ECE 322 Fall 2021 Exam 1 Practice Solutions

1) Given:

$I_E = 3\ mA$
$\beta = 50$
NPN Transistor

$$I_E = I_C\left(\frac{\beta+1}{\beta}\right) \Rightarrow I_C = \frac{I_E\ \beta}{(\beta+1)} = 2.94\ mA$$

$$I_B = \frac{I_E}{(1+\beta)} = 0.05882\ mA = 58.82\ \mu A$$

Hence, $I_C = 2.94\ mA$, $I_B = 58.82\ \mu A$

2) Given:

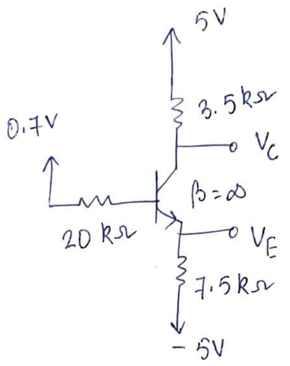
$I_E = 1\ mA$
$\beta = 10$

$$I_B = \frac{I_E}{(1+\beta)} = 0.09\ mA$$

$$\alpha = \frac{\beta}{1+\beta} = 0.9$$

Hence, $I_B = 0.09\ mA$, $\alpha = 0.9$

3) The given circuit,



$\beta = \infty \Rightarrow I_B = 0$

$I_C = I_E$

Given $V_{BE} = 0.7\,V \Rightarrow V_E = V_B - 0.7\,V =$ ~~0.7V~~ $(V_B = 0.7V)$

$= 0V$

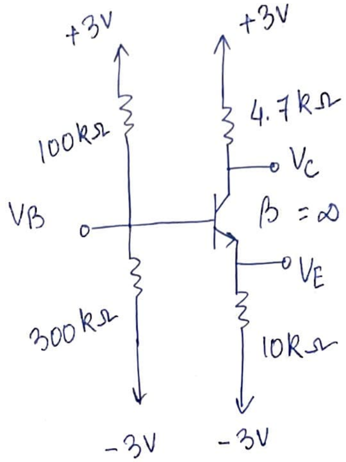
$I_E = \dfrac{V_E + 5V}{7.5\,k\Omega} = 0.67\,mA$

$\therefore I_C = 0.67\,mA = \dfrac{5V - V_C}{3.5\,k\Omega}$

$\Rightarrow V_C = 2.66\,V$

Thus, $\boxed{V_E = 0V}$, $\boxed{V_C = 2.66\,V}$

4) The given circuit,



For the node at the base of the transistor,

$$\frac{3V - V_B}{100\,k\Omega} = \frac{V_B + 3V}{300\,k\Omega}$$

$\Rightarrow \quad V_B = 1.5V$

Given $V_{BE} = 0.7V \quad \Rightarrow V_E = 0.8V$

$\beta = \infty \quad \Rightarrow I_C = I_E \; (I_B = 0)$

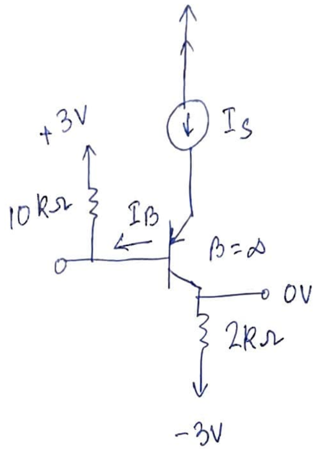
Since, $I_E = \frac{V_E + 3V}{10\,k\Omega} = 0.38\,mA = I_C = \frac{3V - V_C}{4.7\,k\Omega}$

$$\Rightarrow 0.38\,mA = \frac{3V - V_C}{4.7\,k\Omega}$$

$\Rightarrow V_C = 1.214V$

Hence, $\boxed{V_B = 1.5V}$, $\boxed{V_E = 0.8V}$, $\boxed{V_C = 1.214V}$

5) The given circuit,

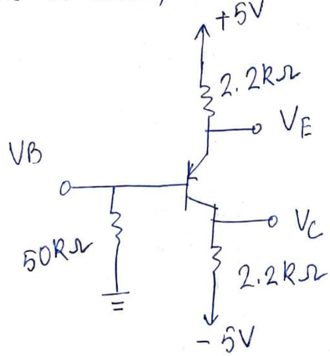


Given, $\beta = \infty \Rightarrow I_C = I_E$, $I_B = 0\text{ A}$

$$I_C = \frac{0V + 3V}{2k\Omega} = 1.5\text{ mA} = I_E$$

Since $I_B = 0\text{ A}$, $V_B = 3V$ since there is no potential drop across the 10 kΩ resistor.

6) The given circuit,



Given: $|V_{BE}| = 0.7V$, $V_B = 0.8V$

$\Rightarrow V_E = 0.7V + 0.8V = 1.5V$

6) contd...

