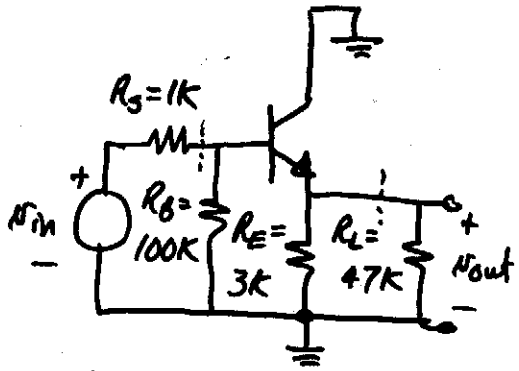
Today's Lecture –

- High frequency analysis of common collector
- High frequency analysis of diff. & common mode diff. amplifier

Monday's Lecture

Next topic – FEEDBACK (Secs. 18.1 & 18.2 next week)

## High Frequency Response of a CC BJT Amplifier

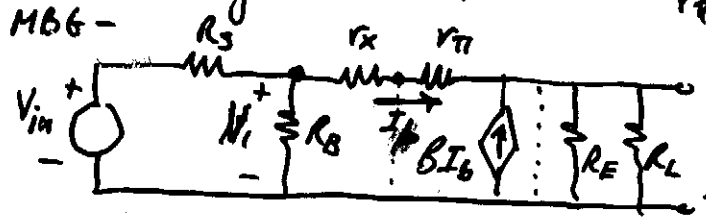



If $\beta_F = 100$, $I_C = 1.5mA$, $r_x = r_b = 150\Omega$, $C_\mu = 0.5pF$, and $f_T = 500MHz$, find the MBG & $\omega_H$.

$$g_m = \frac{I_C}{V_t} = \frac{1.5mA}{25mV} = 60mS$$

$$r_\pi = \frac{100}{60mS} = 1667\Omega$$

Small-signal model:




$$\frac{V_{out}}{V_{in}} = \left(\frac{V_{out}}{I_b}\right)\left(\frac{I_b}{V_1}\right)\left(\frac{V_1}{V_{in}}\right)$$

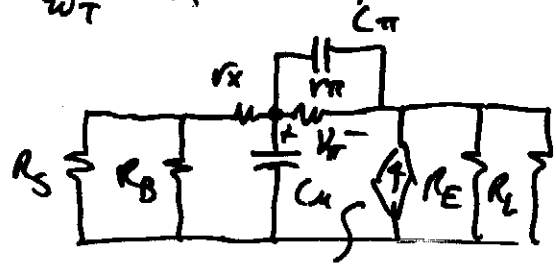
$$\frac{V_{out}}{V_{in}} = \left((1+\beta)R_E \| R_L\right)\left(\frac{1}{R\,[r_x + r_\pi + (1+\beta)R_E \| R_L]}\right)\left(\frac{R_B \| R}{R_S + R_B \| R}\right)$$

$$= \left[(101)(3K \| 47K)\right]\left[\frac{1}{150 + 1667 + (101)(3K \| 47K)}\right]\left[\frac{100K \| R}{1K + 100K \| R}\right]$$

$$= (284.92K)\left(\frac{1}{286.64K}\right)\left(\frac{74.14}{75.14}\right) = \underline{0.974\ V/V}$$

$\omega_H$: $C_\pi = \frac{g_m}{\omega_T} - C_\mu = 18.6\mu F$

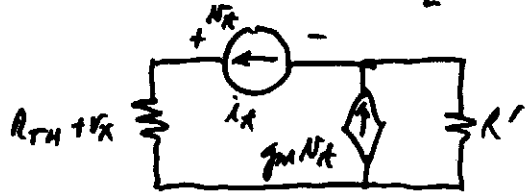
OCTC:




$R_{\pi 0}$:

$R_{TH} = R_S \| R_B$

$R' = R_E \| R_L$

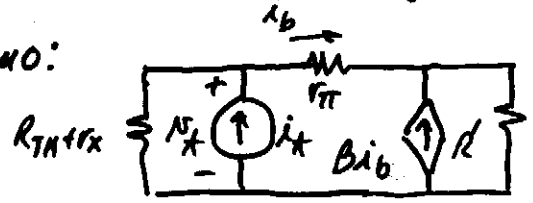



$N_x = i_x(R_{TH}+r_x) + (i_x - g_m N_x)R'$

$N_x(1+g_m R') = i_x[R_{TH}+r_x+R']$

$\therefore R_{\pi 0} = r_\pi \| \left[\frac{R_{TH}+r_x+R'}{1+g_m R'}\right] \approx \frac{R_{TH}+r_x+R'}{1+g_m R'} = 22.4\Omega$

$R_{M0}$:




$i_x = \frac{N_x}{R_{TH}+r_x} + \frac{N_x}{r_\pi + (1+\beta)R'}$

$\therefore R_{M0} = \frac{N_x}{i_x} = \frac{1}{\frac{1}{R_{TH}+r_x} + \frac{1}{r_\pi+(1+\beta)R'}}$

$R_{M0} = \frac{1}{\frac{1}{1.199k} + \frac{1}{286.4k}} = 1.194k$

$\therefore \omega_H \approx \frac{1}{R_{\pi 0}C_\pi + R_{M0}C_\mu} = \frac{10^9}{(0.0224)(18.6)+(1.194)(0.5)}$

$\omega_H = 1.01\times10^9$ rads/sec. $\longrightarrow$ $f_H = 161$ MHz