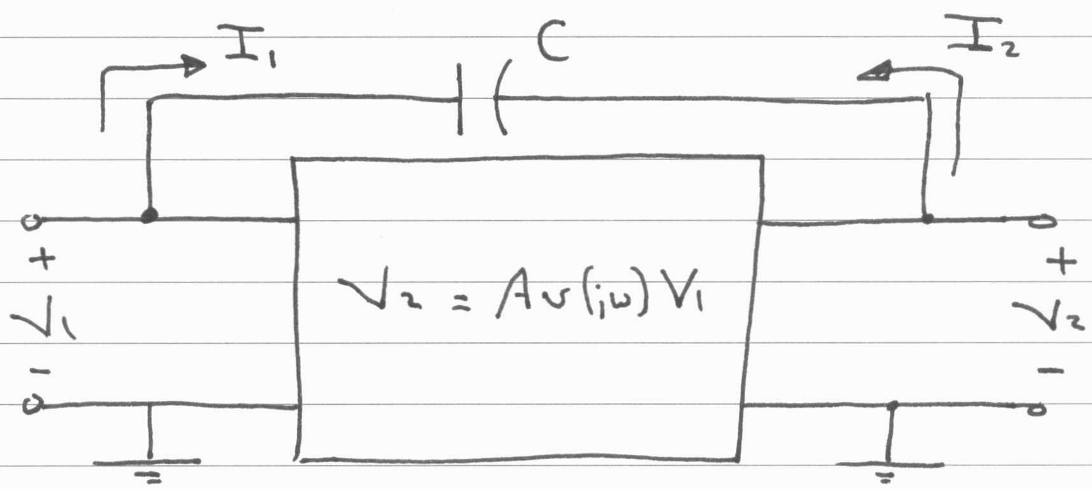
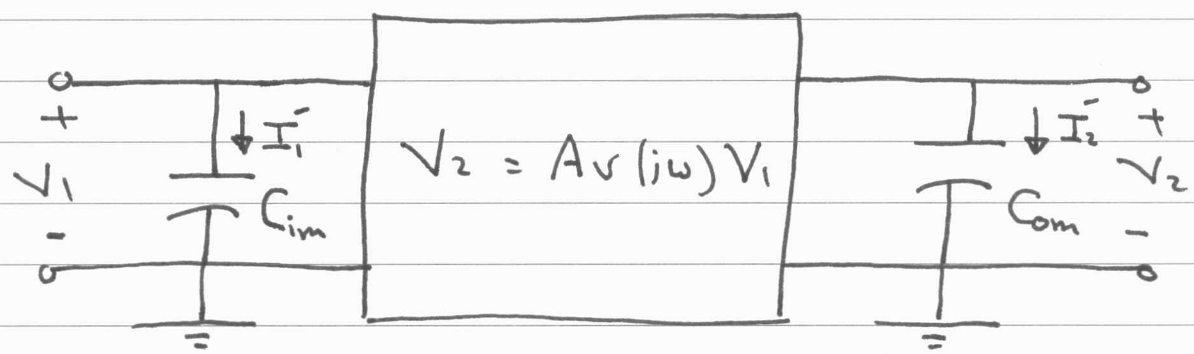
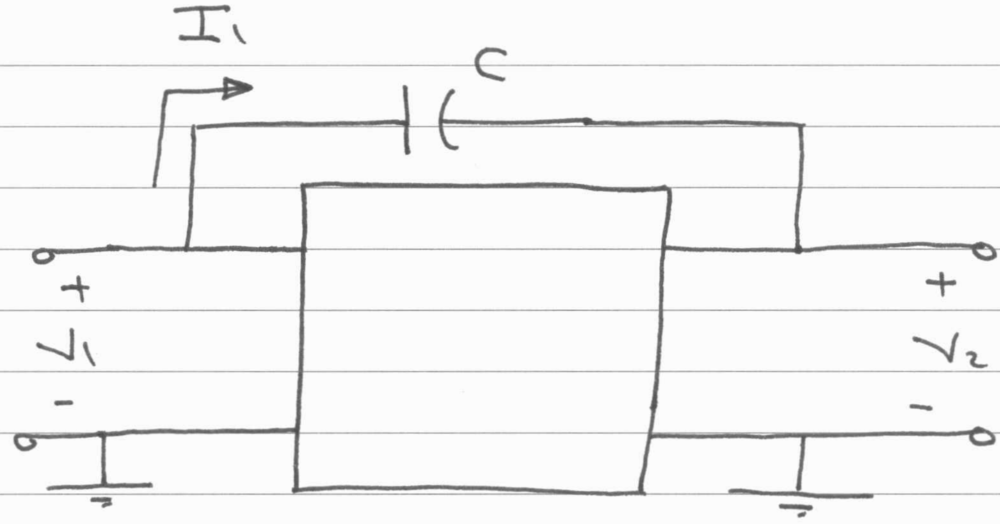
Miller Effect Capacitor





