17.2 How do you find poles and zeros

1.) Direct analysis

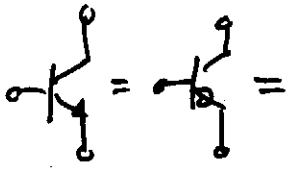
2.) Approximate methods

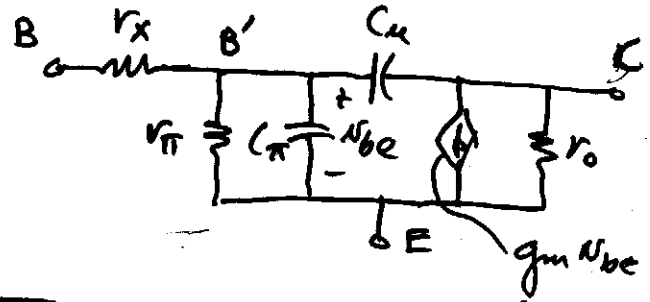
17.3 Short-circuit time constant method to find $\omega_L$.

$$\omega_L \approx \sum_{i=1}^{n} \frac{1}{R_{is} C_i}$$ (Poles must be real. Ignores the zeros)

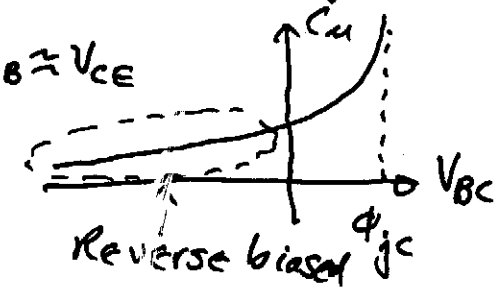
17.4/5 High freq. SS model for transistors

BJT - Hybrid-Pi model



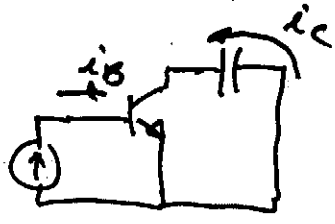



$$C_\mu = \frac{C_{\mu 0}}{\sqrt{1 + \frac{|V_{CB}|}{\phi_{jc}}}}$$ ← $V_{CB} \approx V_{CE}$




$$C_\pi = g_m \tau_F$$

UGBW

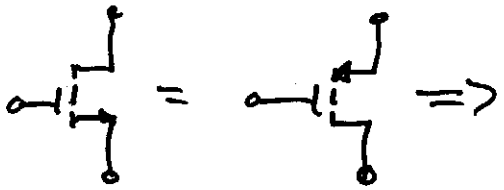


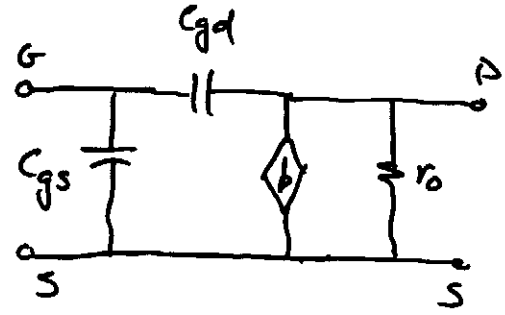

$$\frac{i_c}{i_b} = \beta(j\omega) = 1 \rightarrow \omega = \omega_T$$

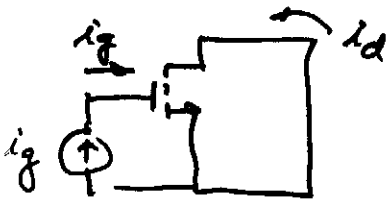
$$\omega_T = \frac{g_m}{C_\pi + C_\mu}$$

$C_\pi \approx 10 C_\mu$

MOSFET (JFET):

