Problem 1

My student ID's last 3 digits are 102.

So, $X = 1+0+2 = 3 = \text{odd}$

So, the BJT model is BC548.

From Datasheet,

$I_C = 2\ mA$

$V_{CE} = 5\ V$

$V_{CC} = 10\ V$

$\beta = 110\ (min)$

Now,

$$V_E = \frac{1}{10} V_{CC} = \frac{1}{10} \times 10\ V = 1\ V$$

$$R_E = \frac{V_E}{I_E} \cong \frac{V_E}{I_C} = \frac{1\ V}{2\ mA} = 500\ \Omega$$

$$R_C = \frac{V_{RC}}{I_C} = \frac{V_{CC} - V_{CE} - V_E}{I_C} = \frac{(10-5-1)\ V}{2\ mA} = 2\ k\Omega$$

$$V_B = V_{BE} + V_E = 0.7 + 1 = 1.7\ V$$

$R_2 \leq \beta R_E$

$$V_B = \frac{R_2}{R_1 + R_2} V_{cc}$$

$$R_2 \leq \frac{1}{10}(110) \times (0.5\,k\Omega) = 5.5\,k\Omega$$

Here,

$$V_B = \frac{R_2}{R_1 + R_2} V_{cc} \Rightarrow 1.7V = \frac{(5.5\,k\Omega)(10V)}{R_1 + 5.5\,k\Omega}$$

