

The Common emitter amplifier : Design

Design a Common emitter amplifier using a transistor

having $\beta(\min) = 480$, and $\beta(\max) = 1500$

to provide a voltage gain $|\frac{V_o}{V_s}| \geq 200$,

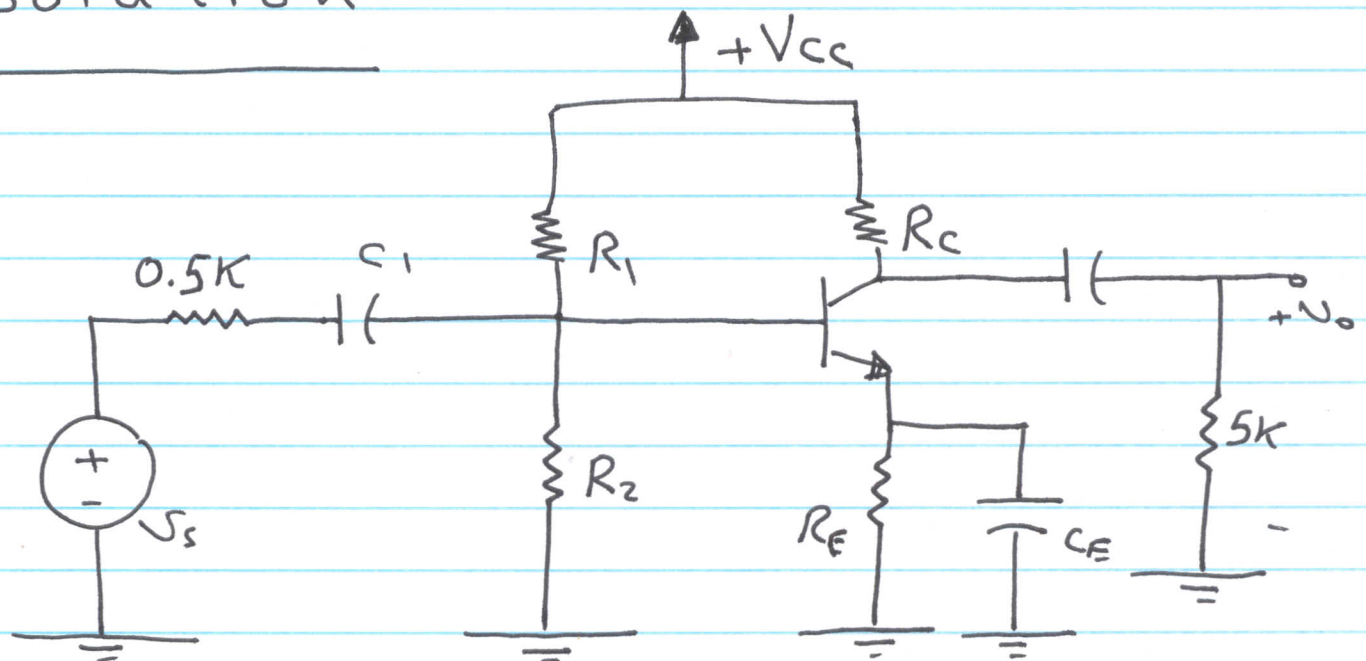
between a small signal voltage source

having a resistance of 500Ω and a load

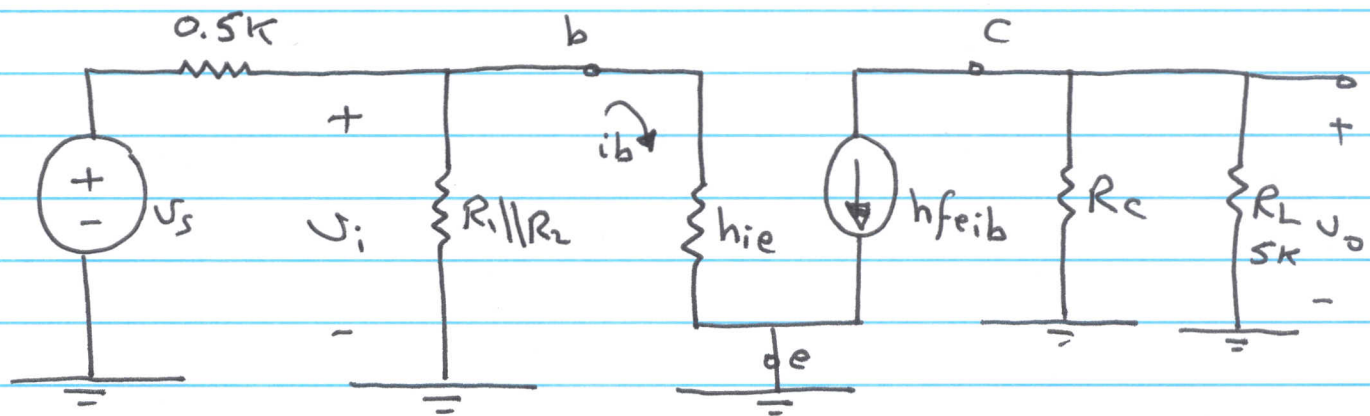
$R_L = 5K$.

