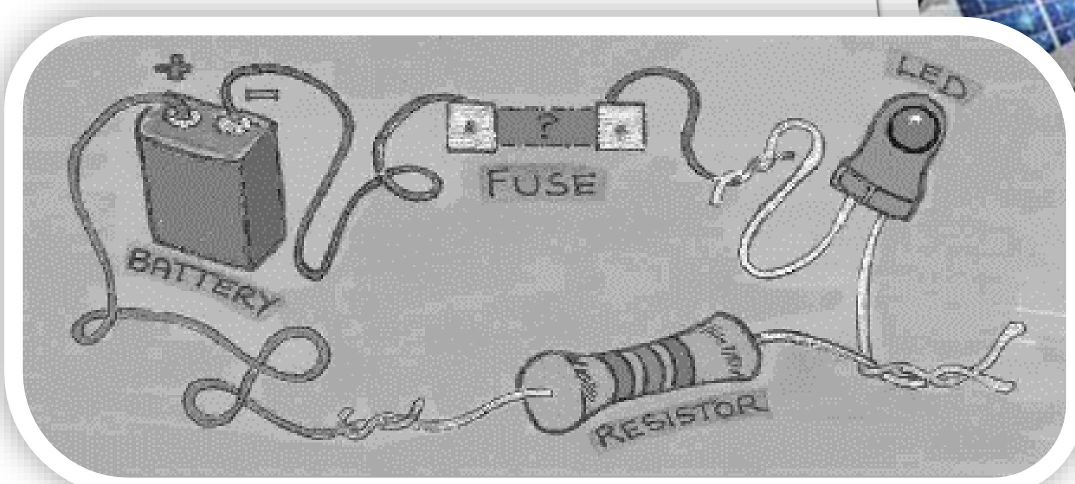
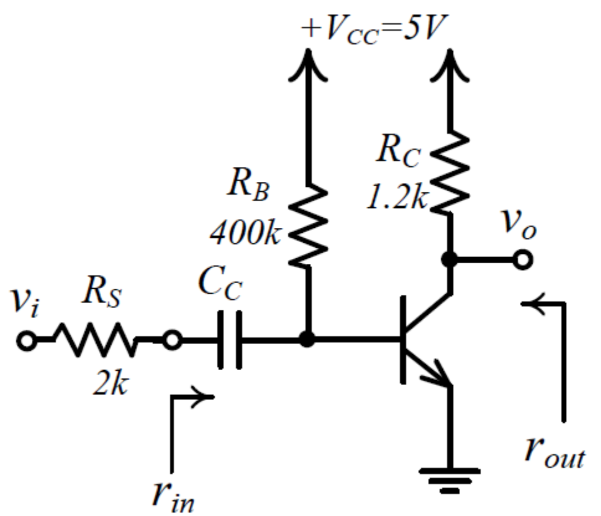
EHB222E QUESTIONS
8^{th} week

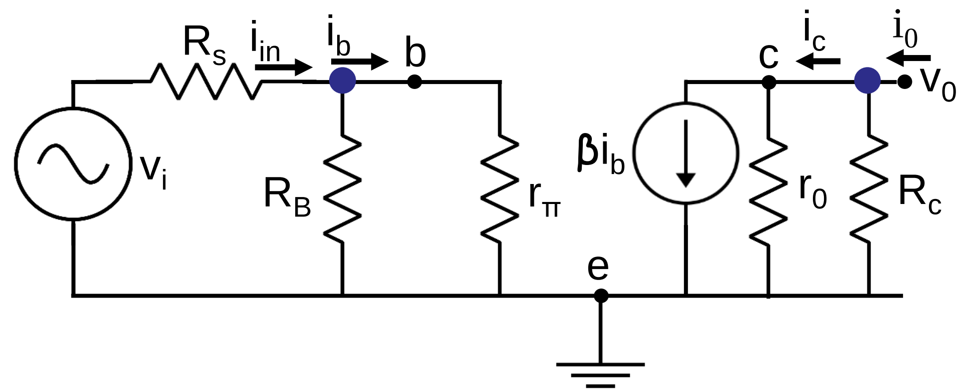


Consider the amplifier shown below. Use the following parameters for your calculations. ***Transistor parameters* : β=200, V_{BE}=0.7V, V_T=25mV, V_A=100V**

a. Find V_B and V_o of the transistor by performing DC analysis.

