ELG3331: Tutorial on Chapter 10

Problem 10.6
See Figure 10.6 in the textbook. Assume the BJT has V_{BE} = 0.7 V and β = 150.

$$R_B = R_1 \ //R_2 = 12.078\ \text{k}\Omega$$

$$V_{BB} = \frac{R_2}{R_1 + R_2} V_{CC} = 3.5\ V$$

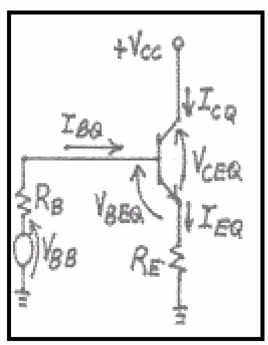
$$I_B = \frac{\text{V}_{\text{BB}} - \text{V}_{\text{BE}}}{R_B + R_E(1+\beta)} = \frac{3.5 - 0.7}{12.078(1+150)} = 15\ \mu\text{A}$$

$$I_C = \beta I_B = 2.25\ \text{mA}$$

$$V_{CE} = V_{CC} - R_C I_C - R_E I_E = 18 - 3300 \times 2.25 \times 10^{-3} - 1200 \times 151 \times 15 \times 10^{-6} = 7.857\ \text{V}$$

From the value of V_{CE}, it is clear that the BJT is in the active region.

Problem 10.15
See Figure 10.14 in the textbook. Assume the BJT has V_{BE} = 0.7 V and β = 100. See the base emitter circuit here!



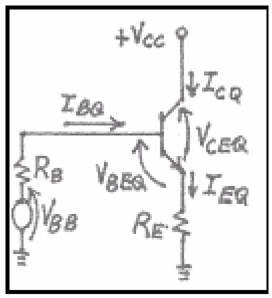
$$R_B = R_1 //R_2 = 9.982\ \text{k}\Omega$$

$$V_{BB} = \frac{R_2}{R_1 + R_2} V_{CC} = 15 \frac{11.7}{11.7 + 68} = 2.202\ \text{V}$$

Redraw the circuit and consider the base emitter closed path. Apply KVL to get

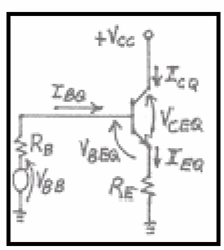
$$-V_{BB} + I_B R_B + V_{BE} + I_E R_E = 0$$
$$-V_{BB} + I_B R_B + V_{BE} + (\beta+1) I_B R_E = 0$$
$$I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta+1)R_E} = \frac{2.202 - 0.7}{9982 + (100+1)\times 200} = 49.76\ \mu A$$
$$I_C = \beta I_B = 49.76\times 10^{-6} \times 100 = 4.976\ mA$$
$$I_E = (\beta+1) I_B = 5.026\ mA$$
$$-V_{CC} + I_C R_C = V_{CE} + I_E R_E = 0$$
$$V_{CE} = 13\ V$$
The BJT is in the active region.

Problem 10.16
See the base emitter circuit here!



Follow a similar procedure to find V_{CE}. You will get
$I_B = 49.76\ \mu A$
$I_C = 4.976\ mA$
$I_E = 5.026\ mA$
$V_{CE} = -5.91\ V$
Therefore, the transistor is not in the active region.

Problem 10.17
See Figure 10.17 of the textbook. See the base emitter circuit here!



$$V_{BB} = V_{CC} \frac{R_2}{R_1 + R_2} = 12 \frac{22}{22+82} = 2.538\ V$$
$$R_B = R_1 // R_2 = 17.35\ k\Omega$$

Apply KVL to the base emitter circuit

$$-V_{BB} + I_B R_B + V_{BE} + I_E R_E = 0$$
$$-V_{BB} + I_B R_B + V_{BE} + (\beta+1) I_B R_E = 0$$
$$I_B = \frac{2.538 - 0.7}{17350 + 131 \times 500} = 22.18\ \mu\text{A}$$
$$I_E = 131 \times 22.18\ \mu\text{A} = 2.906\ \text{mA}$$

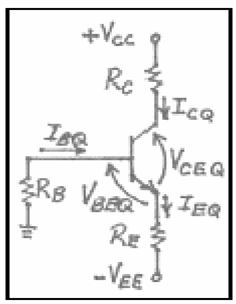
Apply KVL to the collector emitter circuit.

$$-I_E R_E - V_{CE} + V_{CC} = 0$$
$$V_{CE} = 12 - 2.906 \times 0.5 = 10.55\ \text{V}$$
The BJT is in the active region.

Problem 10.18

This is different problem. The BJT biasing is through V_{EE}. This type of biasing is not included in the exam.

The capacitors as usual act as open circuit for DC and short circuit for AC. Apply KVL to the base emitter circuit. See the base emitter circuit here!



$$-V_{EE} + I_B R_B + V_{BE} + I_E R_E = 0$$
$$I_B = \frac{V_{EE} - V_{BE}}{R_B + (\beta+1) R_E} = \frac{4 - 0.7}{100000 + 101 \times 3000} = 8.189\ \mu\text{A}$$
$$I_C = 100 \times 8.189\ \mu\text{A} = 818.9\ \text{mA}$$
$$I_E = 101 \times 8.189\ \mu\text{A} = 827\ \text{mA}$$

Apply KVL to the collector emitter circuit, as usual

$$V_{EE} - I_E R_E - V_{CE} - I_C R_C + V_{CC} = 0$$
$$V_{CE} = V_{EE} + V_{CC} - I_C R_C - I_E R_E = 11.06\ \text{V}$$
The BJT is in the saturation region