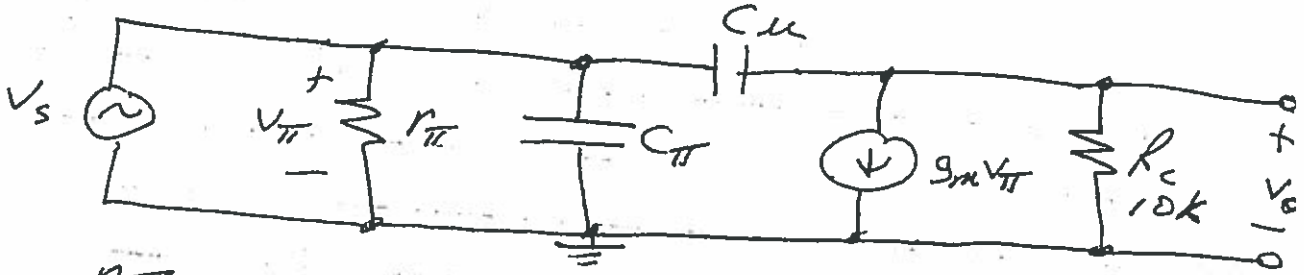
EE352 HW4 Solutions

(b) Text 10.108 (Assume $R_s = 0$, $r_o = \infty$)

(a) AC SS Model



$g_m = \frac{I_C}{V_T} = \frac{.5mA}{25mV} = .02\ A/V$

$r_\pi = \beta/g_m = 5K$, $C_\mu = 2pF$

$C_\pi = \frac{g_m}{2\pi f_t} - C_\mu = 6pF$

At M/B: $V_o = -g_m V_\pi R_c$, $V_\pi = V_s$

$\therefore A_M = \frac{V_o}{V_s} = -g_m R_c = -200\ V/V$

At HF: $\omega_H = \frac{1}{\sum \tau_{j0}} = \frac{1}{\tau_{RC_\pi} + \tau_{RC_\mu}}$ (OCTC's)

$\tau_{RC_\pi} = R_{C_\pi} C_\pi$, $R_{C_\pi} = 0 \Rightarrow \tau_{C_\pi} = 0$

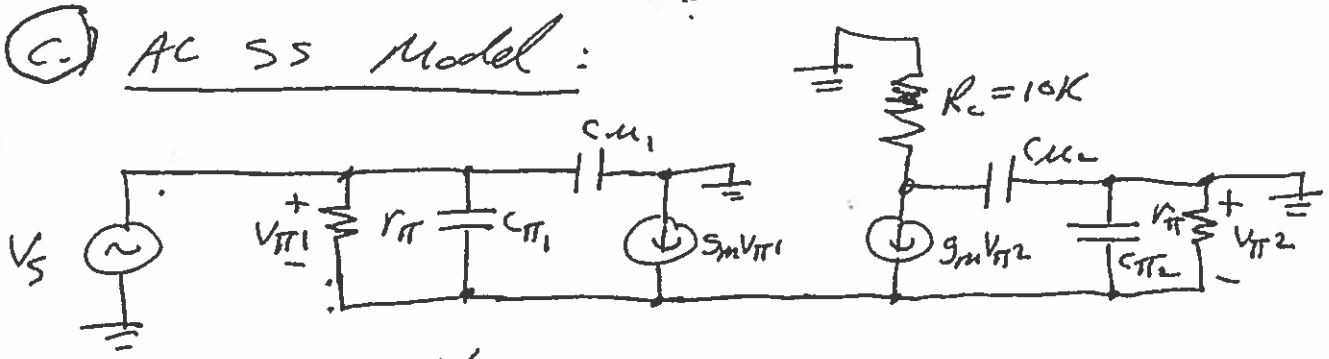
$\tau_{C_\mu} = R_{C_\mu} C_\mu$, $R_{C_\mu} = R_C \Rightarrow \tau_{C_\mu} = 20ns$

$\therefore \omega_H = \frac{1}{0 + 20ns} = 2\pi(8\ MHz)$

$= 50\ Mrad/s$

Text 10.108

(c.) AC SS Model:



$g_m = .02\,A/V$, $r_\pi = 5K$, $C_\mu = 2pF$, $C_\pi = 6pF$

At M/B: $V_o = -g_m V_{\pi 2} R_c$

KCL: $\frac{V_{\pi 1}}{r_\pi} + g_m V_{\pi 1} + \frac{V_{\pi 2}}{r_\pi} + g_m V_{\pi 2} = 0$

$\Rightarrow V_{\pi 1} = -V_{\pi 2}$

KVL: $V_s = V_{\pi 1} - V_{\pi 2} \Rightarrow V_{\pi 1} = -V_{\pi 2} = \frac{V_s}{2}$

$\therefore A_m = \frac{V_o}{V_s} = \frac{g_m R_c}{2} = +100\ V/V$

At HF: $\omega_H = \frac{1}{\Sigma \tau_{j0}} = \frac{1}{\tau_{C\pi 1} + \tau_{C\mu 1} + \tau_{C\pi 2} + \tau_{C\mu 2}}$ (ECTC's)

$\tau_{C\pi 1} = R_{C\pi 1} C_{\pi 1}$; $R_{C\pi 1} = \frac{r_\pi}{2(1+\beta)} = 24.75\Omega$

$\Rightarrow \tau_{C\pi 1} = .149\,ns$

$\tau_{C\mu_1} = R_{C\mu_1} C_{\mu_1}$; $R_{C\mu 1} = 0 \Rightarrow \tau_{C\mu_1} = 0$

$\tau_{C\pi 2} = R_{C\pi 2}$; $R_{C\pi 2} = \frac{r_\pi}{2(1+\beta)} = 24.75\Omega$

$\Rightarrow \tau_{C\pi 2} = .149\,ns$

$\tau_{C\mu_2} = R_{C\mu_2} C_{\mu_2}$; $R_{C\mu_2} = R_c = 10K$

$\Rightarrow \tau_{C\mu_2} = 20\,ns$

$\therefore \omega_H = \frac{1}{.149ns + 0 + .149ns + 20ns} = 49.3\,Mrad/sec$

$= 2\pi [7.8\,MHz]$