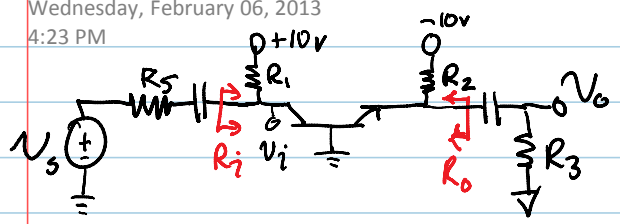
Discussion 2

Wednesday, February 06, 2013
4:23 PM



$$R_i = R_1 \| [r_o (1 + g_m (R_2 \| R_3))]$$

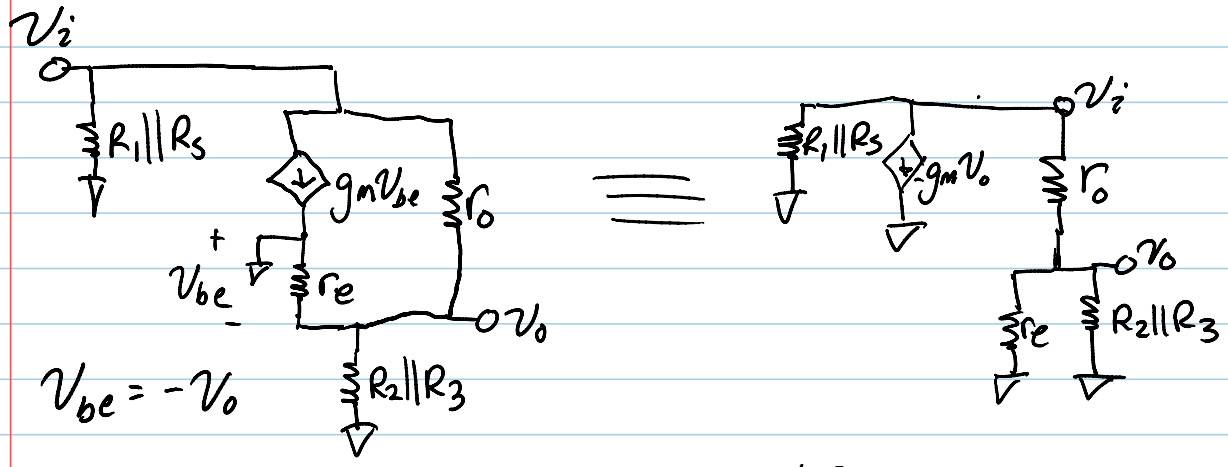
$$R_o = R_2 \| \frac{1}{g_m}$$

$$A_v = \frac{v_o}{v_s} = \frac{v_i}{v_s} \cdot \frac{v_o}{v_i}$$

$\frac{v_i}{v_s}$: voltage divider $\frac{R_i}{R_i + R_s}$

$\frac{v_o}{v_i}$: need this. Not on inspection sheet, so use π/T model

SS ckt w/ T model



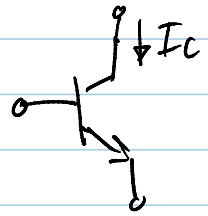
$$v_o = v_i \cdot \frac{r_e \| R_2 \| R_3}{r_e \| R_2 \| R_3 + r_o}$$

$$\frac{v_o}{v_i} = \frac{1}{r_o} \cdot \left[\frac{1}{g_m} \| R_2 \| R_3 \| r_o\right] \approx \frac{1}{r_o} \left[\frac{1}{g_m} \| R_2 \| R_3\right]$$

$$A_v = \frac{v_o}{v_s} = \frac{R_i}{R_i + R_s} \cdot \frac{1}{r_o} \cdot \left[\frac{1}{g_m} \| R_2 \| R_3\right]$$

