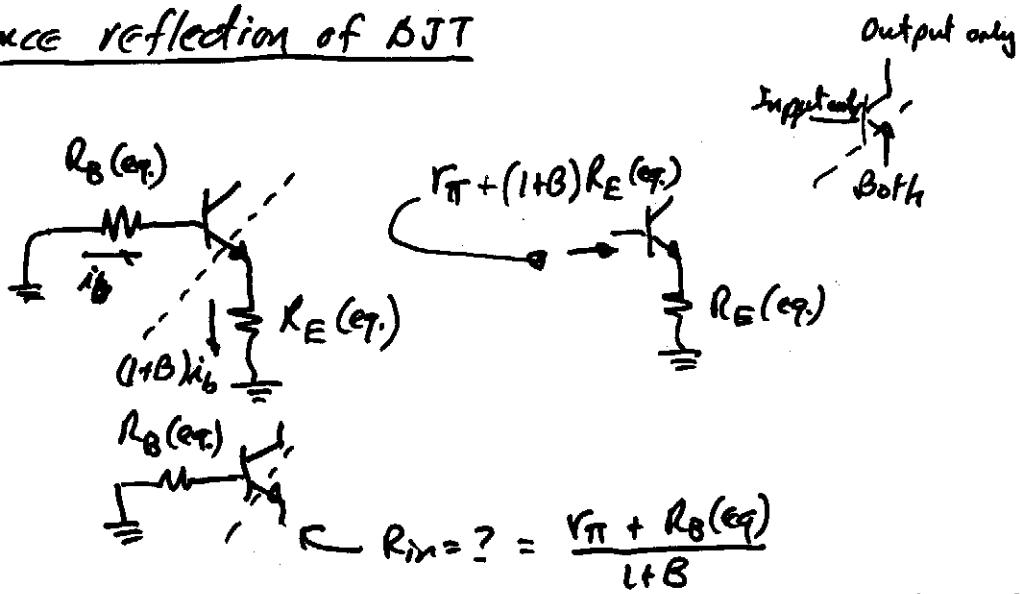
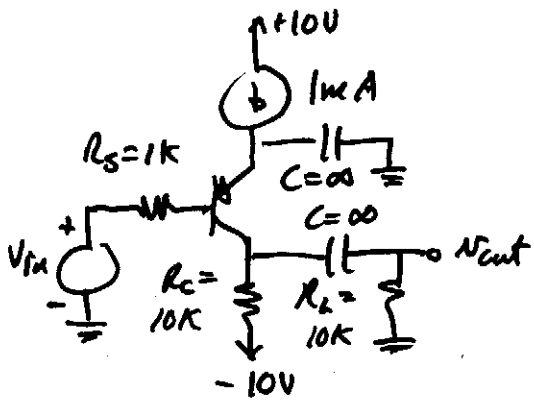
Impedance reflection of BJT



Note that if $R_B(eq.) = 0$, that $R_{in}(\text{emitter}) = \frac{r_\pi}{1+\beta} = \frac{1}{g_m}$

Back to BJT Example

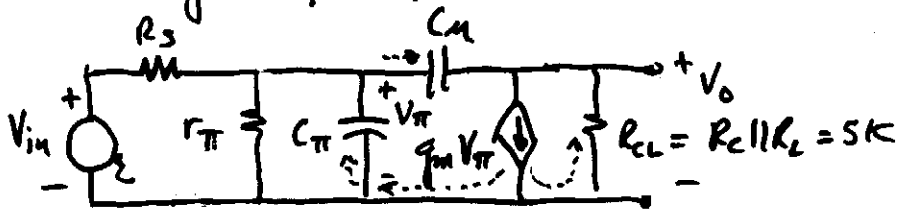


$\beta = 100$, $C_\mu = 2pF$, $V_t = 25mV$, $f_T = 500MHz$, $r_x = r_b = 0$ and $V_A = \infty$

a.) Find C_π, r_π and g_m.

b.) If $r_\pi = 1k$, $g_m = 10mS$ and $C_\pi = 10pF$, find f_H.

S.S. High Frequency Model –



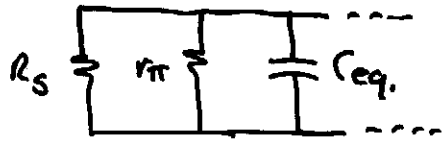
$$MBG = \frac{V_o}{V_{in}} = \left(\frac{V_o}{V_\pi}\right)\left(\frac{V_\pi}{V_{in}}\right) = (-g_m R_{CL})\left(\frac{r_\pi}{r_\pi + R_S}\right) = (-10 \cdot 5)\left(\frac{1}{2}\right) = -25 \frac{V}{V}$$

1.) Use the Miller effect to find f_H.