It is specified that $Z_i \geq 5K$

Solution



ac small signal equivalent ckt



$$V_o = -h_{fe}i_b (R_c \parallel R_L)$$

$$i_b = \frac{V_i}{h_{ie}}$$

$$V_i = \frac{Z_i}{Z_i + R_s} V_s$$

$$\therefore |A_v| = \frac{h_{fe}}{h_{ie}} \frac{Z_i}{Z_i + R_s} (R_c \parallel R_L)$$

$$1 > \frac{Z_i}{Z_i + R_s} > 0.9$$

$$\therefore |A_v| = \frac{h_{fe}}{h_{ie}} (0.9) (R_c \parallel 5k)$$

$$\text{Let } g_m = \frac{h_{fe}}{h_{ie}} = 38.92 I_{CQ}$$

$$\therefore |A_v| = g_m (0.9)(R_c || 5k) \geq 200$$

$$\text{Let } R_c = 8k, \text{ then } g_m \geq 72.2 \text{ mS}$$

$$\text{Let } g_m = 77.86 \text{ mS}, \text{ then } I_{CQ} = 2 \text{ mA}$$

$$\text{Since } V_{RC} = 16 \text{ V}; \text{ Let } V_{CC} = 30 \text{ V}$$

$$\text{Let } V_{RE} = \frac{V_{CC}}{5} = 6 \text{ V}; \therefore R_E = \frac{V_{RE}}{I_E} = 3k$$

$$R_{TH} = \frac{\beta(\min) R_E}{20} = 72k$$

$$\text{from } I_E = \frac{V_{TH} - 0.7}{\frac{R_{TH}}{\beta(\min) + 1} + R_E} \rightarrow V_{TH} = 7 \text{ V}$$