$\beta \cong 100$

$I_C \cong 1mA$



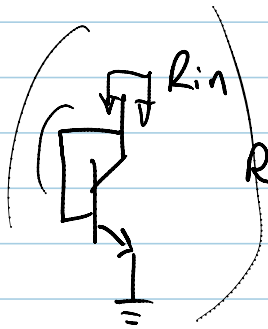
$V_A = 20V - 50V$

$g_m = \frac{I_C}{V_T} = 0.04S \rightarrow \frac{1}{g_m} = r_e = 25\Omega$

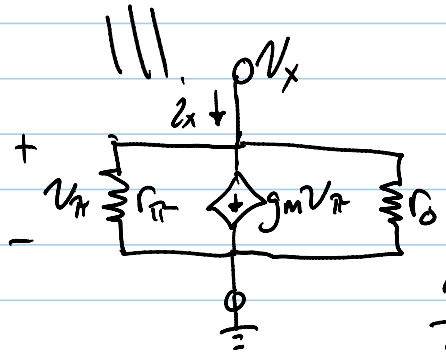
$r_\pi = \beta / g_m = 2.5k\Omega$

$r_o = V_A / I_C = 20k\Omega - 50k\Omega$

$\left[r_o \| r_\pi \| \frac{1}{g_m} \right] \approx r_e = \frac{1}{g_m}$



$R_{in} = \frac{1}{g_m}$ $\quad R_{in} = \frac{1}{g_m} \| r_\pi$

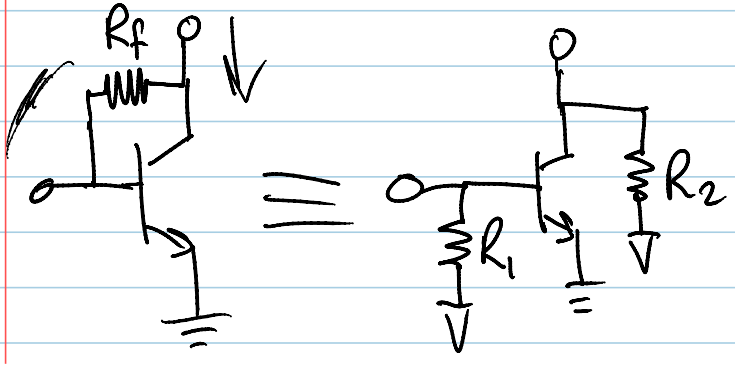


$i_x = \frac{V_x}{r_\pi} + \frac{V_x}{r_o} + g_m V_x$

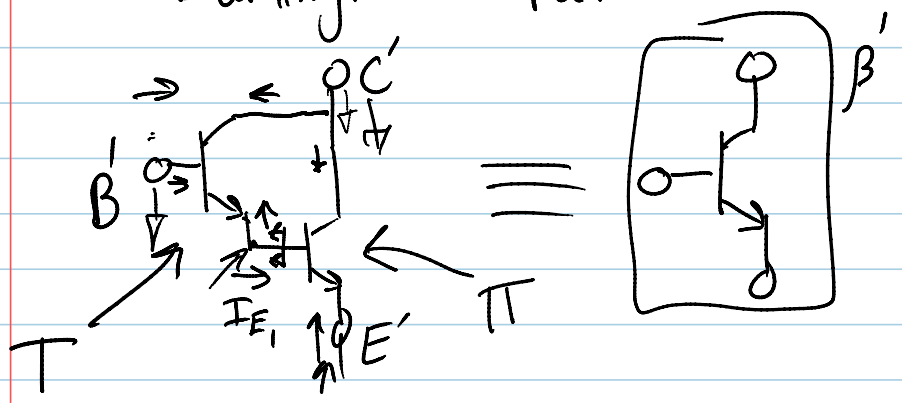
$\frac{V_x}{i_x} = R_{in} = \left[\frac{1}{r_\pi} + \frac{1}{r_o} + g_m \right]^{-1}$