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

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



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

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

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

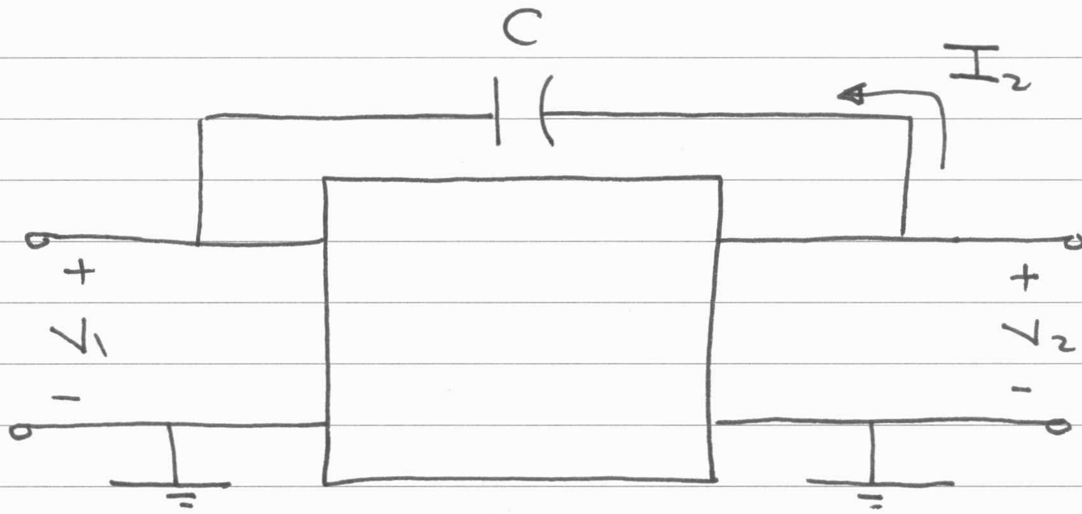
$$I_1 \approx j\omega C V_1\,(1 - A_v(mid))$$

