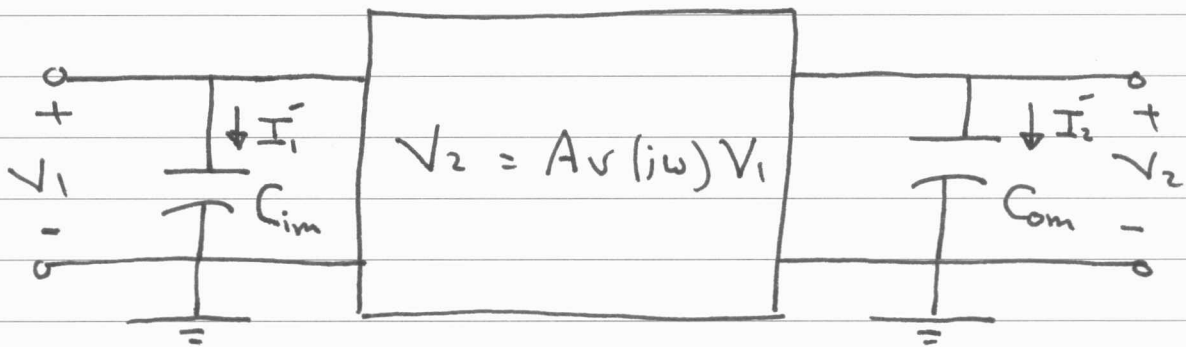
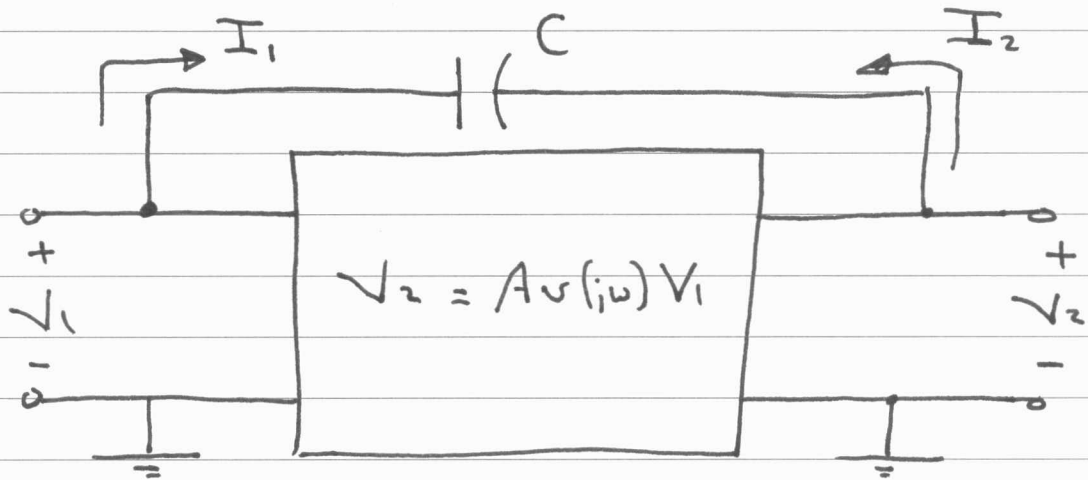
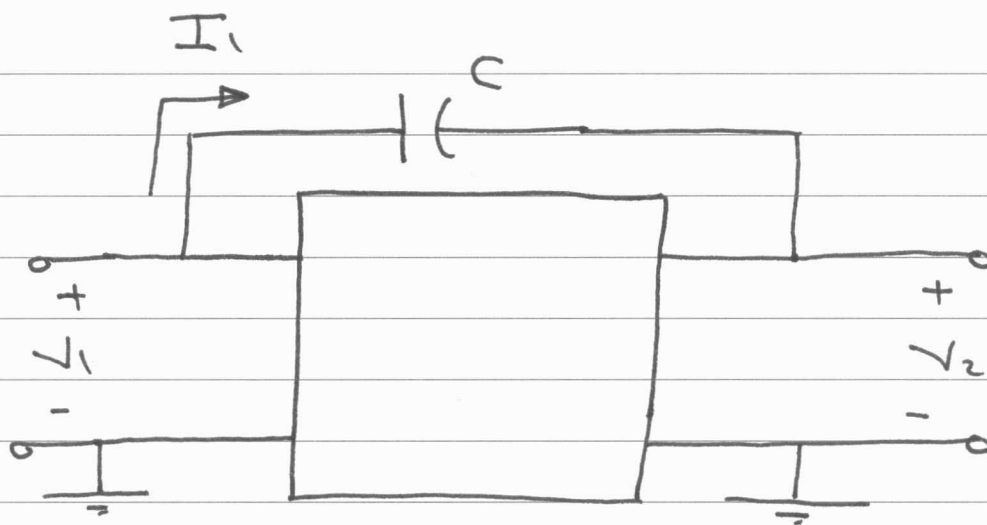


