Hall Ticket No ☐☐☐☐☐☐☐☐☐☐ Question Paper Code: BPE001

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
M.Tech I Semester End Examinations (Regular) - February, 2017
Regulation: IARE–R16
Power Electronics and Electric Drives
(POWER ELECTRONIC CONTROL OF DC DRIVES)

Time: 3 Hours   **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Draw and explain the power circuit of semi-converter feeding a separately excited D.C motor. Explain with typical voltage and current waveforms the operation in both continuous and discontinuous armature current modes. [7 M]

   (b) A 220V, 1200 rpm, 15A, separately excited dc motor has armature resistance and inductance of 1.8 Ω and 32mH respectively. This motor is controlled by a single phase fully controlled rectifier with an ac source voltage of 230V, 50Hz. Identify the modes and calculate the developed torque for $\alpha = 60°$ and speed = 450 rpm. [7 M]

2. (a) A 220V, 1500 RPM, 10A separately excited D.C motor has an armature resistance of 0.1 ohms if it is fed from a single phase fully controlled bridge rectifier with an A.C source voltage of 230V, 50 Hz. Assuming continuous load current compute:

   i. firing angle for rated motor torque at 600 rpm.

   ii. firing angle for rated motor torque at (-500) rpm. [7 M]

   (b) Explain the multi-quadrant operation of D.C of separately excited dc motor using Single phase fully controlled rectifier with a reversing switch. [7 M]

UNIT – II

3. (a) The speed of a 125 HP, 600V, 1800 rpm separately dc motor is controlled by a $3-\Phi$ full converter. The converter is operated from a $3-\Phi$, 480V, 60Hz supply. The rated armature current of the motor is 165A. The motor parameters are Ra= 0.0874Ω, La= 6.5mH and $Ka - \Phi = 0.33V/rpm$. The converter and ac supply are considered to be ideal. Find No load speeds at firing angles $\alpha = 00$ and $\alpha = 300$. Assume that at no load the armature current is 10% of the rated current and is continuous. [7 M]

   (b) Draw the block diagram of the closed loop speed control scheme for control below and above base speed. [7 M]

4. (a) A 220V, 750 rpm, 200A, separately excited motor has an armature resistance of 0.05 ohms. Armature is fed from a three phase non circulating current dual converter consisting of fully controlled rectifiers A and B. Rectifier A provides motoring operation in the forward direction and B in reverse direction. line voltage of the ac source is 400V. Calculate the firing angles of the rectifiers for the following assuming continuous conduction.

     i. Motoring operation at rated torque and 600 rpm.

    ii. Regenerative braking operation at rated torque and 600 rpm.   [7 M]

  (b) Explain the operation of a three phase fully controlled rectifier control of dc separately excited motor in motoring and braking operation.   [7 M]

UNIT – III

5. (a) A 230V, 960 rpm , and 200A dc separately excited dc motor has an armature resistance of 0.02 ohms. It is driving an overhauling load whose torque may vary from zero to rated motor torque. field flux may be changed and field saturates at 1.2 times the rated flux. Calculate the speed range in which motor can hold the load by regenerative braking without exceeding twice the rated current.   [7 M]

  (b) Draw the block diagram for design of speed control loop and resulting transfer function.   [7 M]

6. (a) Discuss the effect of harmonics, power factor and ripple in motor current on a dc drive.   [7 M]

  (b) A 230V, 1000rpm, 105A separately excited dc motor has an armature resistance of 0.06 ohms. Calculate the value of flux as a percent of rated flux for motor speed of 1500rpm when load is such that the developed motor power is maintained constant at rated value for all speeds above rated speed.   [7 M]

UNIT – IV

7. (a) A step down chopper supplied from dc source of 200V. The load parameter are $R = 6\Omega$, $L = 10m\ H$ & $E = 60V$. The chopper is operating with chopping frequency of 1200Hz & duty cycle of 0.6. Assuming continuous conduction. Determine.

     i. average load current

    ii. current ripple   [7 M]

  (b) Draw the block diagram and explain the speed controlled drive system for a dc drive.   [7 M]

8. (a) Draw and explain the circuit for regenerative braking using chopper, for a separately excited dc motor relevant equations. Draw the speed torque charavteristics.   [7 M]

  (b) The speed of a separately excited dc motor is controlled by a chopper. The dc supply Voltage is 120V, armature circuit resistance is 0.5Ω, armature circuit inductance is 20mH and motor constant is $Ka - \Phi = 0.05V/rpm$. The motor drives a constant torque load Requiring an average armature current of 20A. Assume that motor current is continuous. Determine

     i. The range of speed control.

    ii. The range of duty cycle α.   [7 M]

UNIT – V

9. (a) Discuss the dynamic simulation of the speed controlled dc motor drives.   [7 M]

  (b) The buck regulator has an input voltage of Vs=12V. the required average output voltage Va= 5V at R=500 ohms and the peak to peak output ripple voltage is 20mV. The switching frequency is 25K Hz. If the peak to peak ripple current of inductor is limited to 0.8A determine

     i. Duty cycle K

    ii. Filter inductance L

    iii. Filter capacitor C   [7 M]

10. (a) Develop the flow-chart for simulation of a single-quadrant phase controlled DC motor drive. Discuss about the expected simulation results, harmonic and associated problems.   [7 M]

(b) A buck regulator has an input voltage of Vs=12V. the required average output voltage is Va=5V at R=500 ohms and the peak to peak output ripple voltage of 20 mV. The switching frequency is 25kHz. If the peak to peak ripple current of inductor is limited to 0.8A, determine

    i. The duty cycle k

   ii. The filter inductance L

  iii. The filter capacitor C

  iv. The critical values of L and C [7 M]