b. Find the small signal values of r_{in}, r_{out}, and v_o/v_{in}.





$$r_\pi = \frac{V_T}{I_{BQ}}$$

$5V - I_B\, 400k\Omega - V_{BE} = 0 \quad => I_B$ SOLVED

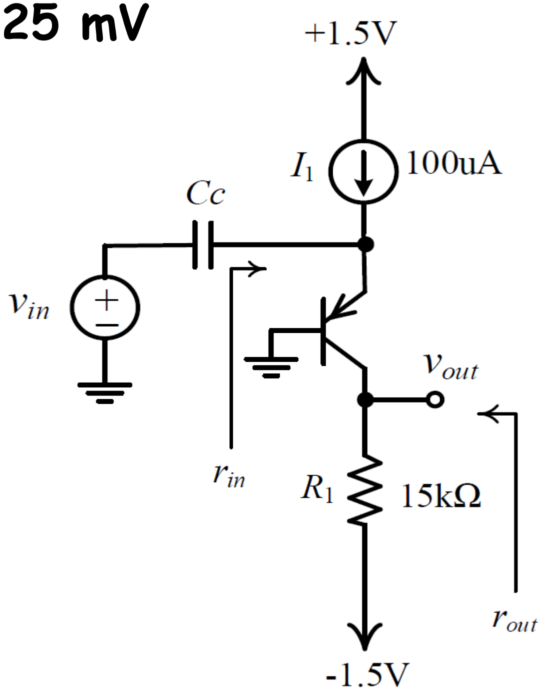
$V_{BE} = V_B = 0.7V$

$5V - \boldsymbol{\beta}\, I_B\, 1.2k\Omega = V_0 \quad => V_0$ SOLVED

$$v_{be} = \frac{R_B//r_\pi}{R_S + R_B//r_\pi} v_i = i_b\, r_\pi \qquad r_{in} = \frac{v_i}{i_{in}} = R_B//r_\pi \qquad r_o = \frac{V_A}{I_{CQ}}$$

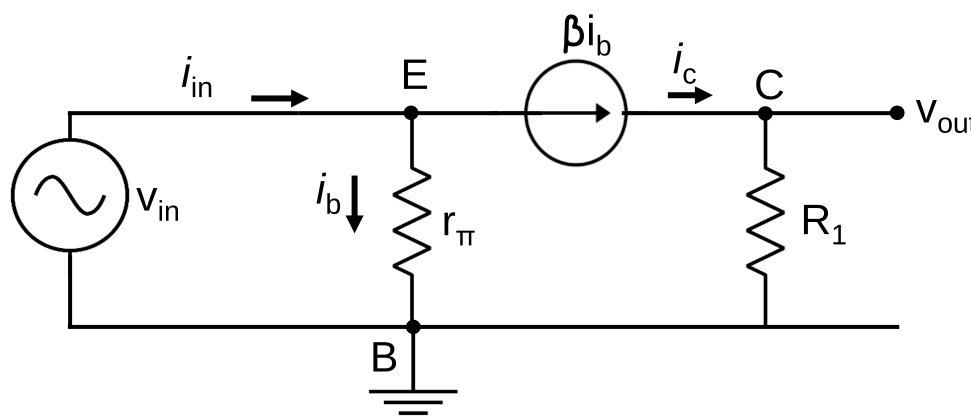
$$v_0 = -\beta\, i_b\, (r_0//R_c) \qquad r_{out} = \frac{v_0}{i_0} = r_0//R_c \qquad \frac{v_0}{v_i} = \frac{-R_B//r_\pi}{r_\pi\,(R_S + R_B//r_\pi)}\, \beta\,(r_0//R_c)$$

Consider an amplifier shown below. "Cc" capacitor can be considered shorted in small signal analysis. Find the small signal values of r_{in} and v_{out}/v_{in}. PNP Transistor Parameters: $|V_{BE}| = 0.7$, $\beta = 100$, $|V_A| = \infty$, $V_T = 25$ mV



$$I_E = 100\mu A \qquad I_B = \frac{I_E}{\beta + 1} = 1\mu A$$

$$I_C = 99\mu A$$



$$v_0 = \beta\, i_b\, R_1 \qquad v_{in} = r_\pi\, i_b \qquad \frac{v_0}{v_{in}} = \frac{R_1\,\beta}{r_\pi}$$