Miller Effect Capacitor



$$C_{im} = C (1 - A_v(\text{mid}))$$

$$C_{om} = C \left(\frac{A_v(\text{mid}) - 1}{A_v(\text{mid})} \right)$$



$$I_1 = \frac{V_1 - V_2}{\frac{1}{j\omega C}} = j\omega C (V_1 - V_2)$$

$$I_1 = j\omega C (V_1 - A_v(j\omega) V_1)$$

$$I_1 = j\omega C V_1 (1 - A_v(j\omega))$$

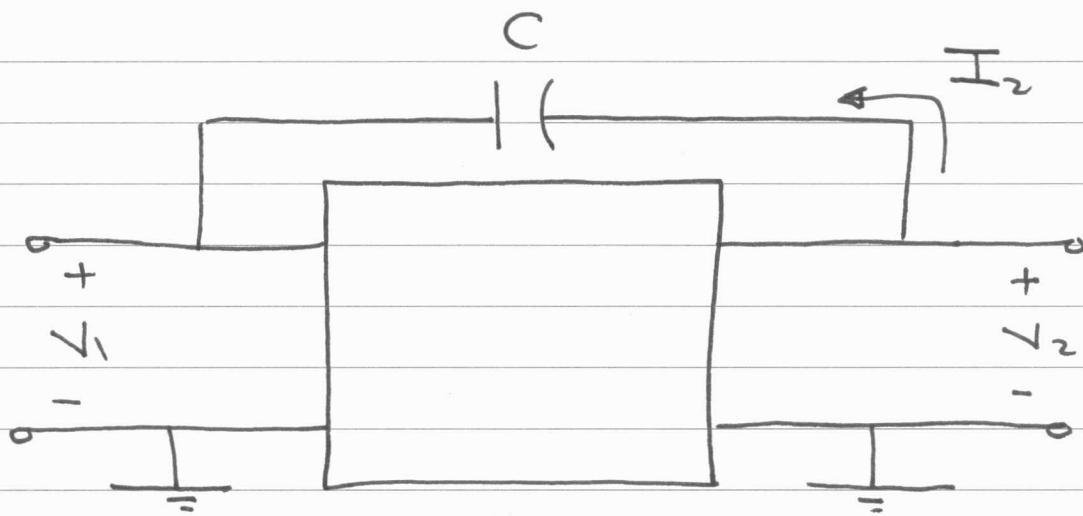
$$I_1 \approx j\omega C V_1 (1 - A_v(\text{mid}))$$

$$\text{But } \underline{I_1} = j\omega C_{im} V_1$$

For the two circuit to be equivalent

$$I_1 = \underline{I_1}$$

$$\therefore C_{im} = C (1 - A_v(\text{mid}))$$



$$I_2 = j\omega C (V_2 - V_1)$$

$$I_2 = j\omega C \left(V_2 - \frac{V_2}{A_v(j\omega)} \right)$$

$$I_2 = j\omega C V_2 \left(1 - \frac{1}{A_v(j\omega)} \right)$$

$$I_2 = j\omega C V_2 \left(\frac{A_v(j\omega) - 1}{A_v(j\omega)} \right)$$

$$I_2 \approx j\omega C V_2 \left(\frac{A_v(\text{mid}) - 1}{A_v(\text{mid})} \right)$$

