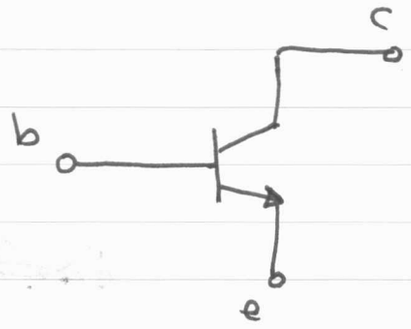
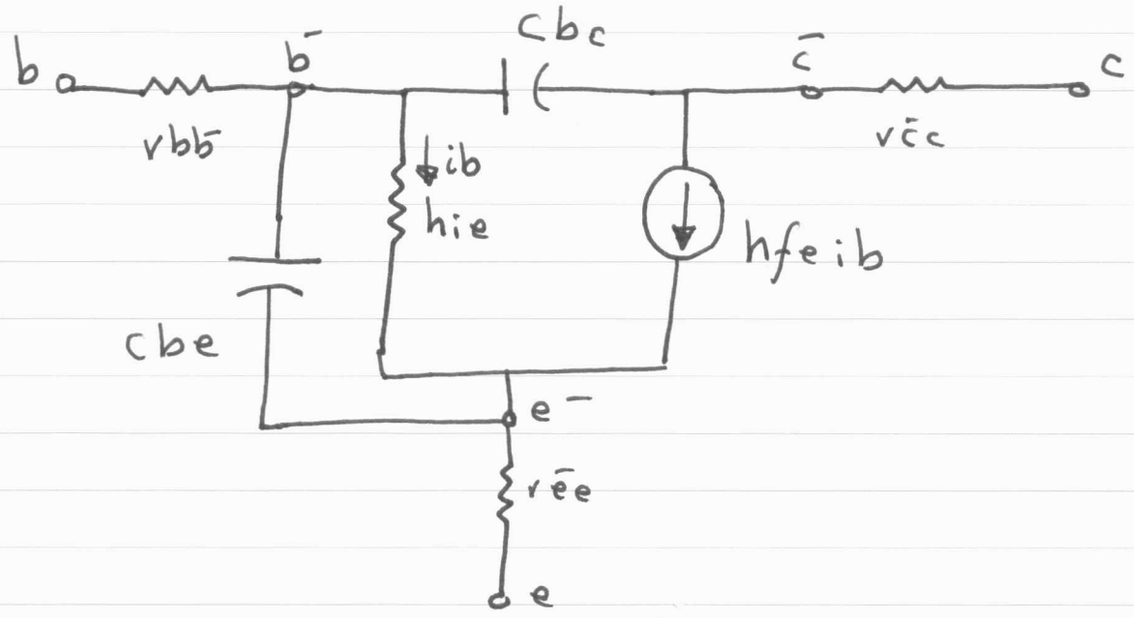
BJT small signal high-frequency equivalent CKT

