G 6420

M.E. DEGREE EXAMINATION, MAY/JUNE 2007.

Second Semester

Power Electronics and Drives

PE 1652 — SOLID STATE DC DRIVES

(Regulation 2005)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain the constant torque and constant horse power operation of dc motors.

2. Discuss briefly about the nature and classification of load torques.

3. List out the Motor and input supply performance parameters pertaining to Phase Controlled dc drives.

4. Compare the advantages and disadvantages of Dual Converters with and without circulating current.

5. Explain briefly with suitable diagrams constant frequency and variable frequency systems of dc choppers.

6. What do you mean by a Multi-phase chopper?

7. Develop the transfer function of a 3-Phase full wave Converter after linearization.

8. Explain the behavior of a typical feedback control system using different types of controllers (P, PI, PID), when it is subjected to permanent disturbance, like step change in load variable.

9. Draw a schematic diagram of a basic Phase Locked-Loop circuit and explain its principle of operation.

10. Mention the advantages of Micro-computer controlled dc drives.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss in detail the principle of operation of a single phase full converter, feeding a Separately excited dc motor, with relevant circuit diagrams and waveforms. Assume the motor current is continuous. (7)

(ii) The speed of a 20 HP, 460V, 1000 RPM separately excited dc motor is controlled by a single-phase full wave controlled rectifier bridge. The rated motor armature current is 35A and the armature resistance is 0.15 ohms. The a.c. supply voltage is 480 volts. The motor back e.m.f constant is $K_{a\phi} = 0.45\,V/rpm$.. Assume that sufficient inductance is present in the armature circuit to make the motor current continuous and ripple free. For a firing angle of 60° and rated armature current, determine

(1) The motor torque

(2) The speed of the motor and

(3) The supply power factor. (9)

Or

(b) The Semi converter is connected to a 120 V, 60 Hz, supply. The current I_a can be assumed to be continuous and its ripple content is negligible. The turns ratio of the transformer is unity

(i) Express the input current in a fourier series determine the harmonic factor of input current Hf, displacement factor DF, and input power factor PF.

(ii) If the delay angle is $\alpha = \frac{\pi}{2}$ calculate Vdc, Vn, Vrms, HF, DF and PF. (16)

12. (a) (i) Explain the Ward-Leonard method of speed control of dc motors Mention the advantages and disadvantages of this method of speed control. (8)

(ii) A 250 V, 10 KW, 1200 RPM dc shunt motor has a full-load efficiency of 80%. Its field and armature resistances are 110 ohms and 0.25 ohm respectively. Calculate the value of resistance to be inserted in series with the armature circuit and the power lost in the armature circuit to reduce the speed to 80 %, when the load torque is constant regardless of the speed. (8)

Or

(b) (i) Explain how the rating of a motor is determined working on a given duty cycle. (8)

(ii) A motor has to deliver load of the following duty cycle.

100 KW for 15 minutes.

NO-load for 6 minutes.

50 KW for 15 minutes

No-load for 6 minutes.

The cycle being repeated continuously. Find the size of continuously rated motor suitable for the load cycle. (8)

13. (a) With relevant voltage and current waveforms, explain the principle of operation of type- A chopper. Discuss in detail the time domain analysis of type —A chopper. (16)

Or

(b) (i) Explain the chopper based regenerative braking operation of a separately excited dc motor. Draw relevant circuit diagrams and characteristics. (8)

(ii) A 230 V, 1200 rpm, 15 A separately excited dc motor has an armature resistance of 1.2 ohms. Motor is operated under dynamic braking mode with chopper control. Braking resistance has a value of 20 ohms. Calculate duty ratio of chopper for motor speed of 1000 rpm and braking torque equal to 1.5 times the rated torque of the motor. (8)

14. (a) Discuss in detail with suitable diagrams, the principle of operation of closed loop speed control of two quadrant dc, motor drive using suitable controlled rectifier bridge. (16)

Or

(b) Discuss in detail the dynamic simulation of the speed controlled dc motor drive. (16)

15. (a) Explain the role of PLL drives for stable operation of large motors. With suitable block schematic diagrams explain the operation of multi motor systems with PLL controllers. (16)

Or

(b) Draw and explain the block schematic of a 4-Quadrant micro – computer controlled dc drive system. Draw and explain a flow chart for the same scheme. (16)