$K = \frac{V_o}{V_\pi}$ For the Miller effect to work $R_{CL} \ll \frac{1}{\omega C_\mu} + \cdots$

If $\frac{1}{\omega_H C_M} >> R_{CL}$, then $K = -g_m(R_C \| R_L) = -50\ V/V$

$$C_{eq.} = C_\pi + C_M(1-K) = 10pF + 2pF(51) = 112pF$$



Dominant pole $= \omega_H = \frac{1}{C_{eq.}(r_\pi \| R_S)}$

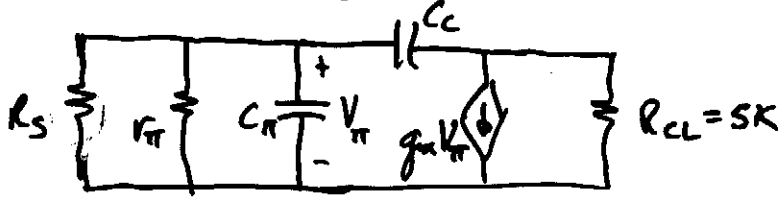
$$\omega_H = \frac{1}{(112pF)(0.5k)} = \frac{1000 \times 10^6}{56} = 17.86\ Mrads/sec$$

$$f_H = 2.842\ MHz$$

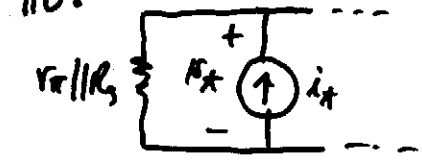
Check assumption:

$$\frac{1}{\omega_H C_M} = \frac{10^6}{(175)(2)} = 28k\Omega > 5k\Omega$$

Repeat b) using the OCTC method -

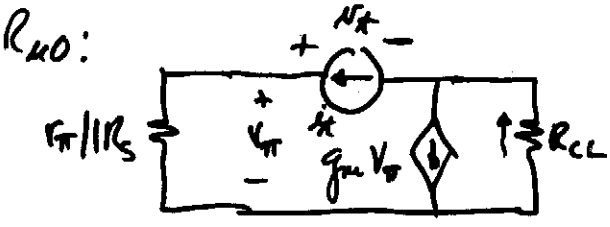


$R_{\pi O}$:



$R_{\pi O} = r_\pi \| R_S = 0.5K$

R_{MO}:



$\frac{v_x}{i_x} \equiv R_{MO}$

$$v_x = i_x(r_\pi \| R_S) + (i_x + g_m V_\pi) R_{CL} = V_\pi + i_x R_{CL} + g_m R_{CL} V_\pi$$

$$v_x = i_x R_{CL} + (1 + g_m R_{CL})(r_\pi \| R_S) i_x$$

$$R_{MO} = \frac{v_x}{i_x} = R_{CL} + (1 + g_m R_{CL})(r_\pi \| R_S) = 5K + (51)(0.5K) = 30.5K$$

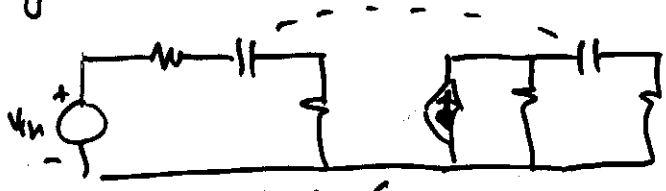
Cont'd

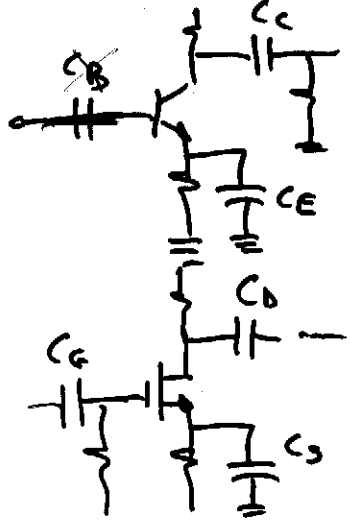
$$\omega_H \approx \frac{1}{R_{\pi O} C_\pi + R_{MO} C_M} = \frac{10^9}{(0.5)(10)+(30.5)(2)} = 15.06 \text{ Mrads/sec}$$

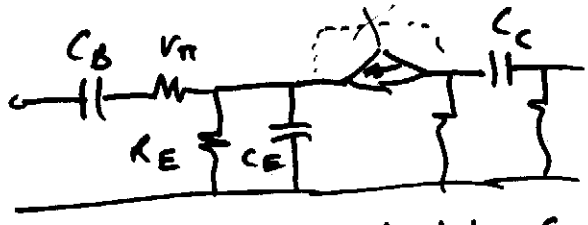
$$f_H = \frac{15.06}{2\pi} \text{ MHz} = 2.4 \text{ MHz}$$

Low frequency analysis:

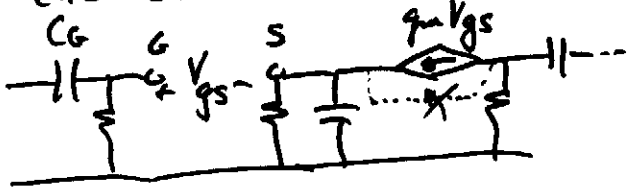
If the capacitances (coupling & bypass) are isolated from each other, then direct analysis and the SCTC give the same results.







C_B and C_G are NOT isolated from each other



Next:

1.) MOG & ω_H of an emitter follower

2.) MOG & ω_H of a diff. amp.