Base current, $I_B = \frac{V_B}{50k\Omega} = \frac{0.8V}{50k\Omega} = 16\ \mu A$

Emitter current, $I_E = \frac{5V - V_E}{2.2k\Omega} = 1.59\ mA$

We know, $I_E = I_B + I_C \Rightarrow I_C = 1.574\ mA$

$V_C = I_C \times 2.2k\Omega - 5V = -1.54\ V$

Common emitter current gain, $\beta = \frac{I_C}{I_B} \approx 98$

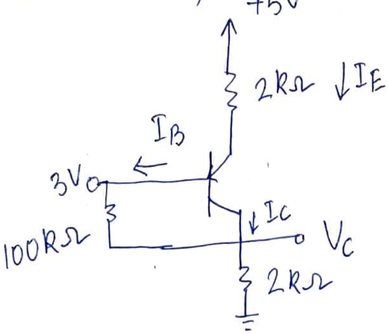
Common base current gain $\alpha = \frac{\beta}{1+\beta} \approx 0.99$

The final answers:

$V_E = 1.5V$, $V_C = -1.54V$, $I_B = 16\ \mu A$, $I_C = 1.574\ mA$

$I_E = 1.59\ mA$, $\beta \approx 98$, $\alpha \approx 0.99$

7) The given circuit,



$|V_{BE}| = 0.7V$

We know, $I_E = I_B + I_C$ ... (1)

and $I_E = \frac{V_C}{2k\Omega}$ .... (2)

$V_B = 3V$, $|V_{BE}| = 0.7V$

$\Rightarrow V_E = 3.7V$ .... (3)

$\therefore I_E = \frac{5V - V_E}{2k\Omega} = 0.65\ mA$ ...(4)

From eqn(s) (1) to (4),

$I_E = 0.65\ mA = \frac{V_C}{2k\Omega}$

$\Rightarrow V_C = 1.3V$

$I_B = \frac{3V - V_C}{100k\Omega} = \frac{3V - 1.3V}{100k\Omega} = 17\ \mu A$

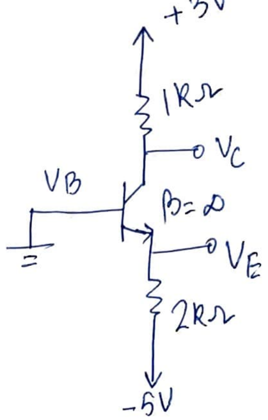
$\beta = \frac{I_C}{I_B} = \frac{I_E}{I_B} - 1 \approx 38$

$\alpha = \frac{\beta}{1+\beta} \approx 0.97$

The final answers:

$I_B = 17\ \mu A$, $V_C = 1.3V$, $\beta \approx 38$, $\alpha \approx 0.97$

8) The given circuit,



$\beta = \infty \Rightarrow I_B = 0, \quad I_C = I_E$

For the given circuit, $V_B = 0V$

$V_{BE} = 0.7V \Rightarrow V_E = -0.7V$

$\therefore I_E = \dfrac{V_E + 5V}{2K\Omega} = 2.15\,mA = I_C$

$I_C = \dfrac{3V - V_C}{1K\Omega} \Rightarrow V_C = 0.85V$

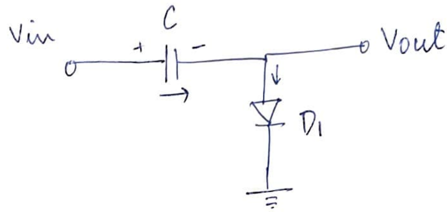
Hence,

$V_E = -0.7V$

$V_B = 0V$ → **Active region.**

$V_C = 0.85V$

9) The given circuit,



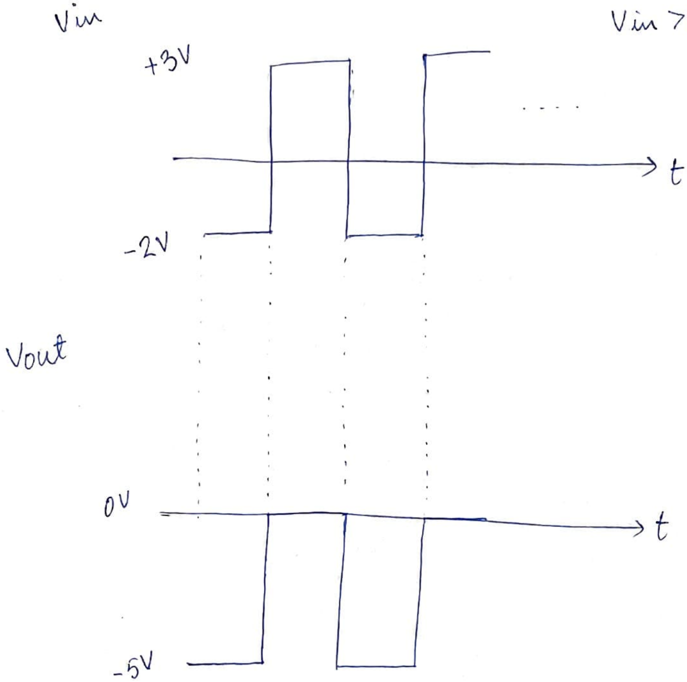
$V_{out} = V_{in} - V_c$

$V_{in} < 0 \Rightarrow D_1$ is off,

Capacitor gets charged to the negative value of $(-2V) - 3V = -5V$)

$V_{in} > 0 \Rightarrow D_1$ is on,

$V_{out} = 0$



10) Case 1: $V_E > V_B$, $V_C < V_B$ $\Rightarrow$ EBJ is forward biased, CBJ is reverse biased $\}$ $\rightarrow$ Active region

Case 2: $V_E > V_B$, $V_C < V_B$ $\Rightarrow$ Active region

Case 3: $V_E > V_B$, $V_C > V_B$ $\Rightarrow$ Saturation region (EBJ is fwd, CBJ biased)