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

For the two circuit to be equivalent

$$I_1 = \bar{I_1}$$

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



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

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

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

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

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

But $I_2 = j\omega C_{om} V_2$

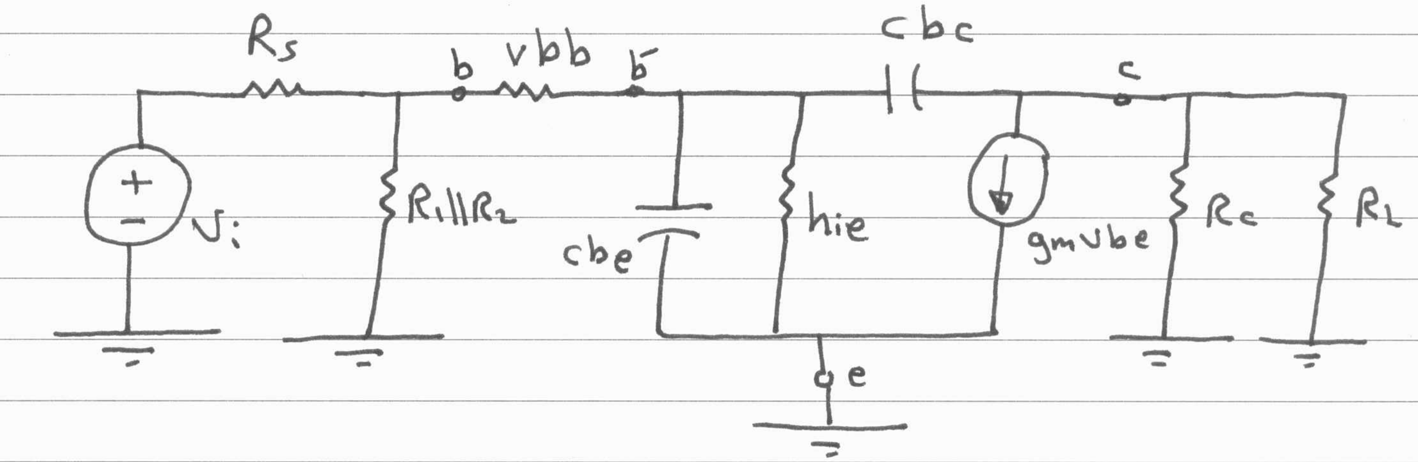
$$\therefore \quad C_{om} = C \left(\frac{A_v(mid) - 1}{A_v(mid)} \right)$$