$V_\pi = V_x$

$R_{in} = r_\pi \| r_o \| \frac{1}{g_m} \approx \frac{1}{g_m}$



Darlington Pair



$$I_{E_1} = I_{B2} = I_{c2}/\beta_2$$

$$R_b' = r_{\pi_1} + (1+\beta_1) r_{\pi_2}$$

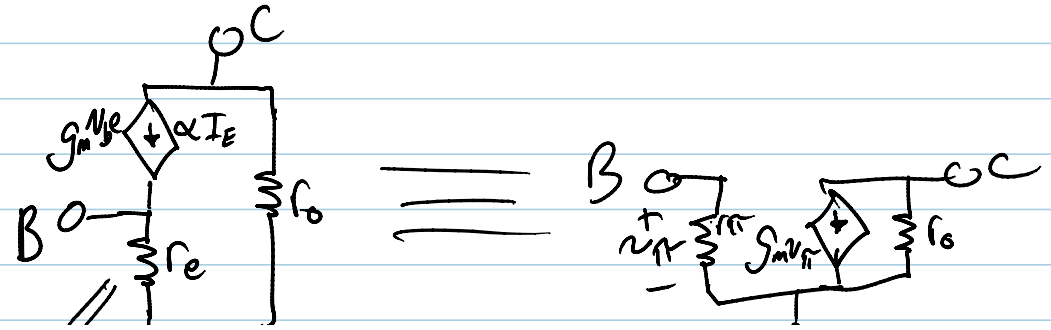
$$R_E' = \frac{r_{\pi_2} + R_{E_1}}{\beta_2 + 1} \simeq \frac{1}{g_{m_2}} + \frac{1/g_{m_1}}{(\beta_2+1)}$$

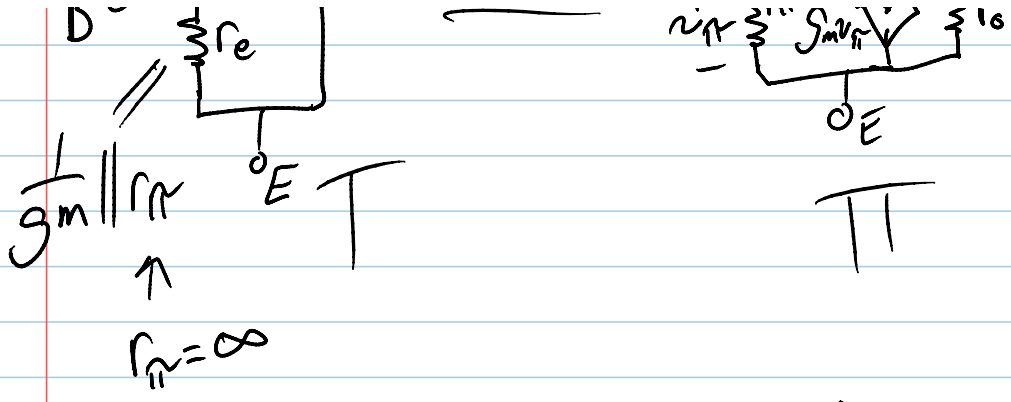
$$R_{E_1} = \frac{r_{\pi_1}}{\beta+1} = r_{\pi_1} \| \frac{1}{g_{m_1}} \simeq \frac{1}{g_{m_1}}$$

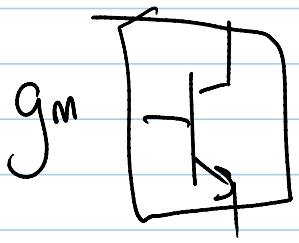
$$\beta' = \frac{I_{c2} + I_{c1}}{I_{B1}} = \frac{\beta_1 I_{B1} + \beta_2(1+\beta_1) I_{B1}}{I_{B1}} = \beta_1 + \beta_2(1+\beta_1) \simeq \beta_1 \beta_2$$

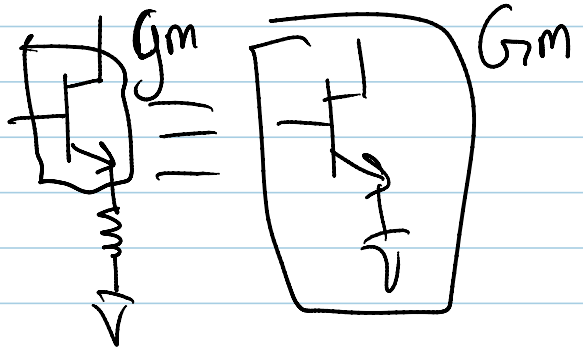
$$I_{c2} = \beta \cdot I_{B2}$$

$$I_{E_1} = (1+\beta_1) I_{B_1}$$




D
r_e
E
$\frac{1}{g_m} \| r_\pi$
$r_\pi = \infty$
E


g_m


Gm
Gm