1) CE and CC

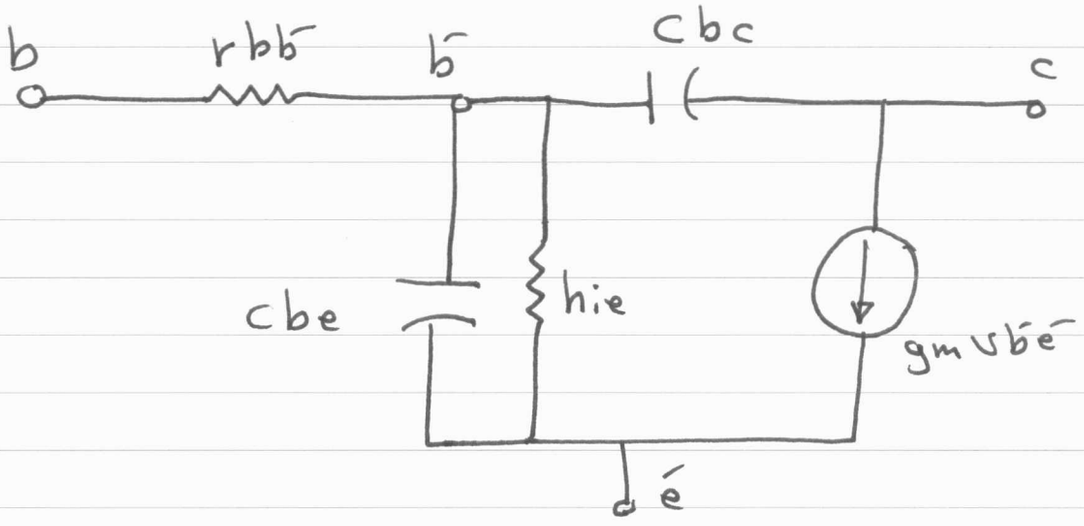




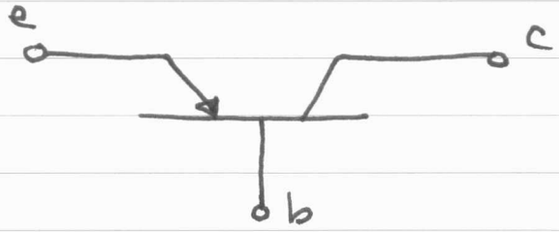
$r_{bb'} = (20\Omega - 200\Omega)$

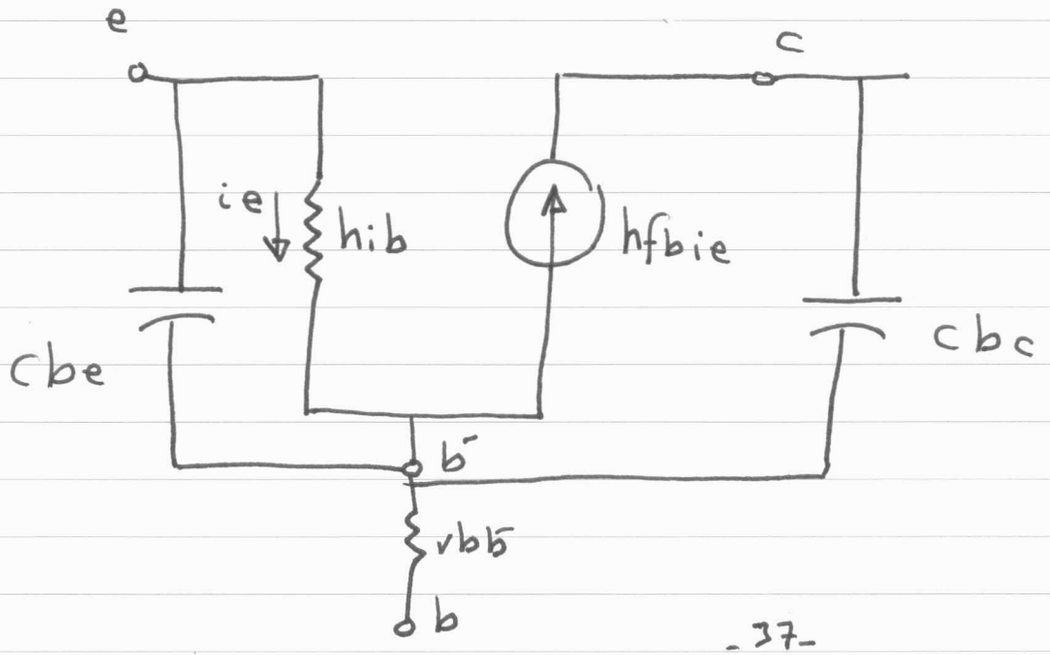
$r_{cc'} = r_{ee'} = (1\Omega - 2\Omega) \longrightarrow 0\Omega$

$$h_{fe} i_b = h_{fe} \frac{v_{b'e'}}{h_{ie}} = \frac{h_{fe}}{h_{ie}} v_{b'e'} = g_m v_{b'e'}$$

