CHAPTER 14

Additional Problems

Solved Problems

14.1 The speed of a separately excited d.c. motor is controlled below base-speed by type-A chopper. The supply voltage is 220 V *dc*. The armature circuit has $R_a = 0.5\ \Omega$ and $L_a = 10$ mH. The motor constant is $K_v = 0.1$ V/rpm. Motor drives a constant torque load requiring an average armature current of 30 A. On the assumption of continuous armature current, determine:

(a) range of speed control and

(b) range of duty cycle.

Sol. Motor terminal voltage,

$$E_t = E_o = E_a + I_a \,.\, R_a.$$

Minimum possible speed of d.c. motor is zero. This gives motor counter emf, $E_q = 0$.

$$\therefore \quad \alpha E_s = E_o = o + I_a \,.\, R_a.$$

$$\alpha \times 220 = 0 + 30 \times 0.5 = 15 \text{ V}$$

$$\therefore \quad \alpha = \frac{15}{220} = 3/44.$$

Maximum possible value of duty cycle is 1.

$$\therefore \quad \alpha E_s = E_a + I_a \,.\, R_a.$$

$$1 \times 220 = \text{kV. N} + 30 \times 0.5.$$

$$\therefore \quad N = \frac{220 - 15}{0.10} = 2050 \text{ rpm.}$$

Therefore

(a) range of speed control is $O < N < 2050$ rpm and

(b) range of duty cycle, $\frac{3}{44} < \alpha < 1$

14.2 A separated excited d.c. motor is fed from three phase six-pulse fully controlled bridge converter. The motor develops its full-load torque at a rated speed of 1800 rpm taking a rated current of 60 A at 440 V. The input to three-phase converter is from an ideal source of 50 Hz.

(a) Determine the *rms* value of line voltages input to the converter if motor runs at its rated conditions for delay angle $\alpha = 0°$.

(b) What is the range of firing angles for a speed control of 1800 rpm to 900 rpm? The armature resistance is 0.5 ohm.

Sol. (a) We have, $E_{dc\alpha} = \frac{3\sqrt{2}\,E}{\pi}\cos\alpha$

At $\alpha = 0°$, $E_{dc\alpha} = 440$ V

$\therefore \quad 440 = \frac{3\sqrt{2}\,E}{\pi} \quad \therefore E = 326$ V.

(b) Back emf of motor at rated condition,

$$Eb_1 = 440 - 60 \times 0.5 = 410 \text{ V} = K \times 1800$$

Back emf at 900 rpm = $Eb_2 = K \times 900$

Or $\frac{Eb_2}{410} = \frac{K \times 900}{K \times 1800} = 1/2$ or

$$Eb_2 = \frac{410}{2} = 205 \text{ V}.$$

Hence of 900 rpm,

$$E_{dc\alpha} = Eb_2 + I_a \,.\, R_a = 205 + 60 \times 0.5$$
$$= 235$$

$\therefore$ Hence, $235 = 1.35 \times 326 \cos\alpha$

$$\cos\alpha = 235/1.35 \times 326 = 0.534$$
$$= \cos 57.71°$$

$\therefore \quad \alpha = 57.71°$.

$\therefore$ Range of firing delay angle is

$$\theta \le \alpha \le 57.710$$