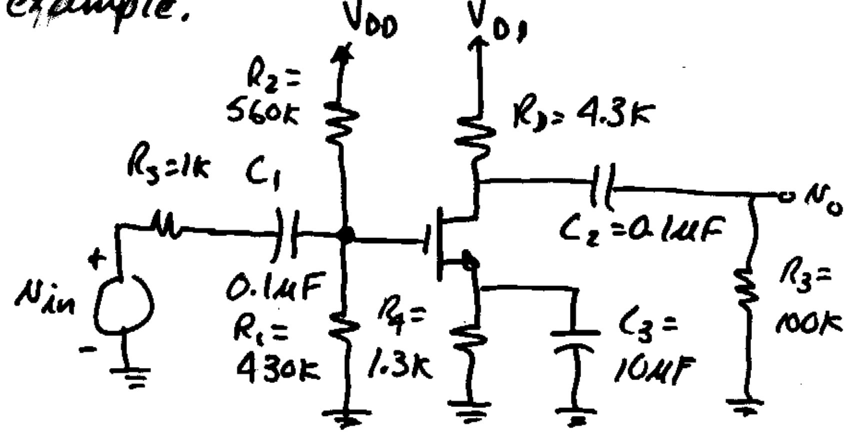
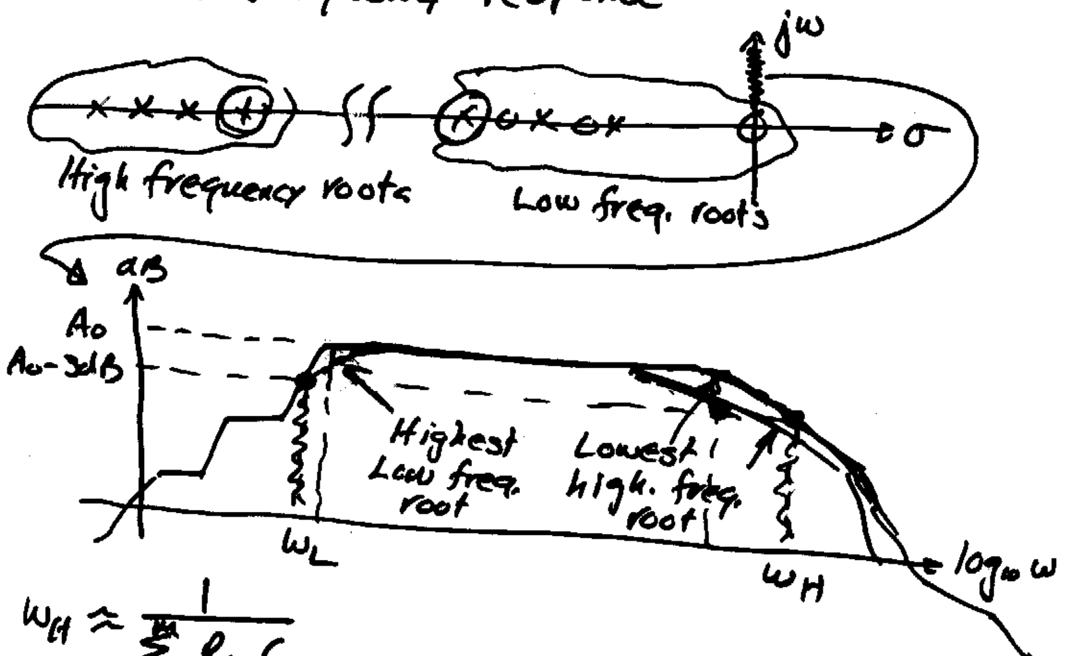
MOSFET Example

Use the OCTC approach to find ω_H of the previous example.