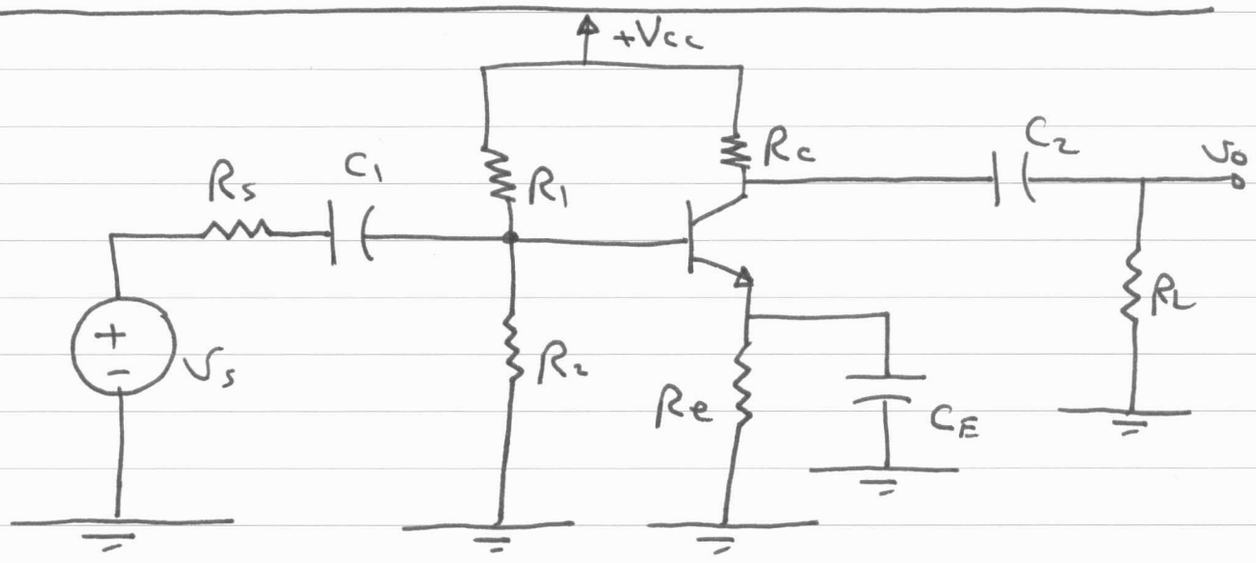


2) CB





Common Emitter Amplifier High-frequency Analysis



$g_m = 33.5\ m\mho$, $h_{ie} = 8.78\ k$

$R_1 \| R_2 = 16.67\ k$, $R_s = 1\ k$, $R_c = 5\ k$

$R_L = 2\ k$, $R_e = 1\ k$, $r_{bb'} = 50\ \Omega$