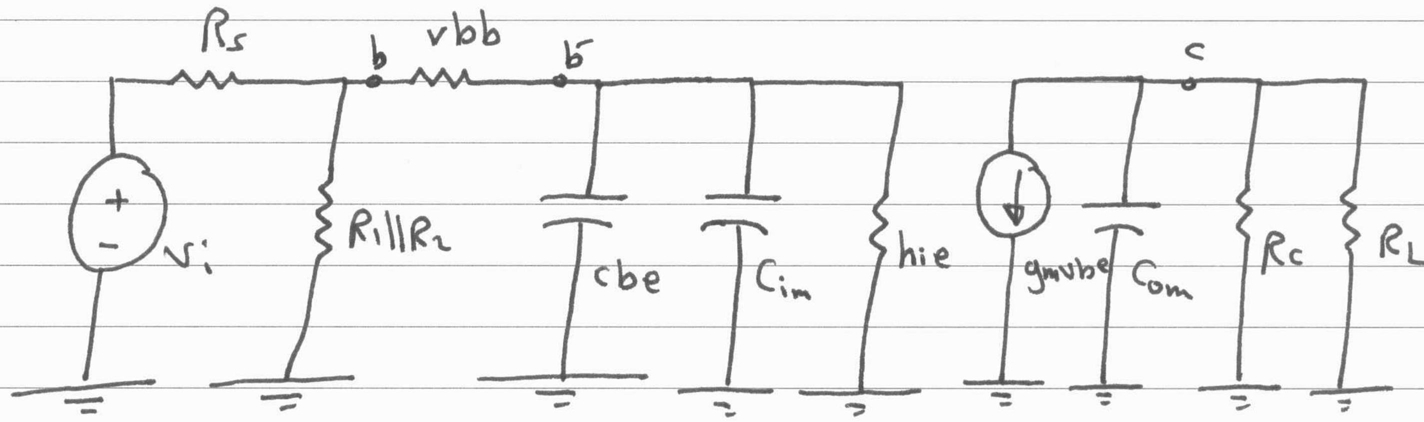
if $|A_v(mid)| \gg 1$

$$C_{om} \doteqdot C$$

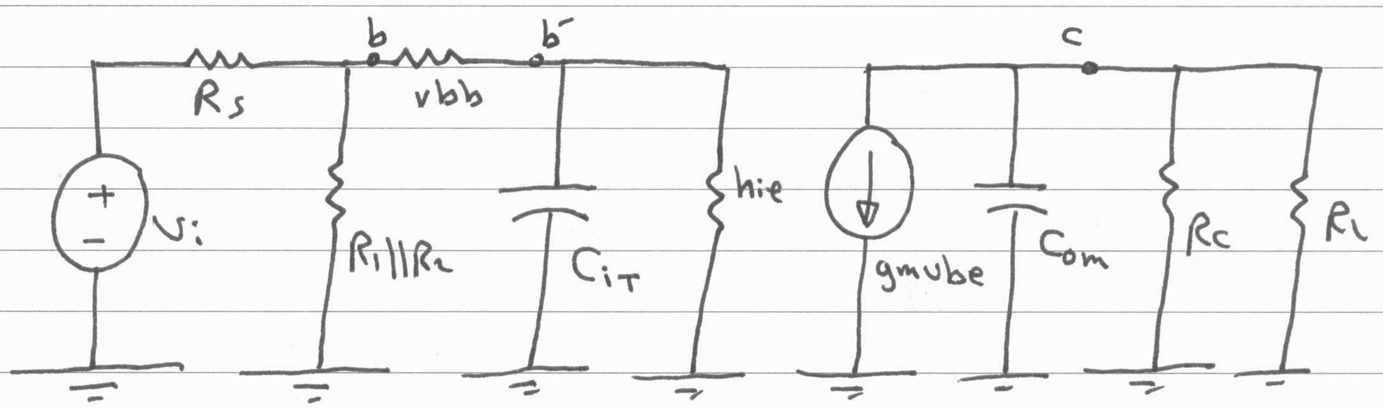
Common Emitter High-frequency Aanalysis

Using Miller-effect Capacitor





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



$$C_{iT} = C_{be} + C_{im} \quad ; \quad C_{om} = C_{bc}$$

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

$$\tau_{C_{iT}} = C_{iT} \cdot R_{TH_1}$$

$$R_{TH_1} = h_{ie} \parallel (r_{bb} + R_s \parallel R_1 \parallel R_2)$$