But $I_2 = j\omega C_{\text{com}} V_2$

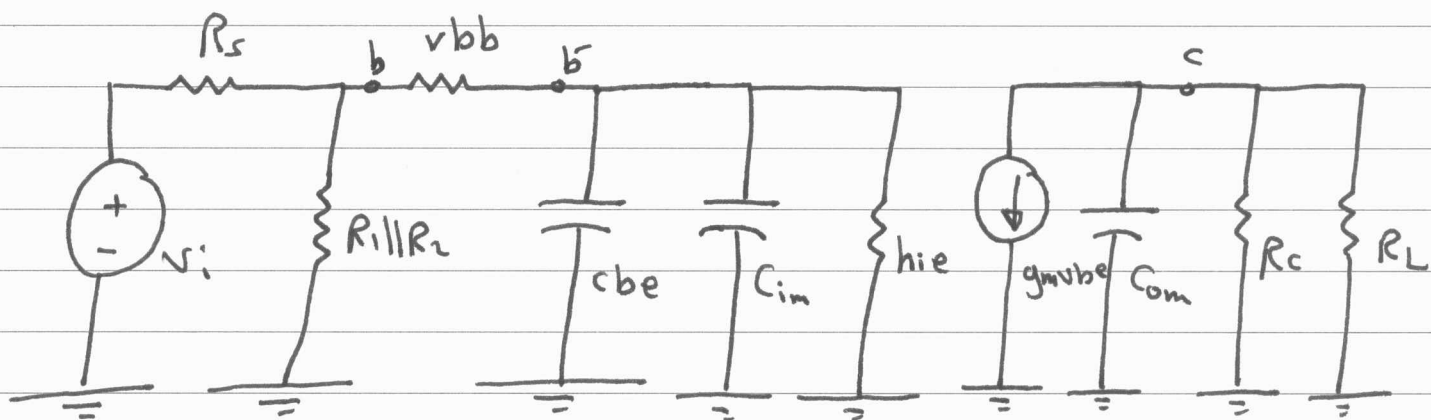
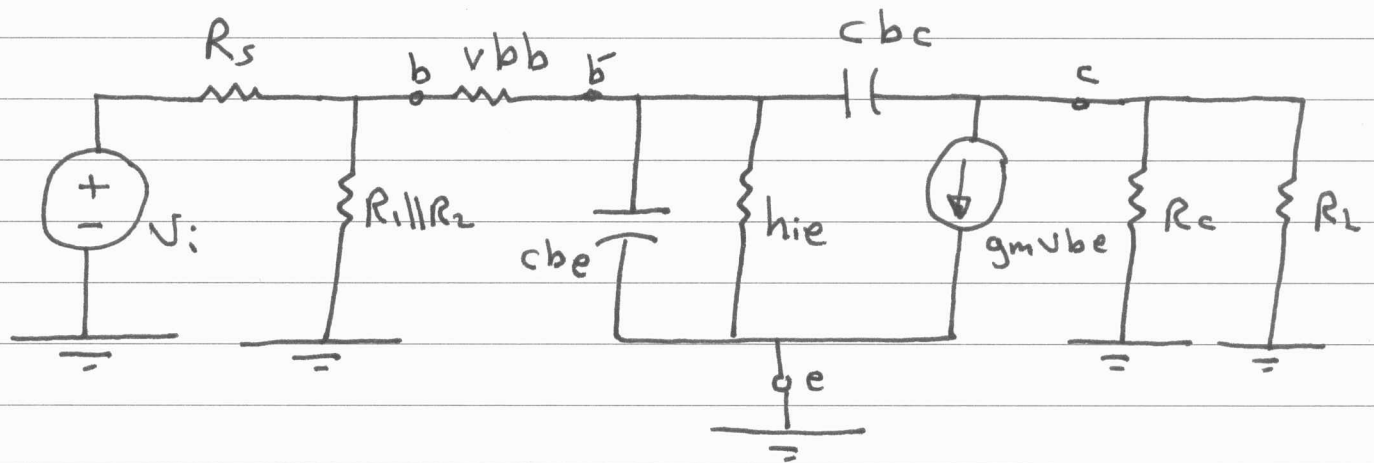
$$\therefore C_{\text{com}} = C \left(\frac{A_v(\text{mid}) - 1}{A_v(\text{mid})} \right)$$