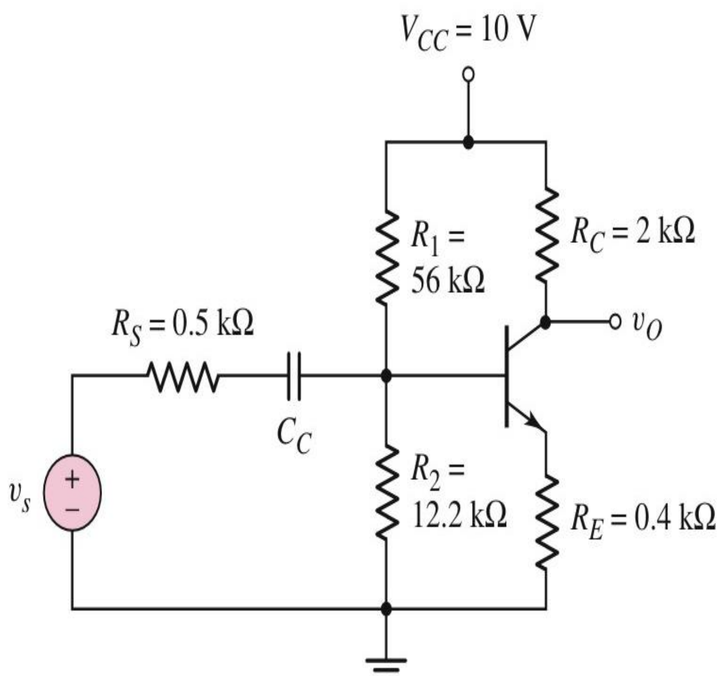
$$r_{in} = \frac{v_{in}}{i_{in}} = \frac{r_\pi\, i_b}{(\beta+1) i_b} = \frac{r_\pi}{(\beta+1)}$$

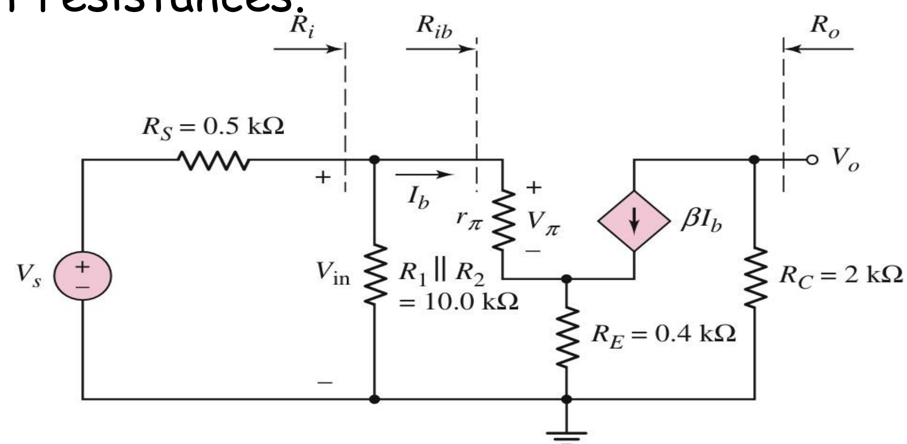
For the circuit shown, transistor parameters are $V_A = \infty$, $V_T = 25$ mV, $|V_{BE}| = 0{,}7$ V, and $h_{fe} = h_{FE} = \beta = 100$.

a. Determine DC collector currents.

b. Find the small signal voltage gain v_o/v_{in}.

c. Determine the input and output resistances.