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

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

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

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

$$\therefore C_{iT} = 105.2\ pF$$

$$\therefore \tau_{C_{iT}} = 91.3\ ns$$

$$\therefore W_{C_{iT}} = 10.95\ M\ r/s$$

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

$$\tau_{C_{om}} = C_{om} R_{TH_2}$$

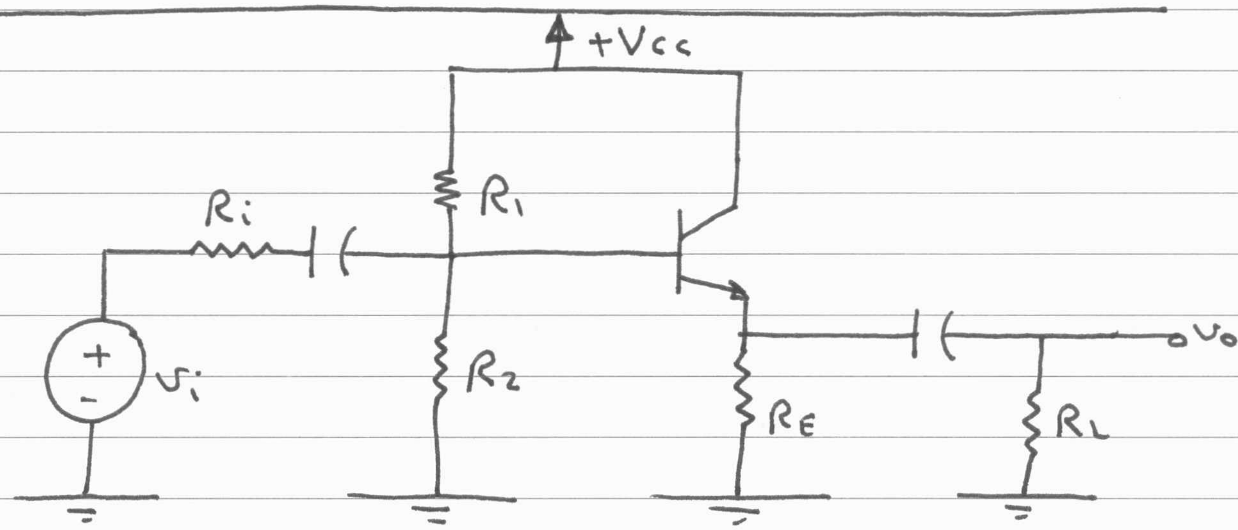
$$R_{TH_2} = R_c \parallel R_L$$