if $|A_v(\text{mid})| \gg 1$

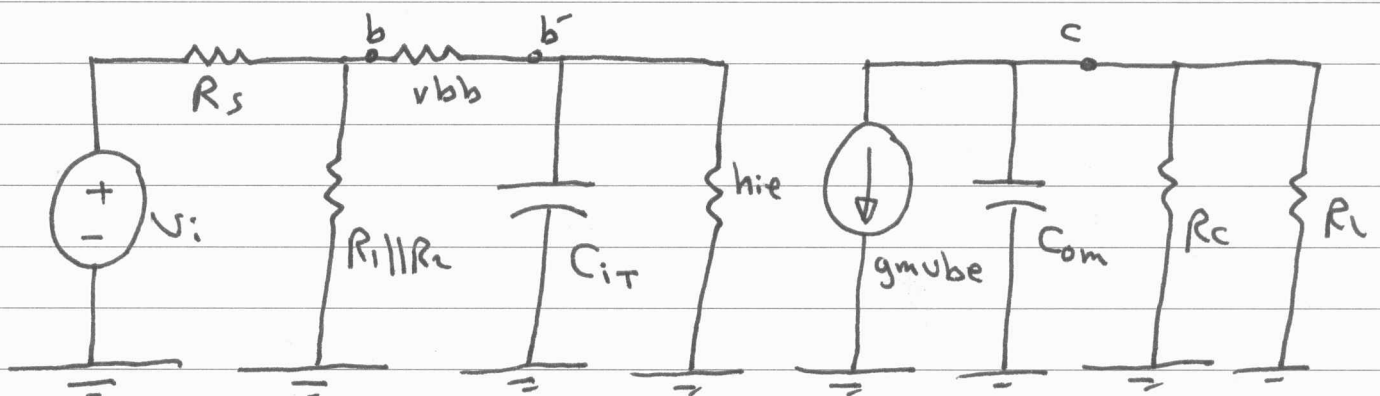
$$C_{\text{com}} \approx C$$

Common Emitter High - frequency Analysis

Using Miller-effect Capacitor



$$C_{in} = C_{bc} (1 - A_v(\text{mid}))$$



$$C_{iT} = C_{be} + C_{in} \quad ; \quad C_{oT} = C_{bc}$$

1) To find $\tau_{C_{IT}}$, set C_{om} open

$$\tau_{C_{IT}} = C_{IT} \cdot R_{TH1}$$

$$R_{TH1} = h_{ie} \parallel (v_{bb} + R_s \parallel R_1 \parallel R_2)$$

$$C_{IT} = C_{be} + C_{im}$$

$$C_{im} = C_{bc} (1 - A_v(\text{mid}))$$

$$A_v(\text{mid}) = -g_m (R_c \parallel R_L)$$

$$\therefore C_{im} = 87.97 \text{ pF}$$

$$\therefore C_{IT} = 105.2 \text{ pF}$$

$$\therefore \tau_{C_{IT}} = 91.3 \text{ ns}$$

$$\therefore W_{C_{IT}} = 10.95 \text{ Mv/s}$$

2) To find $\tau_{C_{om}}$; set C_{IT} open

$$\tau_{C_{om}} = C_{om} R_{TH2}$$

$$R_{TH2} = R_c \parallel R_L$$

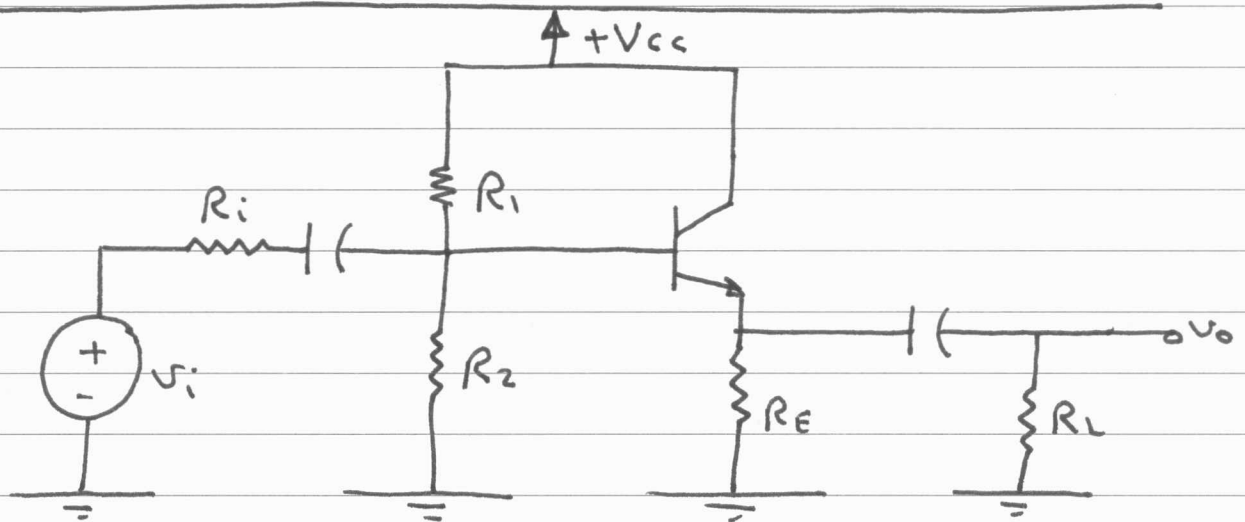
$$\therefore \tau_{C_{om}} = 2.57 \text{ ns} ; W_{C_{om}} = 388.9 \text{ Mv/s}$$

