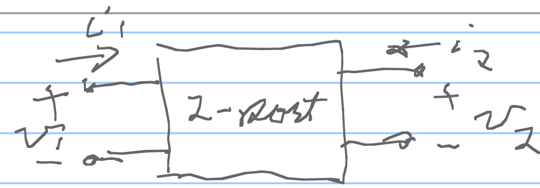
Note Title 9/15/2014

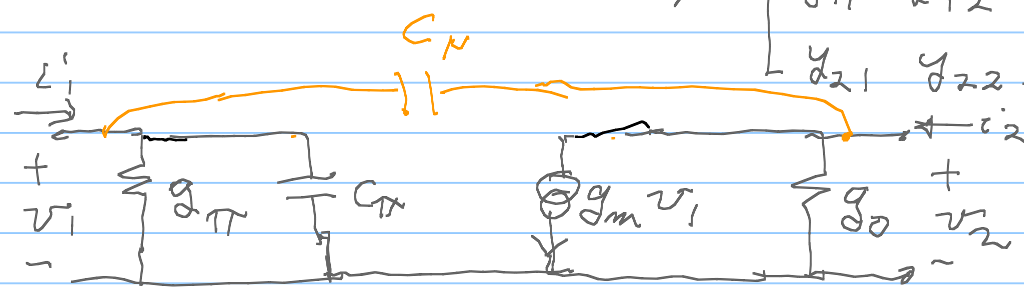
EE 303H
09/18/14

Y matrix



$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = Y \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$Y = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$



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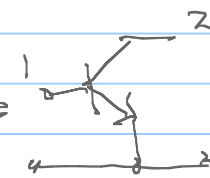


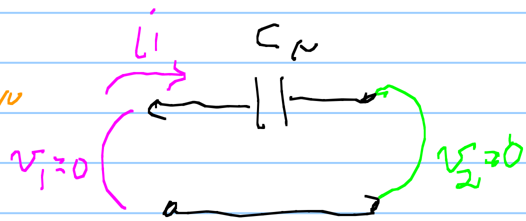
$$i_1 = g_\pi v_1 + sCv_1 = y_1(s)\, v_1 + 0 \cdot v_2$$

$$i_2 = g_m v_1 + g_o v_2$$

$$= \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} g_\pi + sC_\pi & 0 \\ g_m & g_o \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$Y_{BJT} = \begin{bmatrix} g_\pi + sC_\pi & 0 \\ g_m & g_o \end{bmatrix}$$

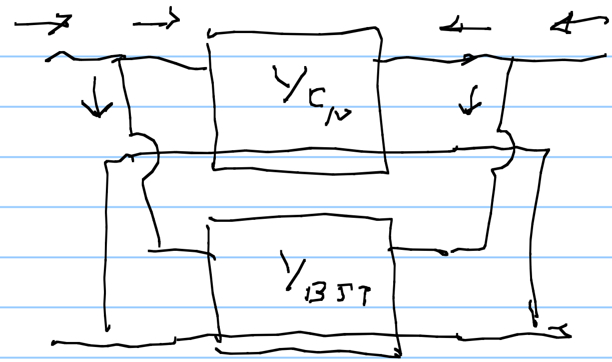
for C_μ



$$y_{11_{C_\mu}} = \frac{i_i}{v_1}\bigg|_{v_2=0} = \frac{sC_\mu v_1}{v_1}\bigg|_{v_2=0} = sC_\mu$$

$$-sC_\mu = y_{12_{C_\mu}} = \frac{i_i}{v_2}\bigg|_{v_1=0} = \frac{-sC_\mu v_2}{v_2}\bigg|_{v_1}$$ apply v_2 & find i_i

$$Y_{C_\mu} = \begin{bmatrix} sC_\mu & -sC_\mu \\ -sC_\mu & sC_\mu \end{bmatrix} = sC_\mu \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$



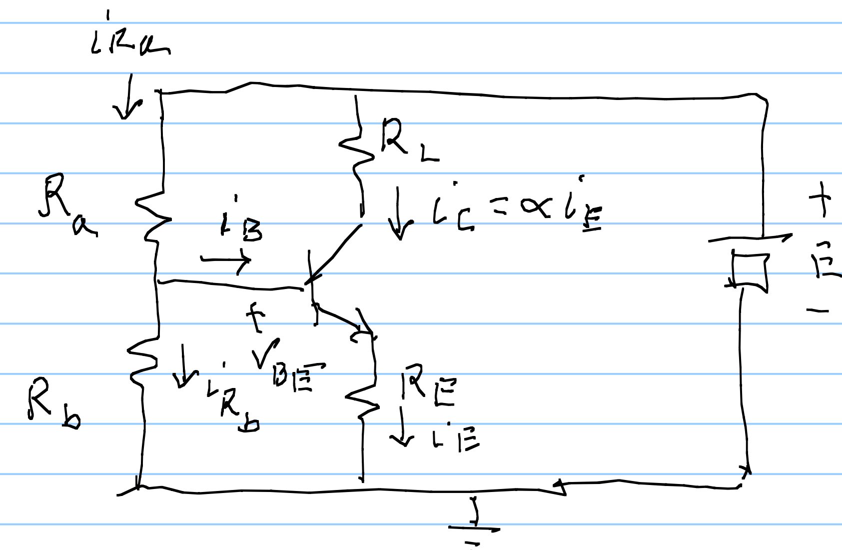
$$\underline{i} = Y_{C_\mu}\,\underline{v} + Y_{BJT}\,\underline{v} = \left(Y_{C_\mu} + Y_{BJT}\right)\underline{v}$$