$$V_{in} = I_b r_\pi + (I_b + \beta I_b) R_E$$

$$V_o = -(\beta I_b) R_C$$

$$V_{in} = \left(\frac{R_i}{R_i + R_S} \right) V_s$$

$$R_{ib} = \frac{V_{in}}{I_b} = r_\pi + (1 + \beta) R_E$$

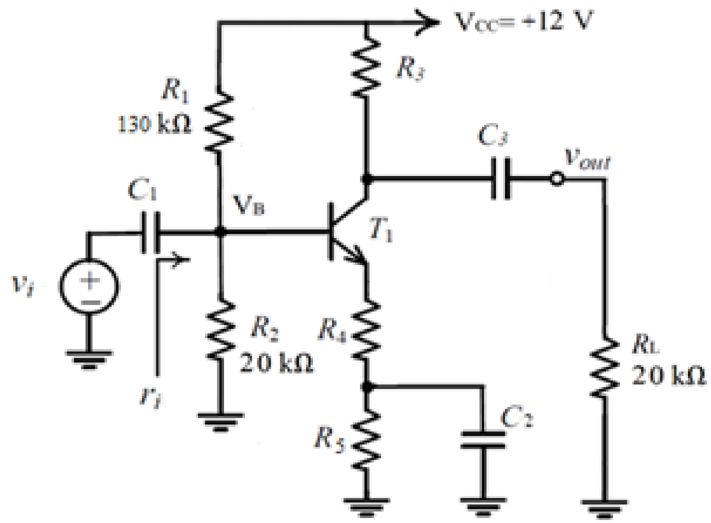
$$A_v = \frac{V_o}{V_s} = \frac{-\beta R_C}{r_\pi + (1 + \beta) R_E} \left(\frac{R_i}{R_i + R_S} \right)$$

$$R_i = R_1 \| R_2 \| R_{ib}$$

For the transistor shown below $\beta = h_{fe} = h_{FE} = 200$, $V_{BE} = 0.6V$, and $V_T = 25mV$. All capacitors are ideal.

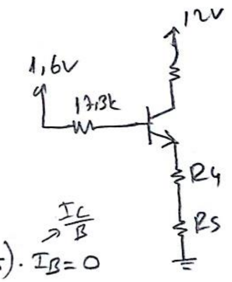
a) Find R_3, R_4 and R_5 for $I_C = 1mA$, $V_{CE} = 4V$ and $r_i = 10k\Omega$

b) Calculate v_o/v_i.



$R_{th} = R_1 // R_2 = 17,3k$

$V_{th} = 1,6V$



$$1,6 - 17,3k \cdot \underbrace{I_B}_{\frac{I_C}{\beta}} - 0,6 - (R_4 + R_5) \cdot \underbrace{I_B}_{\frac{I_C}{\beta}} = 0$$

$$1,6 - 17,3k \cdot 5\mu A - 0,6 - (R_4 + R_5) \cdot 5\mu A = 0$$

$$\underline{R_4 + R_5 = 182k}$$

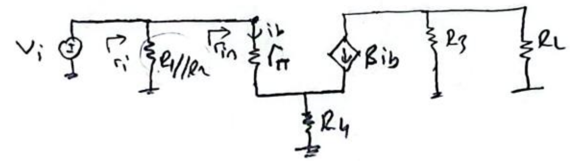
$\underline{V_B = 1,51}$ $\underline{V_E = 0,91}$ $V_{CE} = 4V$

$\underline{V_C = 4,91V}$

c

$12 - R_3 \cdot I_C = 4,91V$

$\underline{R_3 = 7k}$



$\underline{r_{in} = r_\pi + (\beta+1) \cdot R_4}$

$r_i = R_1 // R_2 // (r_\pi + (\beta+1) \cdot R_4)$ $r_\pi = \frac{V_T}{I_B} = \frac{25m}{5\mu A} = 5k$

$10k = 17,3k // (\underbrace{5k + 201 \cdot R_4}_{x})$

$10k = \frac{17,3k \cdot x}{17,3k + x} \rightarrow 170 \cdot 10^6 + 10k \cdot x = 17,3k\, x$

$170 \cdot 10^6 = 7,3k \cdot x$

$\underline{x = 23,3k}$

$201 \cdot R_4 = 18,3k$

$\underline{R_4 = 91\Omega}$

$\underline{R_5 \cong 181,9\,k}$

b) $V_i = i_b \cdot r_\pi + (\beta+1) \cdot i_b \cdot R_4$

$V_o = -\beta \cdot i_b \cdot (R_3 // R_L)$

$$\frac{V_o}{V_i} = \frac{\beta \cdot (R_3 // R_L)}{(\beta+1) R_4 + r_\pi} = \frac{200 \cdot 5,2k}{18,2k + 5k}$$

$$\frac{V_o}{V_i} \cong 44,8$$