$C_{be} = 17.25\ pF$, and $C_{bc} = 1.8\ pF$

Estimate ω_H

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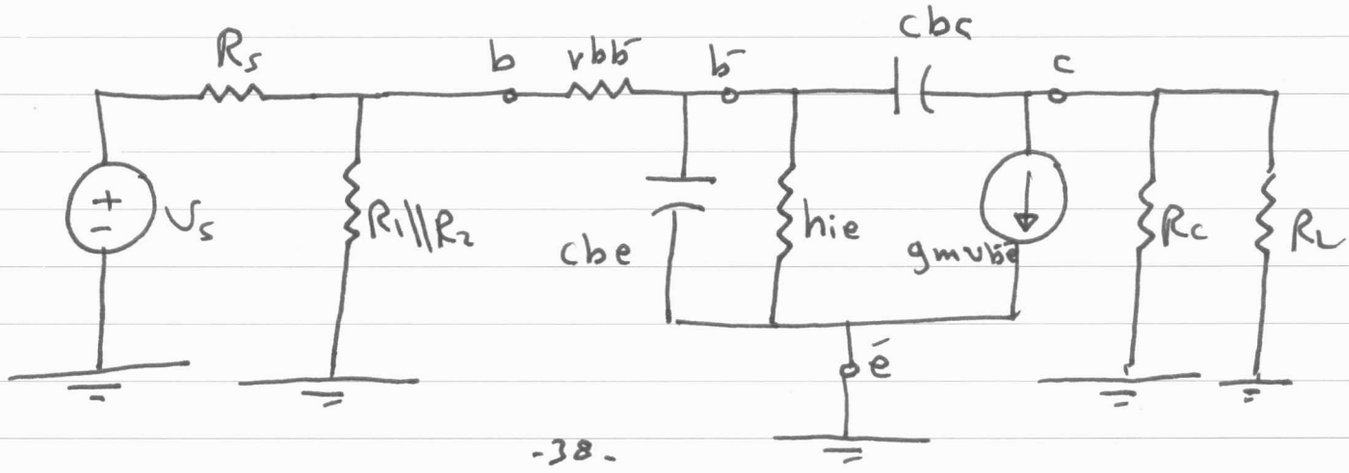
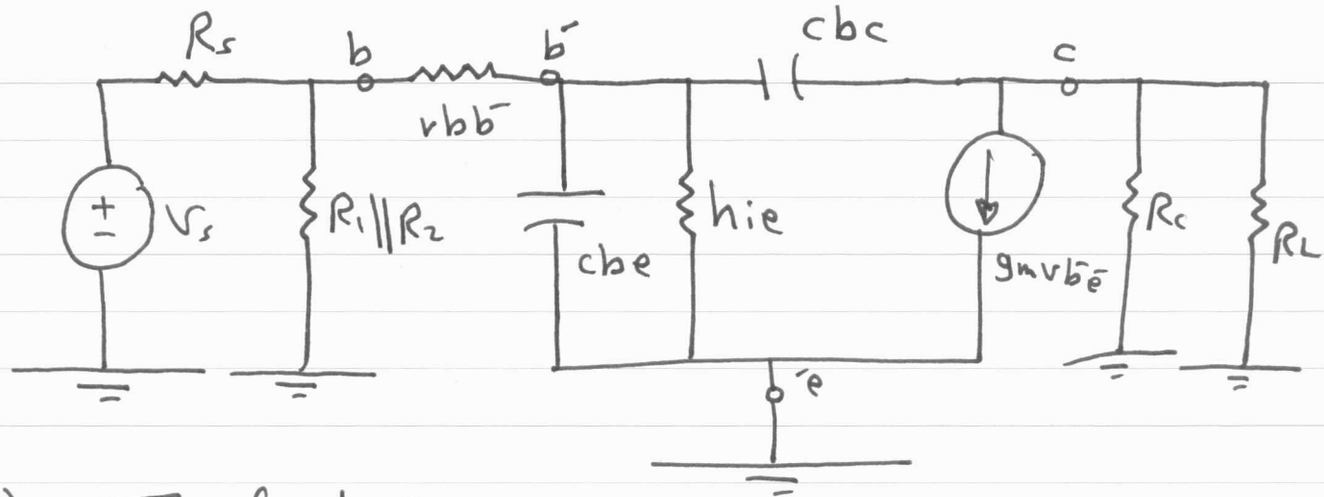
ac small signal high-frequency equivalent CKT