$$\therefore \tau_{C_{om}} = 2.57\ ns \quad ; \quad W_{C_{om}} = 388.9\ M\ r/s$$

$$10.65\ M\ r/s < W_H < 10.95\ M\ r/s$$

$$W_H \equiv 10.7\ M\ r/s$$

Common Collector High-Frequency Response



$g_m = 38\ m℧$, $h_{ie} = 6K$, $R_1 \| R_2 = 40K$

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

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

Estimate ω_H

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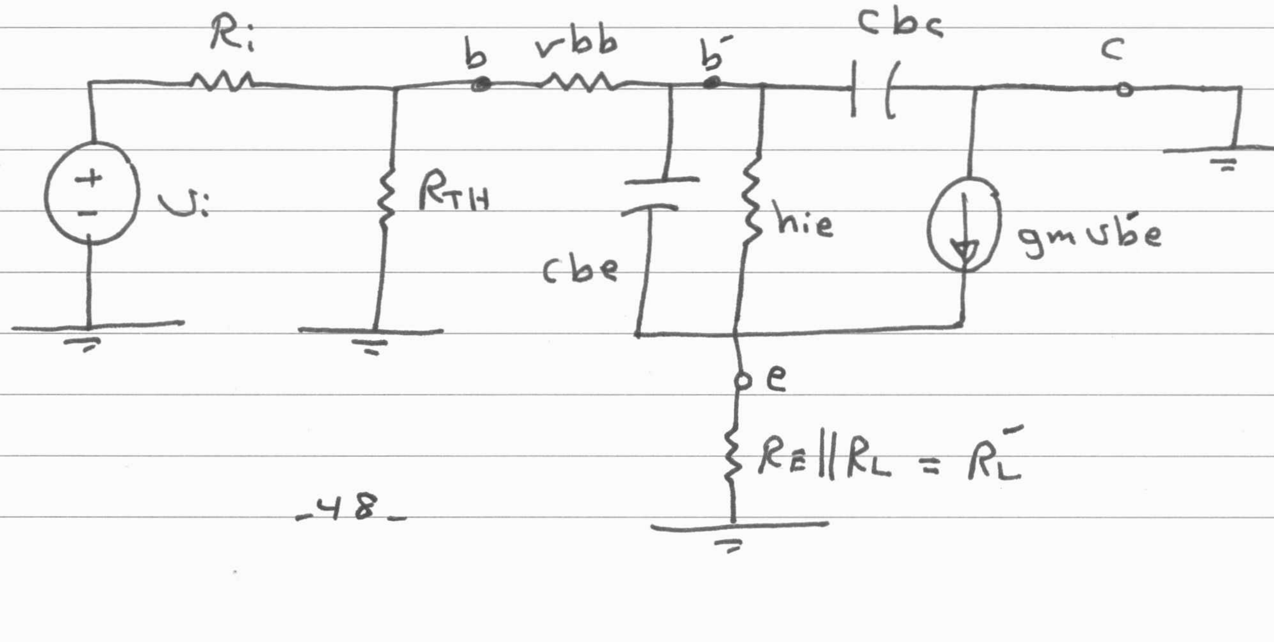
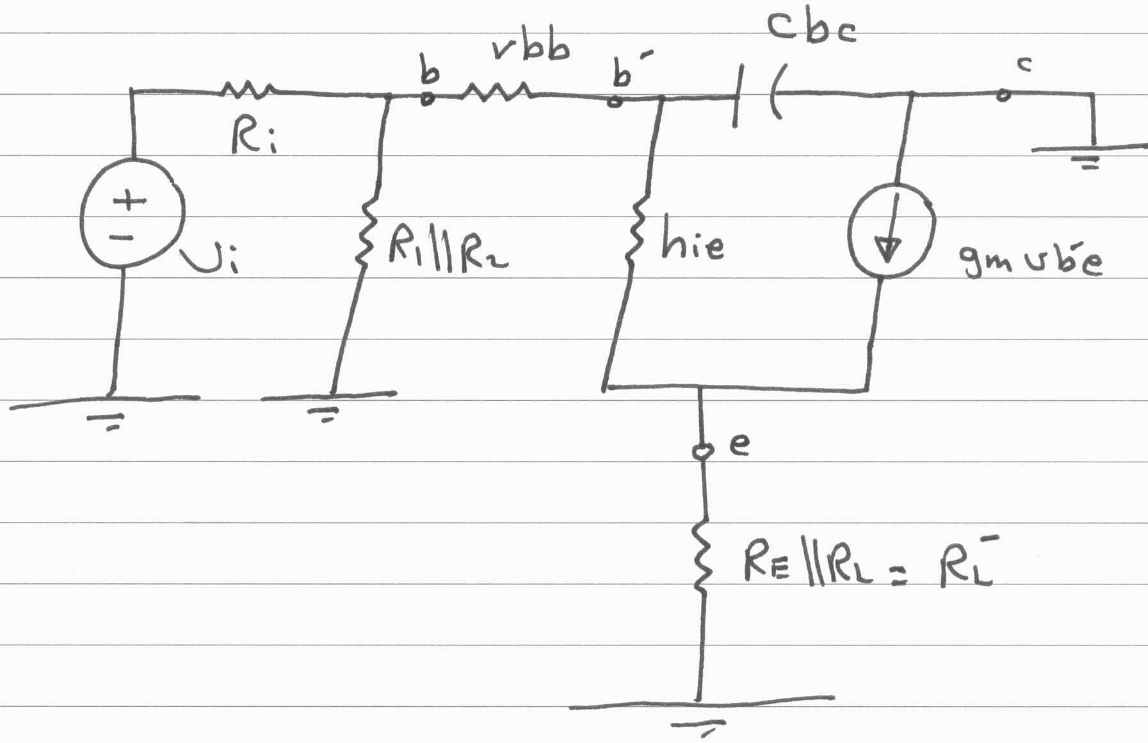
ac small signal high-frequency equivalent circuit.