$$10.65 \text{ Mv/s} < W_H < 10.95 \text{ Mv/s}$$

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$$W_H \approx 10.7 \text{ Mv/s}$$

Common Collector High-Frequency Response



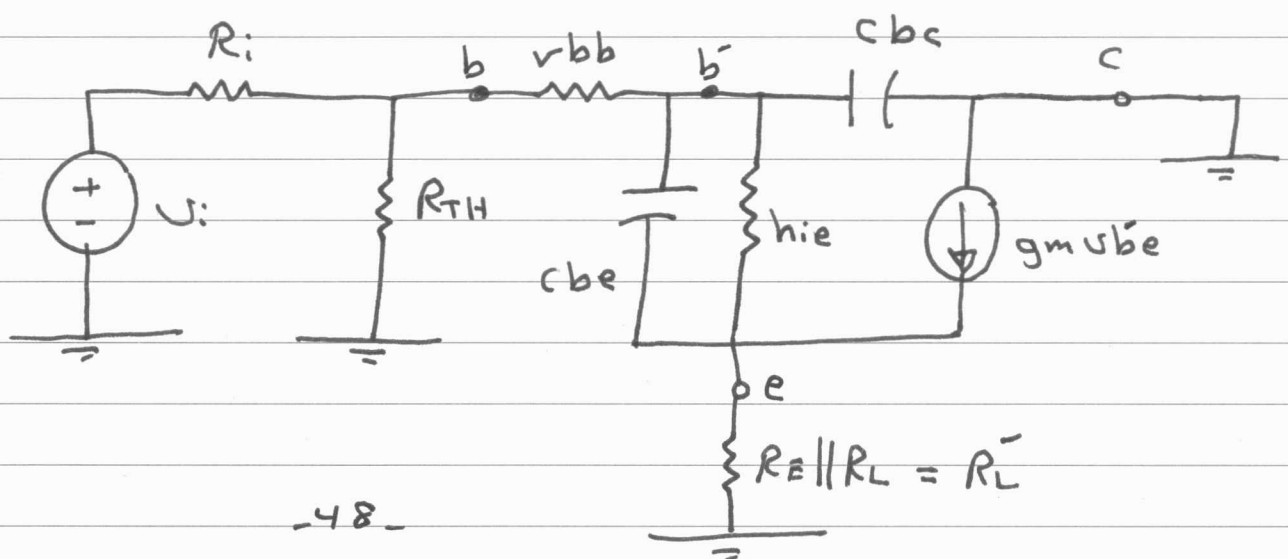
$$g_m = 38 \text{ mS}, h_{ie} = 6 \text{ k}\Omega, R_1 \parallel R_2 = 40 \text{ k}\Omega$$

$$h_{fe} = 228, r_{bb} = 100 \Omega, R_E = 1 \text{ k}\Omega, R_L = 10 \text{ k}\Omega$$