$$Y_{total} = Y_{C_\mu} + Y_{BJT}$$

$$Y_{total} = \begin{bmatrix} g_\pi + s(C_\pi + C_\mu) & -sC_\mu \\ g_m - sC_\mu & g_o + sC_\mu \end{bmatrix}$$

(Y for π equivalent high frequency circuit of the BJT)

Biasing for BJT

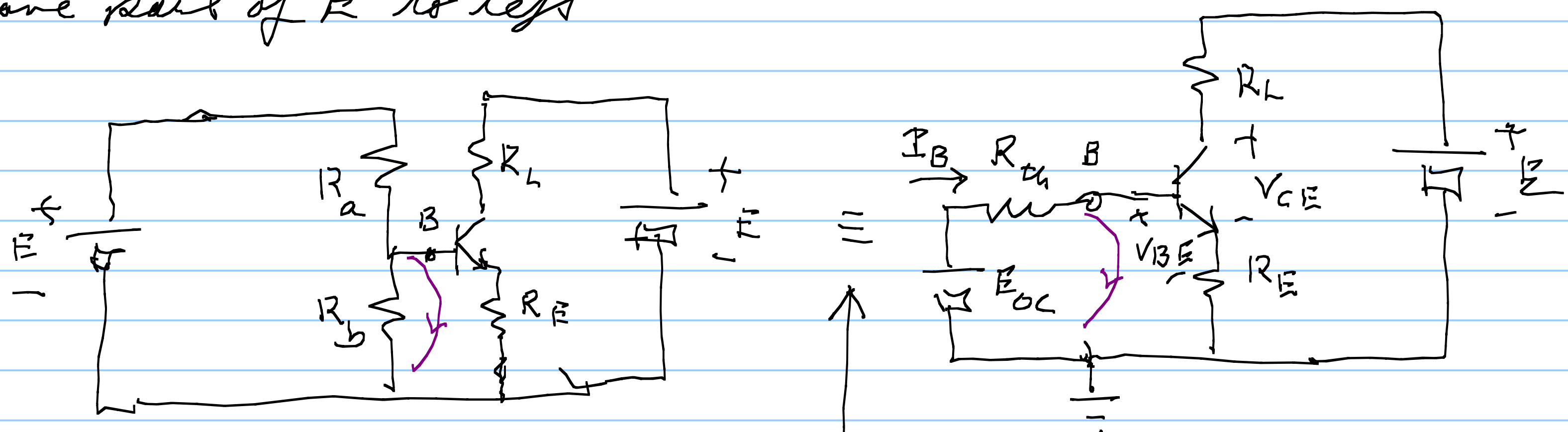


given $A_v = -g_m R_L$, E, β, I_B, V_{CE} & $V_{BE} \approx 0.7$

desire to choose R_a, R_b, R_E, R_L

use KVL, KCL & laws of components

move part of E to left



Thevenin's theorem

$$E_o = \frac{R_a}{R_a+R_b} \cdot E$$

$$I_{SC\,left} = \frac{E}{R_a} = \frac{E_{OC}}{R_{th}} = I_{SC\,right} \Rightarrow R_{th} = \frac{E_{OC}}{E} \cdot R_a = \frac{R_a}{R_a+R_b} \times R_a$$

$$R_{th} = \frac{R_a}{1 + R_b/R_a}, \quad E_0 = \frac{1}{1+R_b/R_a} E$$

KVL input loop: $0 = -E_{0C} + R_{th} I_B + V_{BE} + R_E(-I_E)$

(3 unknowns) $\Rightarrow$ $0 = -\frac{1}{1+R_b/R_a} E + \frac{R_a}{1+R_b/R_a} \cdot I_B + 0.7 + R_E \cdot \frac{\beta}{\alpha} \cdot I_B$ 1)

KVL output loop $\Rightarrow$ $0 = -E + R_L \cdot \beta I_B + V_{CE} + R_E \frac{\beta}{\alpha} I_B$

(R_L, R_E free if know V_{CE}) $\equiv$ $E = (R_L + \frac{R_E}{\alpha}) \beta I_B + V_{CE}$ 2)

but

$$A_v \simeq -g_m R_L \simeq -\frac{\beta I_B}{V_T} \cdot R_L$$

$\Downarrow$

gives R_E

1) gives R_a vs R_b/R_a once R_E is given by 2)