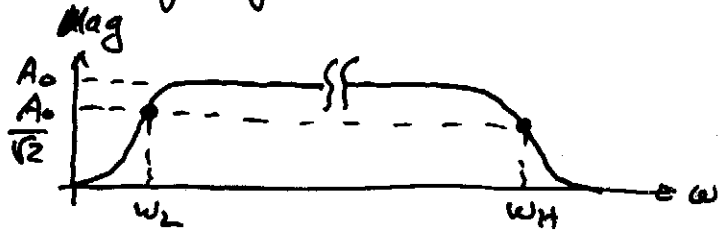





$$\omega_T = \frac{g_m}{C_{gs}+C_{gd}} \rightarrow f_T = 10GHz - 50GHz$$

17.6 What is $\omega_H$?

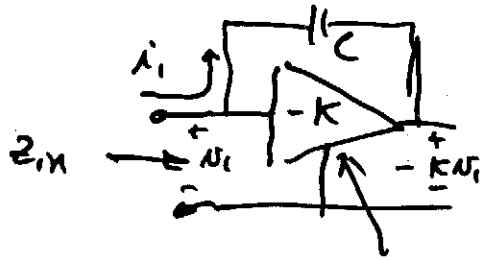



1.) Direct analysis (messy)

2) Approximate method $s^2 + A_1 s + A_0 \rightarrow$ roots

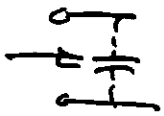
$p_1 \simeq -\frac{1}{A_1}$? $p_2 \simeq -\frac{A_0}{A_1}$ ?

17.7 Miller Multiplication




$Z_{in} = \frac{V_1}{i_1} = ?$ $\quad i_1 = \frac{V_1 - (-kV_1)}{1/sC}$

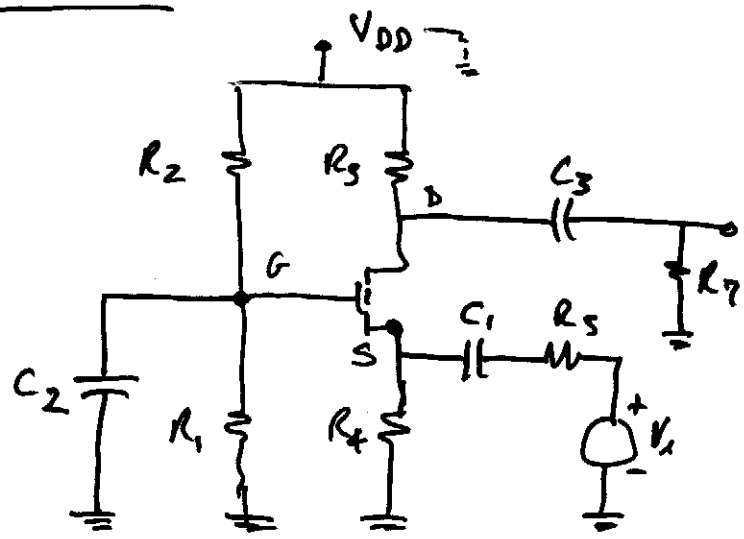
$$Z_{in} = \frac{V_1}{sC(V_1 + kV_1)} = \frac{1}{sC(1+k)}$$

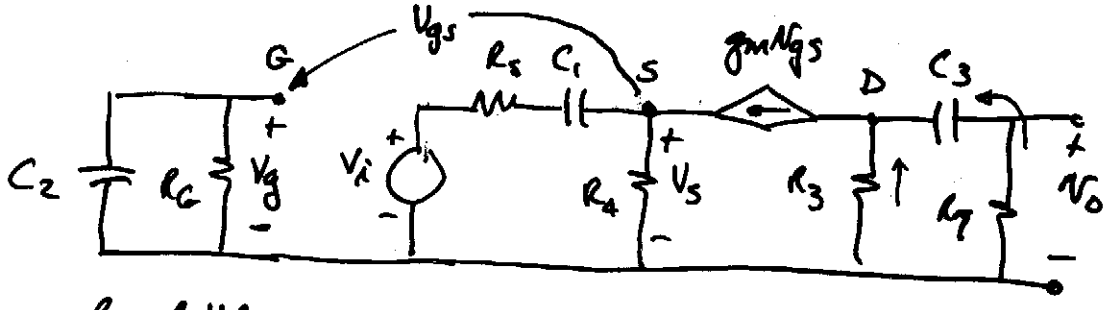
$C(1+k)$  → Dominant pole $\simeq \omega_H$