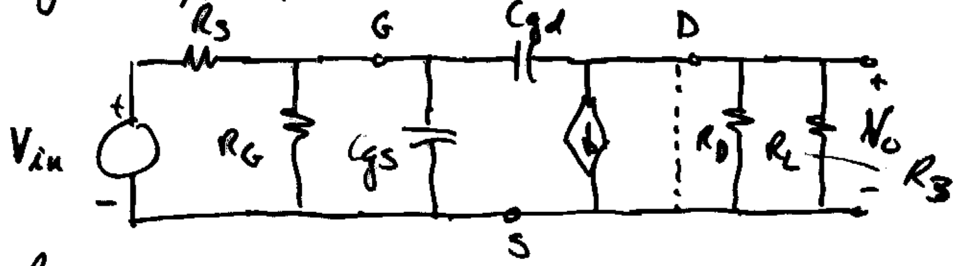
Roots and frequency response–



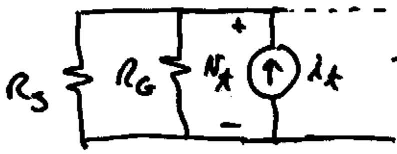
$$\omega_H \approx \frac{1}{\sum_{i=1}^{m} R_{io} C_i}$$

where R_{io} is the resistance seen by C_i with all other capacitors open.

High-frequency s.s. model –

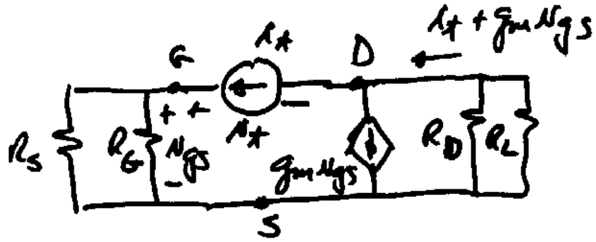


R_{cgso}:



$\rightarrow R_{cgs0} = R_S \| R_G = 1k \| 243k = 996\,\Omega$

R_{cgdo}:



$R_{cgdo} = \frac{v_x}{i_x}$

$$v_x = i_x (R_S \| R_G) + (i_x + g_m v_{gs}) R_D \| R_L$$

$$v_{gs} = i_x (R_S \| R_G)$$

$$v_x = i_x \left[(R_S \| R_G) + (R_D \| R_L) + g_m (R_D \| R_L)(R_S \| R_G) \right]$$

$$\therefore\ R_{cgdo} = (R_S \| R_G)\left[1 + g_m (R_D \| R_L)\right] + R_D \| R_L$$

$$= 0.996K\,[1 + 5.07] + 4.122K = 10.168K$$

$$\omega_H \approx \frac{1}{R_{cgso} C_{gs} + R_{cgdo} C_{gd}} = \frac{1}{(0.996k)10pF + 10.168k(2pF)}$$

33.33×10^6 rads/sec $\rightarrow$ $\underline{f_H = 5.3\,MHz}$

Miller effect (7.22 MHz)

Direct analysis (5.67 MHz)

General Concept-

1.) Find the roots (high freq.)

a.) Direct method → $A(s) = K \frac{(s+z_1)}{s^2+A_1s+A_0}$

b.) Use the approx. polynomial solution (that the roots are real)

$(s+a)(s+b) = s^2+A_1s+A_0$

$a \approx A_1 \quad b \approx \frac{A_0}{A_1}$ IF $a \ll b$

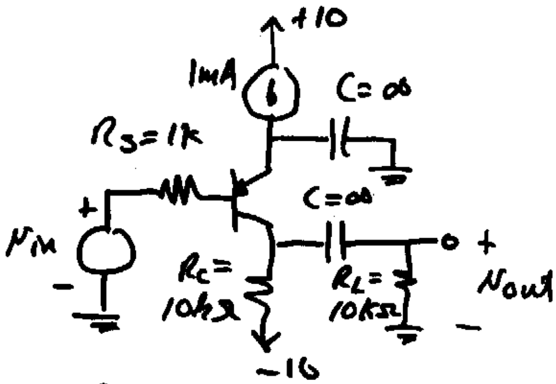
2.) Find ω_H

a.) Dominant root (lowest pole ≈ ω_H)

b.) OCTC

c.) Miller effect

BJT Example



$\beta = 100$, $C_\mu = 2pF$, $V_t = 25mV$, $f_T = 500MHz$, $r_b = r_x = 0\Omega$, $r_o = \infty$. ~~Find Av~~

a.) Find r_π, g_m & C_π

$g_m = \frac{I_c}{V_t} = \frac{1mA}{25mV} = \frac{1}{25}\mho = 40mS$

$r_\pi = \frac{\beta}{g_m} = 100 \times 25 = 2.5k\Omega$

$C_\pi = \frac{g_m}{\omega_T} - C_\mu = \frac{40mS}{1000\pi \times 10^6} - 2pF$

$C_\pi = 10.732pF$

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