ELG2136 - Winter 2016

Solution of Assignment 6

The transistors in the circuit shown in Figure 1 have β = 100. Find the labelled node voltages.

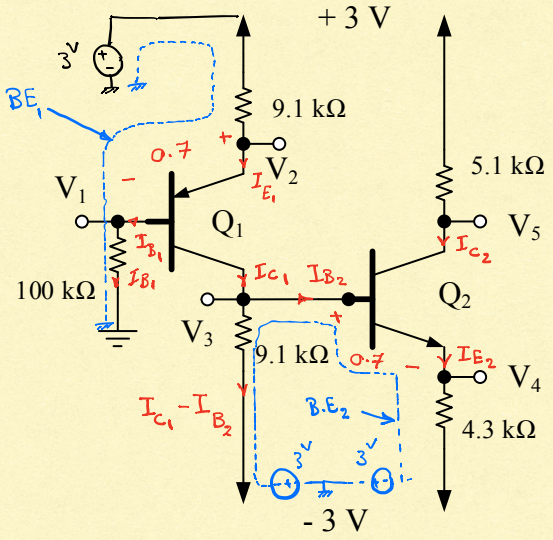

Figure 1

Assume both transistors are in the active mode

KVL @ BE1

$$-3 + I_{E_1} \times 9.1\,k + 0.7 + I_{B_1} \times 100\,k\Omega = 0$$

$$I_{E_1} = (\beta+1)\, I_{B_1}$$

$$\text{Hence } I_{B_1} = \frac{3 - 0.7}{101 \times 9.1\,k + 100\,k} = 0.0023\,mA$$

$$I_{C_1} = \beta I_{B_1} = 0.23\,mA$$

$$I_{E_1} = 0.228\,mA$$

KVL @ BE_2

$$+3^V - (I_{C_1} - I_{B_2}) \times 9.1^{k\Omega} + 0.7 + I_{E_2} \times 4.3^{k} - 3^V = 0$$

Since Q_2 is assumed to be active, then

$$I_{E_2} = (\beta + 1) I_{B_2}$$

Substituting for I_{C_1}, we get

$$I_{B_2} = \frac{I_{C_1} \times 9.1^{k} - 0.7}{9.1^{k} + 101 \times 4.3^{k}} = 0.0081 \text{ mA}$$

$$I_{C_2} = \beta I_{B_2} = 0.81 \text{ mA}$$

$$I_{E_2} = (\beta + 1) I_{B_2} \approx 0.81 \text{ mA}$$

$$V_1 = I_{B_1} \times 100^{k\Omega} = 0.23^V$$

$$V_2 = 3 - 9.1^{k} \times I_{E_1} = 0.93^V$$

$$V_3 = (I_{C_1} - I_{B_2}) \times 9.1^{k} + (-3^V) \approx -1^V$$

$$V_4 = I_{E_2} \times 4.3^{k} + (-3)^V = 1.7^V$$

$$V_5 = 3 - I_{C_2} \times 5.1^{k} = 1.47^V$$

Validation of active mode

Base currents are consistent with active mode

For Q_1 (PNP) $V_3 < V_2 \rightarrow B\_C_1$ is Reverse-biased

For Q_2 (NPN) $V_5 > V_3 \rightarrow B\_C_2$ is Reverse-biased