | |
| 15 (b) | Derive the transfer function w(s)/ w* (s) for 3 phase full converter fed separately excited dc motor having PI controller for both speed and current controller. | 13 | CO5 | L4 |

## PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

| Q. No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 16. (i) | Explain how speed and armature current are varied for a separately excited dc motor by<br>i)doubling flux with armature voltage and load torque remaining constant.<br>ii)halving the armature voltage and field current with load torque remaining constant<br>iii) by halving armature voltage with the flux remaining constant and $T_L$ proportional to speed squared. | 6 | CO1 | L5 |
| (ii) | A 230 V, 500 rpm, 90 A separately excited dc motor has armature resistance of 0.2 ohm and 12 mH respectively. The motor is controlled by class C chopper operating with source voltage of 230 V and frequency of 400 Hz.<br>a)Calculate the motor speed for a motoring operation at δ=0.5 and half the rated torque<br>b) What will be the motor speed when regenerating at δ=0.5 and the rated torque | 9 | | |