1) To find τ_{be}, set cbc open circuit

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

$$R_{be} = \left(R_s \| R_1 \| R_2 + v_{bb\bar{}}\right) \| h_{ie}$$

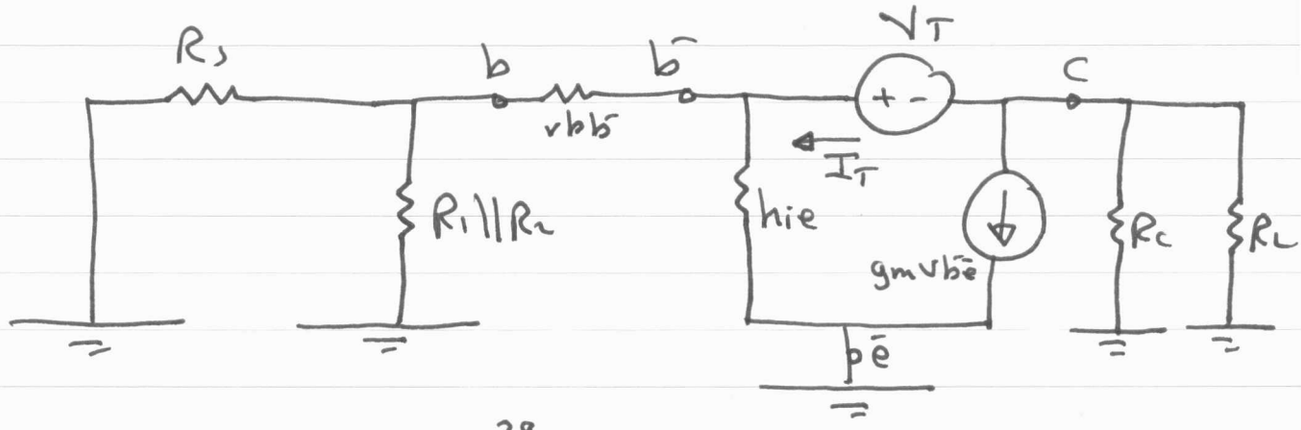
$$\tau_{be} = 14.98 \text{ ns}$$

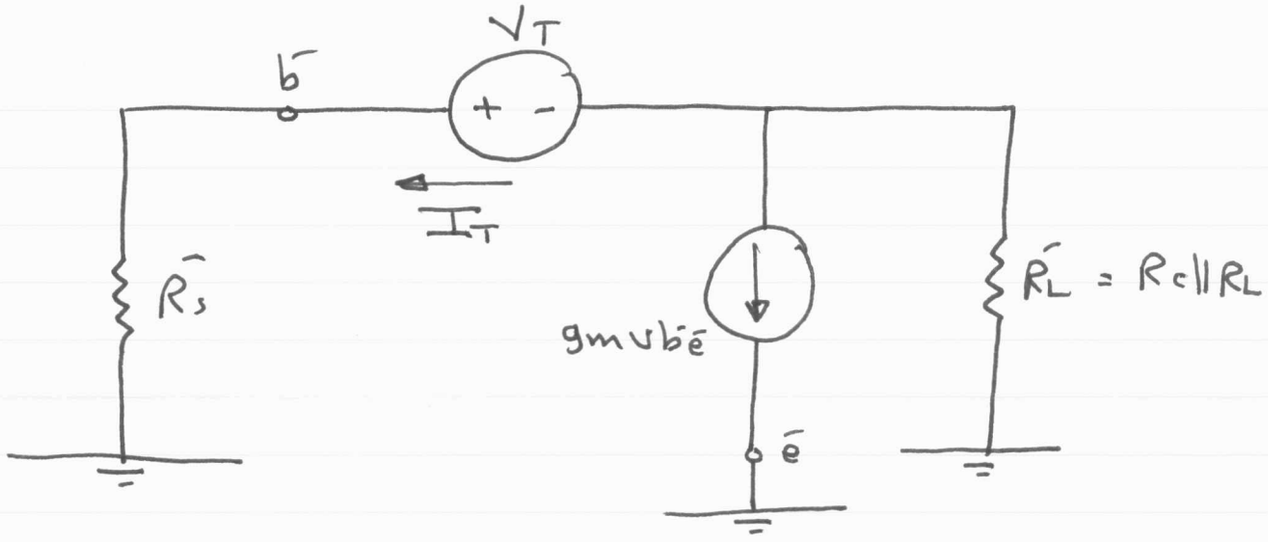
$$\therefore \omega_{be} = 66.76 \text{ mrad/s}$$