17.8 Open-circuit T.C. method

$$\omega_H \simeq \frac{1}{\sum_{i=1}^{n} R_{i0} C_i}$$ (Real poles & ignores zero)

Prob. 17.14




$R_G = R_1 \| R_2$

$$\frac{V_o}{V_i} = \left(\frac{V_o}{V_{gs}}\right)\left(\frac{V_{gs}}{V_s}\right)\left(\frac{V_s}{V_i}\right)$$

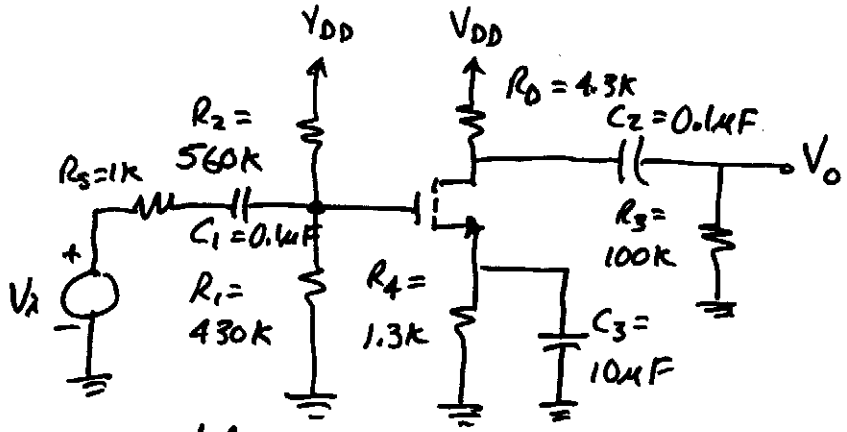
$V_{gs} = V_g - V_s \quad (V_g = 0)$

$V_s = g_m V_{gs}\left[R_4 \| \left(R_S + \frac{1}{sC_1}\right)\right]$

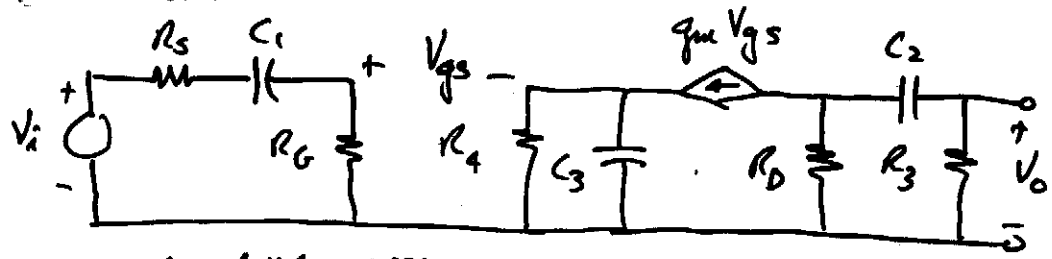
$$V_s = V_i \frac{R_4 \| \frac{1}{g_m}}{R_4 \| \frac{1}{g_m} + R_S + \frac{1}{sC_1}}$$

$$V_o = (-g_m V_{gs})\left(\frac{R_3}{R_3 + R_T + \frac{1}{sC_3}}\right)(R_T)$$

$$\frac{V_o}{V_{gs}} = \left(\frac{-g_m R_3 R_T}{R_3 + R_T}\right)\left(\frac{1}{1 + \frac{1}{sC_3(R_3 + R_T)}}\right)$$




SS model




$R_G = R_1 \| R_2 = 243K$