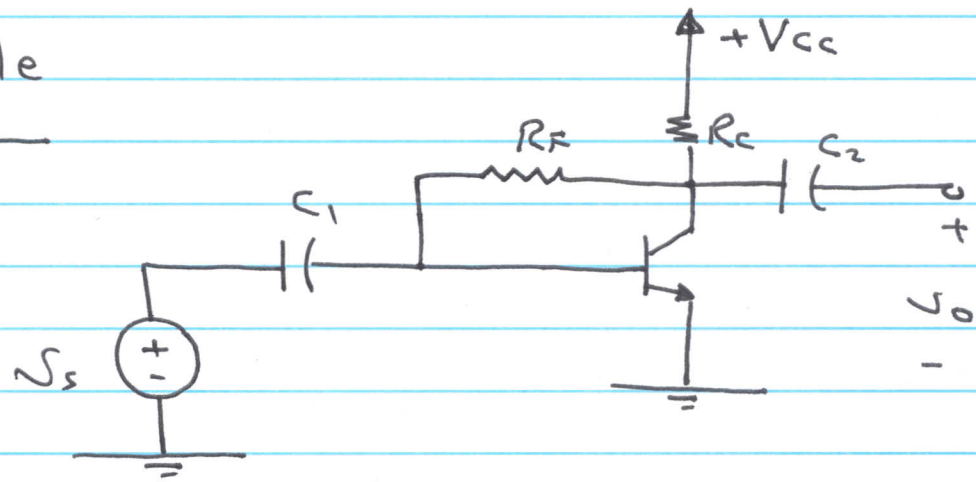
$$\therefore R_{TH} = 72k$$

$$V_{TH} = 7 \text{ V}$$

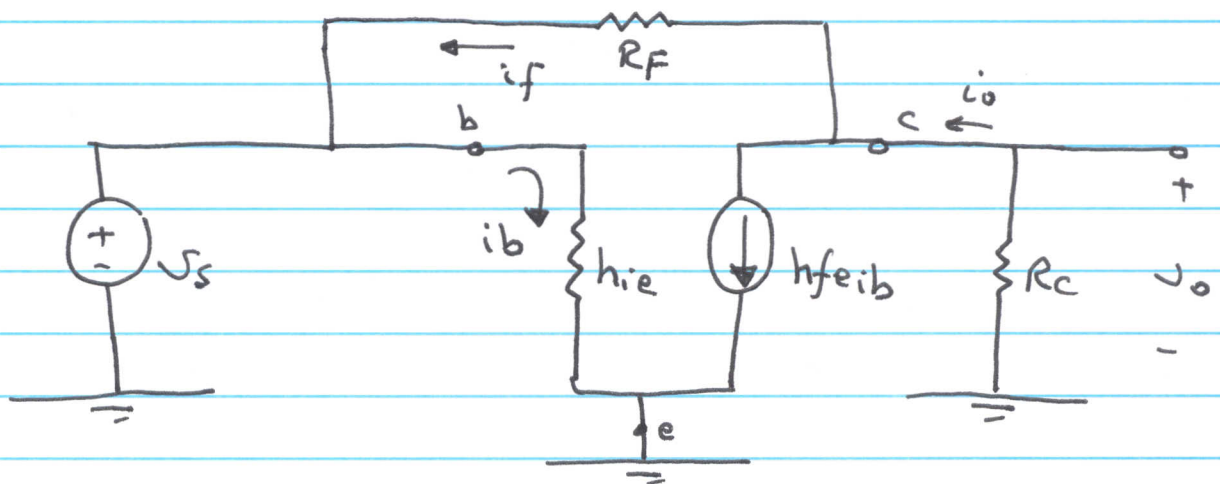
$$\therefore R_1 = 93.9k$$

$$\therefore R_2 = 308.6k$$

Example



ac small signal equivalent ckt



$$V_o = -R_C i_o$$

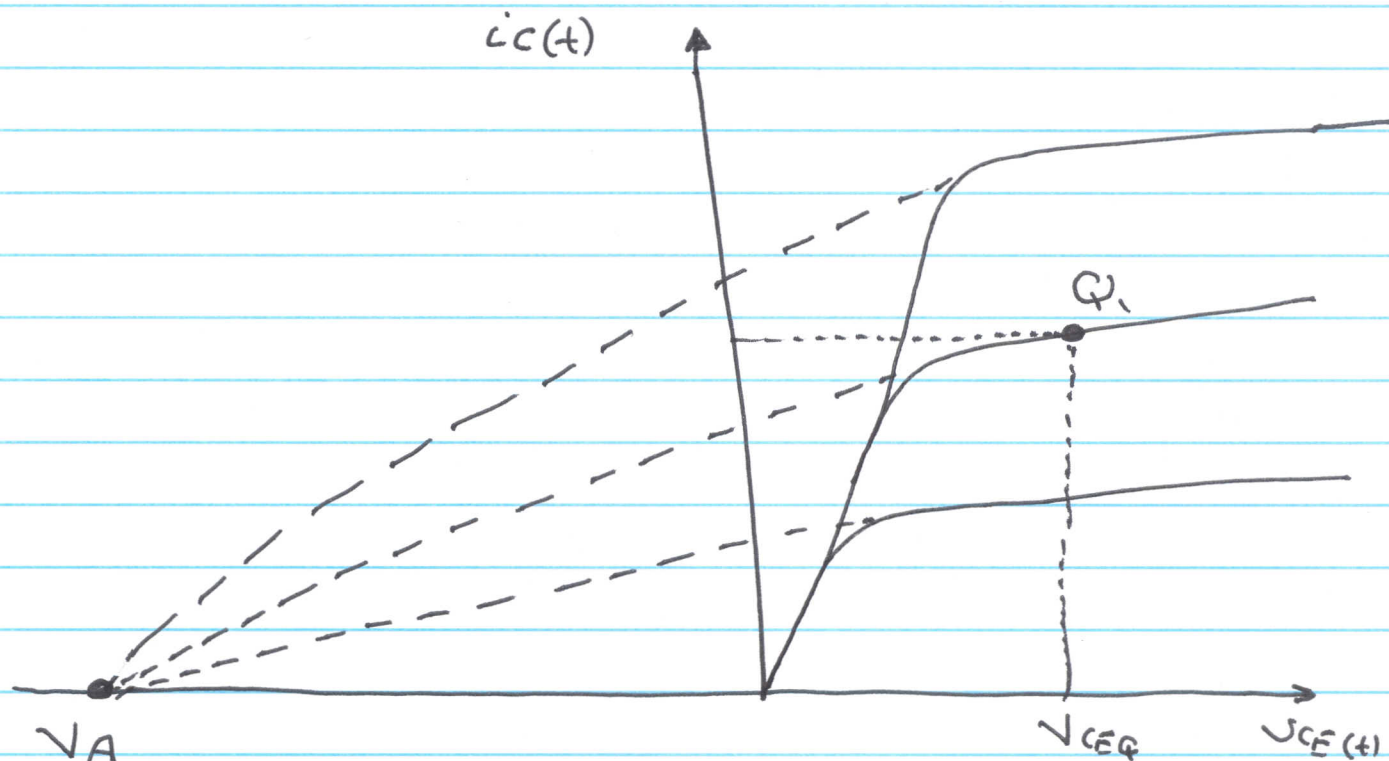
$$i_o = h_{fe}i_b + i_f$$

$$i_f = \frac{V_o - V_s}{R_F}$$

$$i_b = \frac{V_s}{h_{ie}}$$

$$\therefore A_v = - \frac{\frac{R_C}{R_E} - R_C \frac{h_{fe}}{h_{ie}}}{1 + \frac{R_C}{R_E}}$$

Early Voltage ; V_A



$$\frac{1}{h_{oe}} = \frac{V_{CEQ} + V_A}{I_{CQ}}$$

$$\frac{1}{h_{oe}} \approx \frac{V_A}{I_{CQ}}$$

$$V_A = 100, 150, 200$$

If V_A is given ; we must include

$\frac{1}{h_{oe}}$ in the ac small signal equivalent ckt