2) To find τ_{bc}, set cbe open circuit

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

to find R_{bc}





$$R_s^- = \left[R_s \| R_1 \| R_2 + r_{bb}^- \right] \| h_{ie}$$

$$R_L' \left(I_T + g_m v_{\bar{b}\bar{e}} \right) + R_s^- I_T = V_T$$

$$v_{\bar{b}\bar{e}} = R_s^- I_T$$

$$\therefore \frac{V_T}{I_T} = R_{bc} = R_s^- + R_L^- + g_m R_L^- R_s^-$$

$$\therefore \tau_{bc} = 78.9 \text{ ns}$$

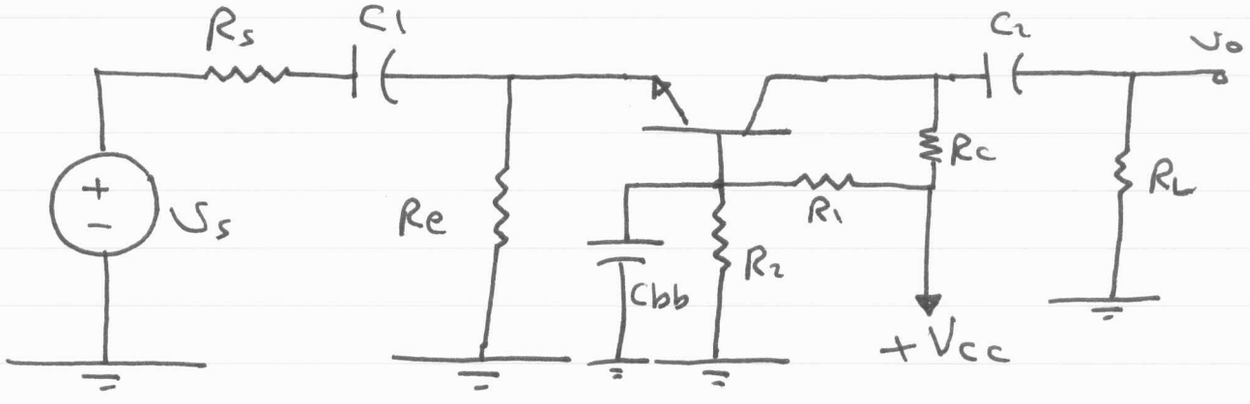
$$\therefore \omega_{bc} = 12.67 \text{ Mrad/s}$$