1) To find τ_{bc} ; set C_{be} open



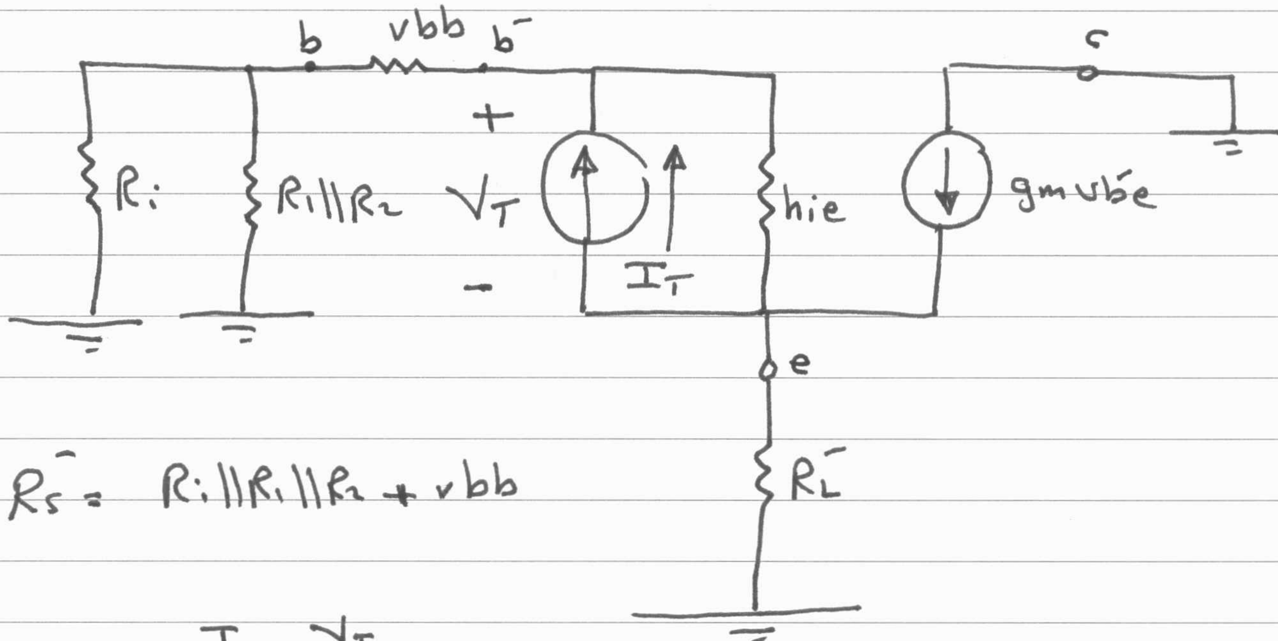
$$\tau_{bc} = C_{bc} R_{bc}$$

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

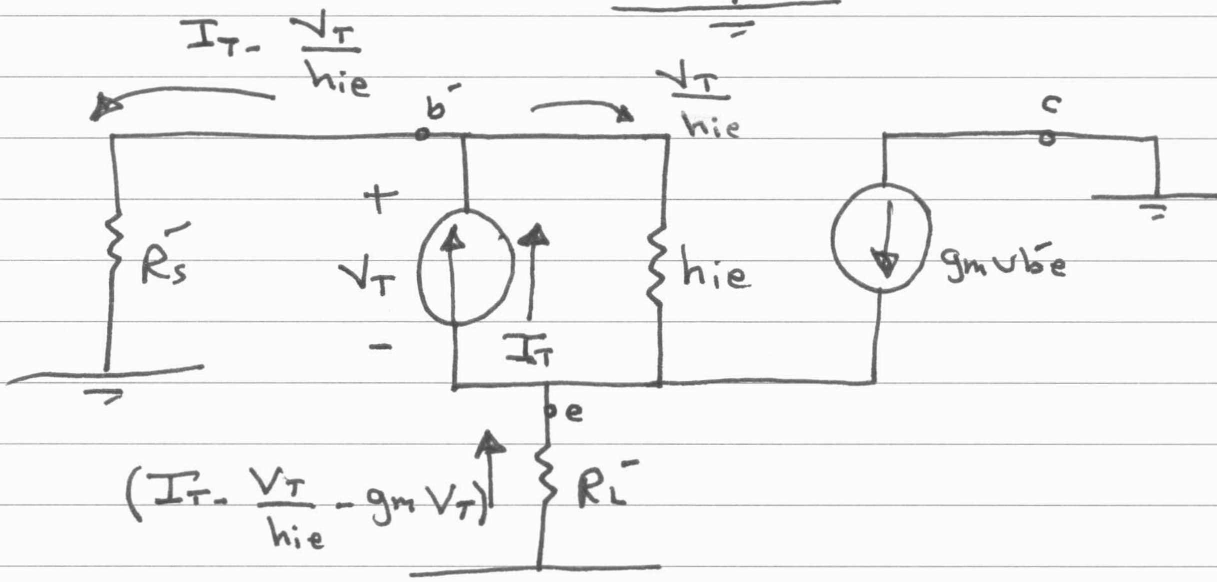
$$\tau_{bc} = 0.399\ ns$$

$$\therefore \omega_{bc} = 2506.3\ Mr/s$$

2) To find τ_{be} ; set C_{bc} open and using $\frac{V_T}{I_T} = R_{be}$



$R_s' = R_i \| R_1 \| R_2 + r_{bb}$



$$V_T = R_s'\left(I_T - \frac{V_T}{hie}\right) + R_L'\left(I_T - \frac{V_T}{hie} - g_m V_T\right)$$

$$\therefore \frac{V_T}{I_T} = \frac{R_s' + R_L'}{1 + \frac{R_s'}{hie} + \frac{R_L'}{hie} + R_L' g_m}$$

$\therefore\ \tau_{be} = 0.621\ ns$

$\therefore\ \omega_{be} = 1610.3\ Mrad/s$

$981\ Mrad/s < \omega_H < 1610.3\ Mrad/s$