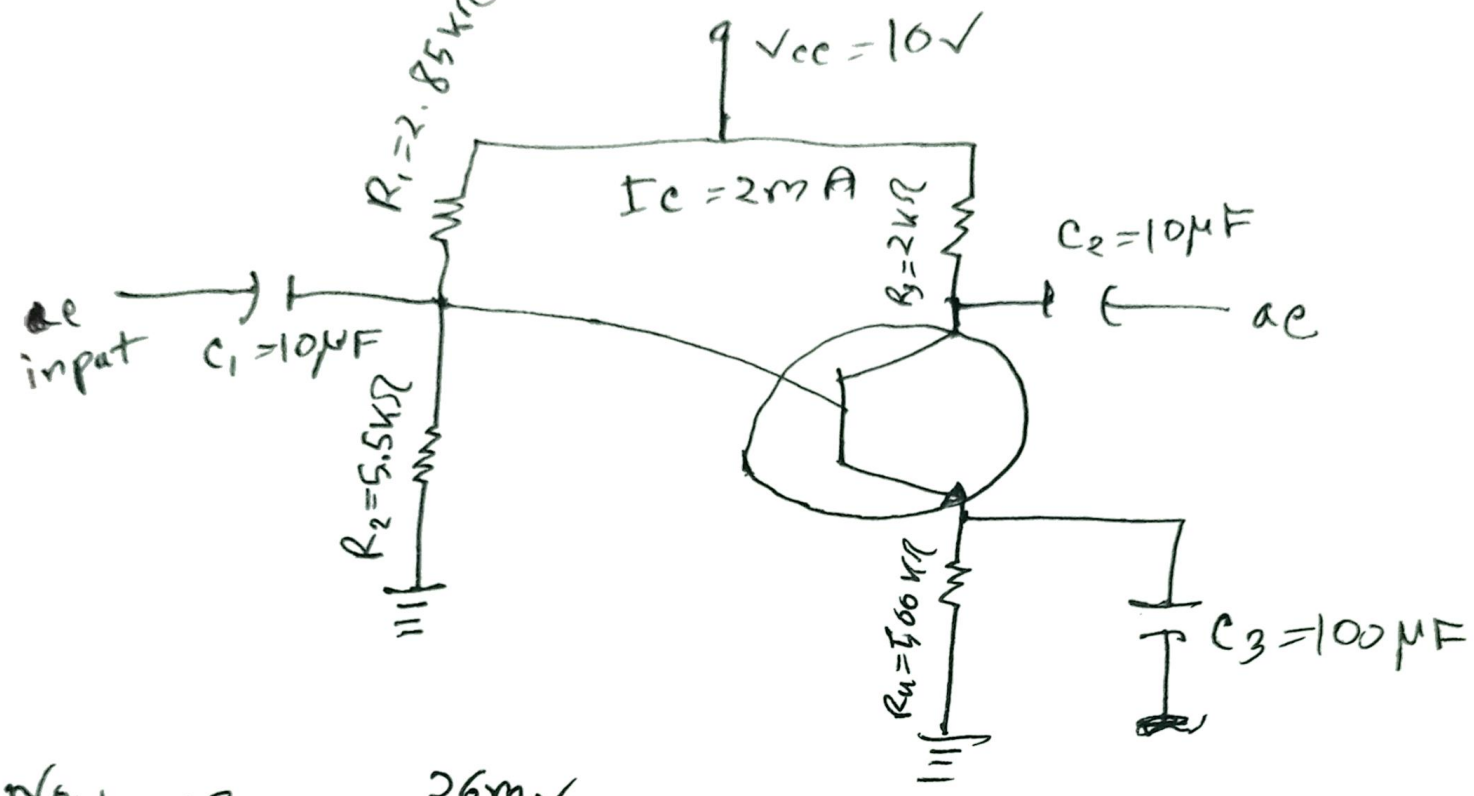
$\therefore R_1 = 26.85\,k\Omega$

So, $R_1 = 26.85\,k\Omega$

$R_2 = 5.5\,k\Omega$

$R_C = 2\,k\Omega$

$R_E = 500\,\Omega$



Now, $r_e = \frac{26mV}{I_E} \simeq \frac{26mV}{I_C} = \frac{26mV}{2mA} = 13\Omega$

Input impedence, $Z_{in} = R_1 \parallel R_2 \parallel \beta r_E$

$= \left(\frac{1}{26.85} + \frac{1}{5.5} + \frac{1}{110 \times 13 \times 10^3} \right)^{-1}$

$= 1.089 K\Omega$

Out Put impendence Z_{out}

$$= R_C \parallel r_o$$

$$= \left(\frac{1}{R_C} + \frac{1}{r_o}\right)^{-1}$$

$$= \left(\frac{1}{R_C} + \frac{1}{\alpha}\right)^{-1}$$

$$= R_C$$

$$= 2\,K\Omega$$

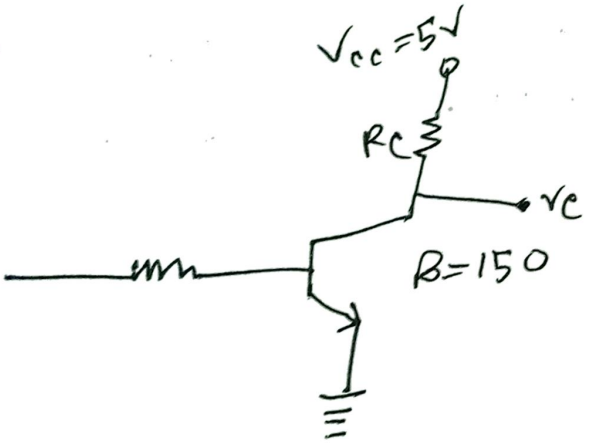
Input AC $V = \left(\frac{1+0+2}{3}\right) V$

$= 1\,V$

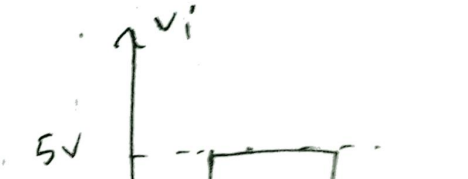
Problem-2:

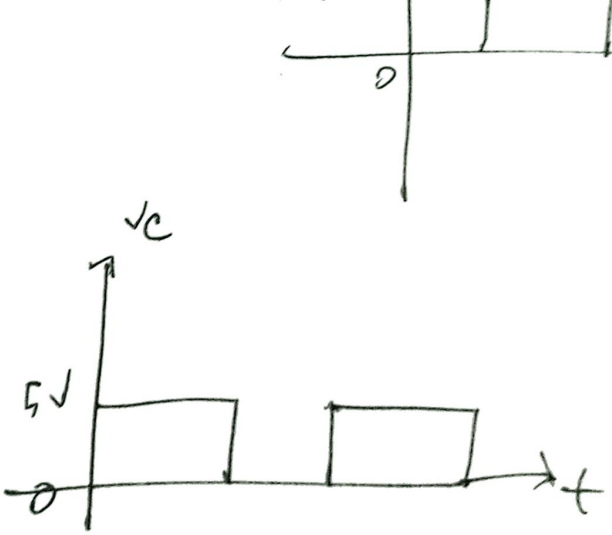
The sum of my student ID's last 3 digits are 1+0+2 = 3 = odd. So, I am going to design a 5V relay module circuit using the SRD-05VDC-SL-C relay.

From Datasheet, $I_{C\,SAT}$ = 89.3 mA



$\beta = 150$





$$I_B > \frac{I_{CSAT}}{\beta}$$

$$\Rightarrow I_B > \frac{89.3\,mA}{150}$$

$$\therefore I_B = 0.595\,mA$$

Let, $I_B = 0.6\,mA$

$$\therefore R_B = \frac{5 - 0.7}{0.6}$$

$$= 7.167\,k\Omega$$