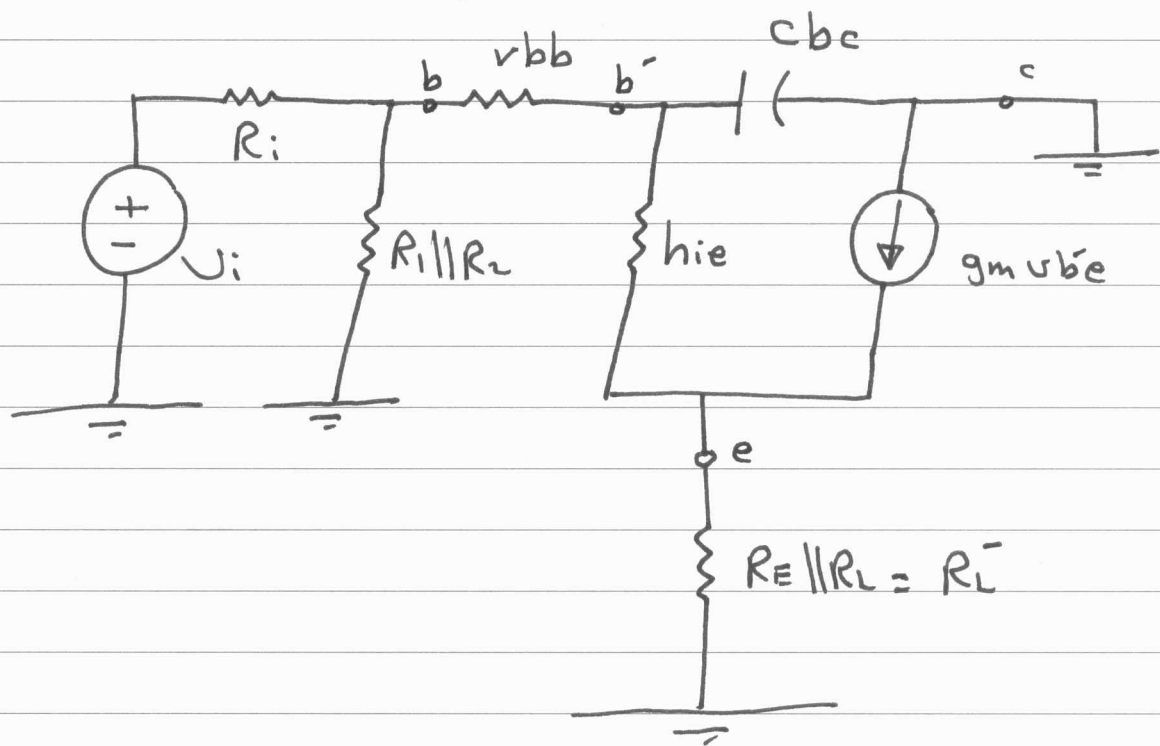
$$C_{be} = 20 \text{ pF} \text{ and } C_{bc} = 2 \text{ pF}$$

Estimate W_H

ac small signal high-frequency equivalent circuit.



1) To find τ_{bc} ; set C_{be} open



$$\tau_{bc} = C_{bc} R_{bc}$$

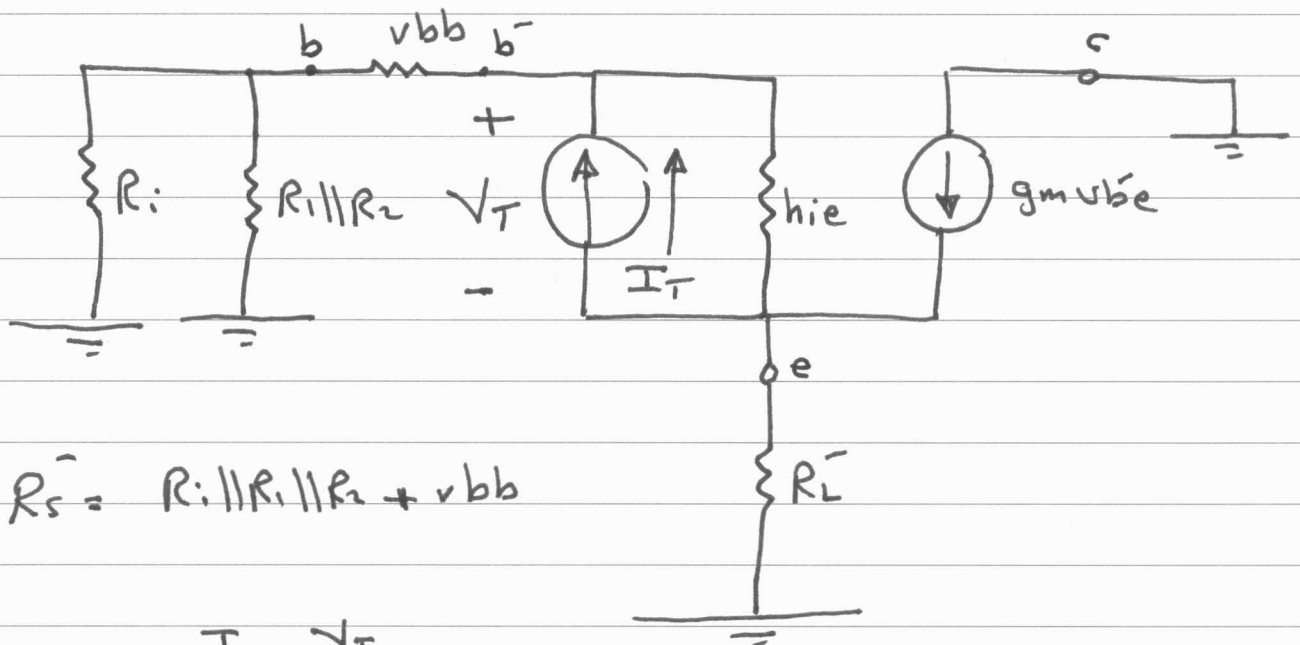
$$R_{bc} = \left(h_{ie} + R_L (h_{fe} + 1) \right) \parallel \left(r_{bb} + R_i \parallel R_1 \parallel R_2 \right)$$

