Thapar University, Patiala

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code: UEC 301; Course Name: Analog Electronics

B.E. (ECE/ENC) (IV-Sem), "Tutorial Sheet No. - 4"

Solution

Q1.

To determine R_B:

The operating point is at $V_{CE} = 7$ V and $I_C = 1$ mA

Here,
$$R_C = \frac{V_{CC} - V_{CE}}{I_C} = \frac{12 - 7}{1 \times 10^{-3}} = 5\ \text{k}\Omega$$

$$I_B = \frac{I_C}{\beta} = \frac{1 \times 10^{-3}}{100} = 10\ \mu\text{A}$$

Using the relation,
$$R_B = \frac{V_{CC} - V_{BE} - I_C R_C}{I_B} = \frac{12 - 0.7 - 1 \times 10^{-3} \times 5 \times 10^3}{10 \times 10^{-6}} = 630\ \text{k}\Omega$$

Stability factor,
$$S = \frac{1 + \beta}{1 + \beta\left[\frac{R_C}{R_C + R_B}\right]}$$

$$= \frac{1 + 100}{1 + 100\left[\frac{5 \times 10^3}{(5 + 630) \times 10^3}\right]} = 56.5$$

To determine new operating point when $\beta = 50$

$$V_{CC} = \beta I_B R_C + I_B R_C + V_{BE}$$

$$= I_B(\beta R_C + R_B) + V_{BE}$$

$$12 = I_B(50 \times 5 \times 10^3 + 630 \times 10^3) + 0.7$$

$$I_B = \frac{11.3}{880 \times 10^3} = 12.84\ \mu\text{A}$$

Therefore,
$$I_C = \beta I_B = 50 \times 12.84 \times 10^{-6} = 0.642\ \text{mA}$$

$$V_{CE} = V_{CC} - I_C R_C = 12 - 0.642 \times 10^{-3} \times 5 \times 10^3 = 8.79\ \text{V}$$

Therefore, the coordinates of the new operating point are $V_{CEQ} = 8.79$ V and $I_{CQ} = 0.642$ mA.

Q2. Refer Millman, Halkias and Parikh, Second Edition book.

Q3. Refer Millman, Halkias and Parikh, Second Edition book.

Q4. Done in the class.

Q5.

To determine the quiescent point:

We know that the collector to base bias transistor circuit

$$V_{CC} = \beta I_B R_C + I_B R_B + V_{BE}$$

Therefore,
$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta \cdot R_C}$$
$$= \frac{10 - 0.7}{100 \times 10^3 + 50 \times 2 \times 10^{+3}} = 46.5\ \mu A$$

Hence,
$$I_C = \beta I_B = 50 \times 46.5 \times 10^{-6} = 2.325\ mA$$

$$V_{CE} = V_{CC} - I_C R_C = 10 - 2.325 \times 10^{-3} \times 2 \times 10^3 = 5.35\ V$$

Therefore, the co-ordinates of the new operating point are

$$V_{CEQ} = 5.35\ V \text{ and } I_{CQ} = 2.325\ mA$$

To find the stability factor S:

$$S = \frac{1 + \beta}{1 + \beta\left[\frac{R_C}{R_C + R_B}\right]}$$

$$= \frac{1 + 50}{1 + 50\left[\frac{2 \times 10^3}{2 \times 10^3 + 100 \times 10^3}\right]} = 25.75$$