$$\frac{1}{\tau_{be} + \tau_{bc}} < \omega_H < 12.67 \text{ Mrad/s}$$

$$10.65 \text{ Mrad/s} < \omega_H < 12.67 \text{ Mrad/s}$$

$$\omega_H \equiv 10.7 \text{ Mrad/s}$$

Common base amplifier

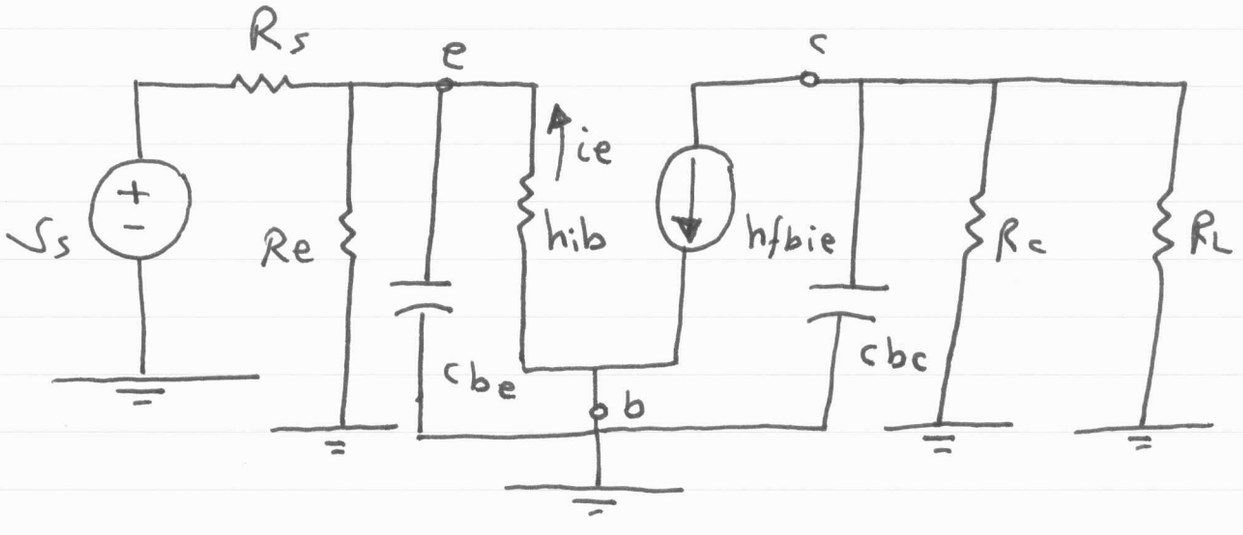


$R_s = 0.1\text{k}$, $R_e = 1\text{k}$, $R_c = 10\text{k}$, $R_L = 10\text{k}$

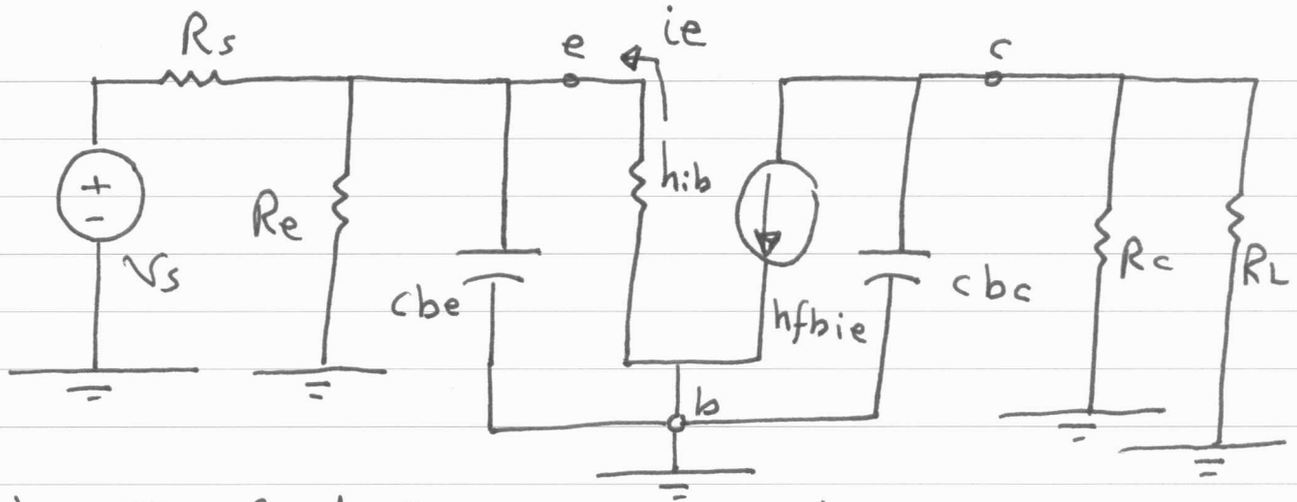
$R_1 \| R_2 = 16.67\text{k}$, $h_{ib} = 0.026\text{k}$, $v_{bb'} = 0$

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

Estimate ω_H



ac small signal high-frequency equivalent CKT



1) To find τ_{be}, set C_{bc} open circuit

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

$$R_{be} = R_s \| R_e \| h_{ib}$$

$$\therefore \tau_{be} = 0.40797 \text{ ns}$$

$$\therefore \omega_{be} = 2451 \text{ Mrl/s}$$

2) To find τ_{bc}, set C_{be} open circuit

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

$$R_{bc} = R_c \| R_L$$

$$\therefore \tau_{bc} = 10 \text{ ns}$$

$$\therefore \omega_{bc} = 100 \text{ Mrl/s}$$

$$96.1 \text{ Mrl/s} < \omega_H < 100 \text{ Mrl/s}$$

$$\omega_H \equiv 99.8 \text{ Mrl/s}$$