$$\tau_{bc} = 0.399 \text{ ns}$$

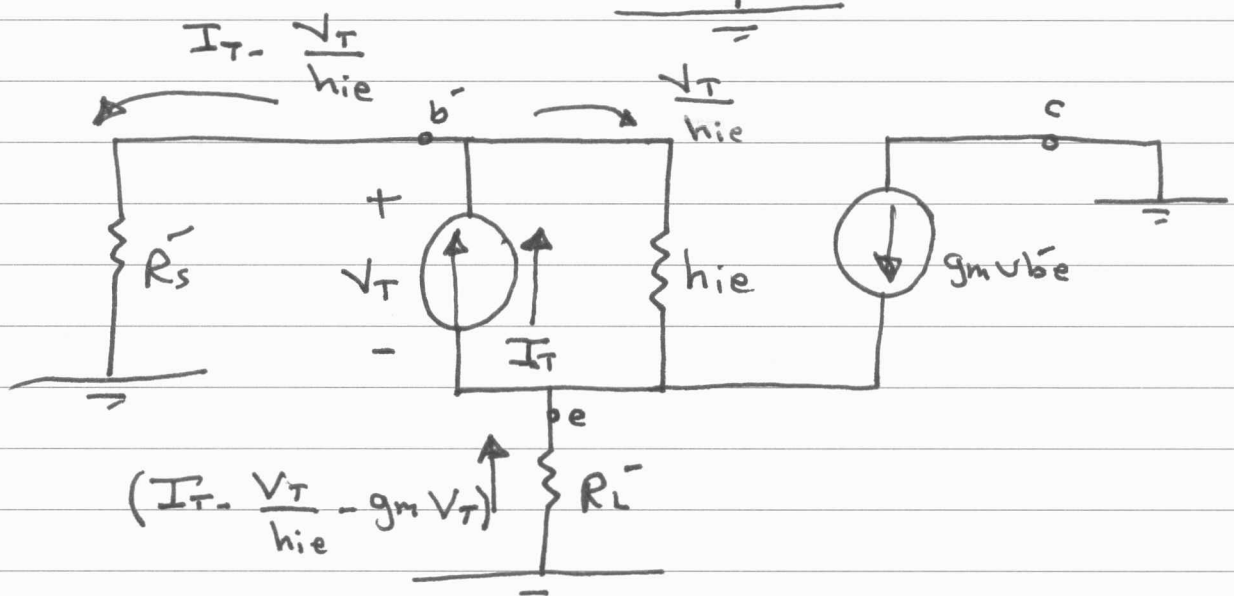
$$\therefore \omega_{bc} = 2506.3 \text{ Mrad/s}$$

2) To find T_{be} ; set C_{bc} open

and using $\frac{V_T}{I_T} = R_{be}$



$$R_s^- = R_1 \parallel R_2 \parallel R_3 + v_{bb}$$



$$V_T = R_s^- \left(I_T - \frac{V_T}{h_{ie}} \right) + R_L^- \left(I_T - \frac{V_T}{h_{ie}} - g_m V_T \right)$$

$$\therefore \frac{V_T}{I_T} = \frac{R_s^- + R_L^-}{1 + \frac{R_s^-}{h_{ie}} + \frac{R_L^-}{h_{ie}} + R_L^- g_m}$$

$$\therefore T_{be} = 0.621 \text{ ns}$$

$$\therefore W_{be} = 1610.3 \text{ mV/s}$$

$$981 \text{ mV/s} < W_H < 1610.3 \text{ mV/s}$$