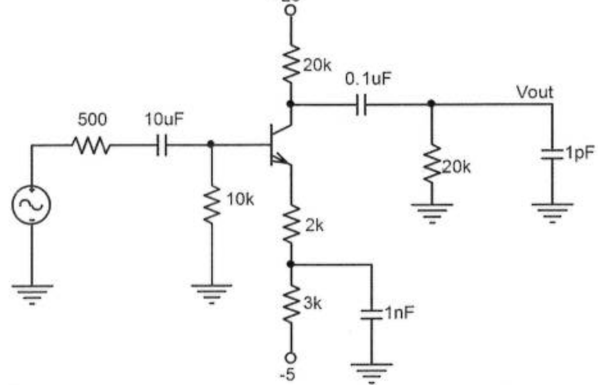
ELEC 401, Fall 2014 Test 1 Name Key

1. Recalling that the gain of a common emitter amplifier can be approximated by R_C/R_E, sketch an <u>approximate</u> magnitude frequency response for the circuit below. Label the following:
    a. Midband gain(s) in dB
    b. Frequency rolloff rates in dB/decade

It is not necessary to label the frequency breakpoints



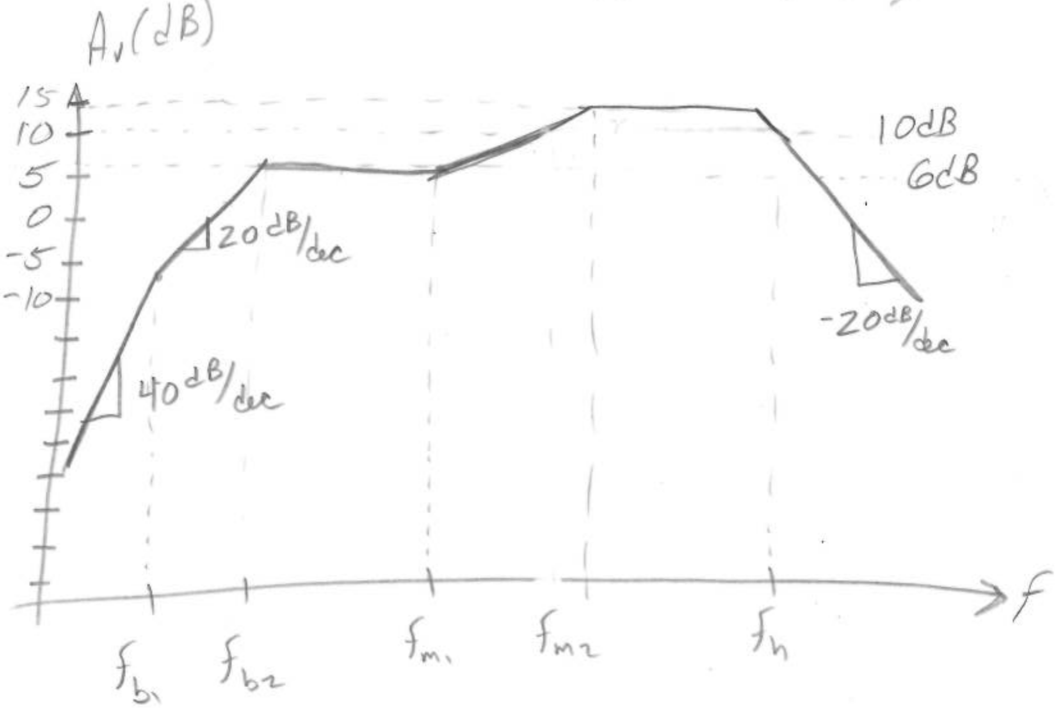
W/ 1nF Cap open (Low Freq)

gain $\approx \frac{10k}{5k} = \Rightarrow 6\,dB$

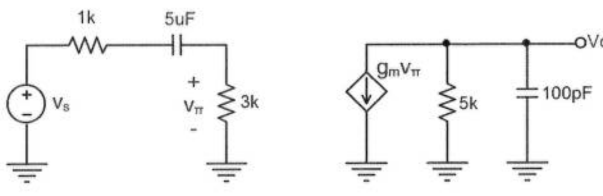
w/ 1nF cap short (higher freq)

gain $\approx \frac{10k}{2k} = 5 \rightarrow 14\,dB$

→ 10µF & 0.1µF affect low freq
→ 1nF affects mid-band gain
→ 1pF affects high freq.



2. Determine the midband gain and the high and low frequency breakpoints for the small signal model of an amplifier shown below.



g_m=10mA/V

Midband gain $V_\pi = V_s \cdot \frac{3}{4}$

$V_o = -g_m \cdot V_\pi \cdot 5k$

$\Big\}\ V_o = -(10)(\frac{3}{4})(5)V_s \Rightarrow \frac{V_o}{V_s} = \underline{-37.5\ V/V}$

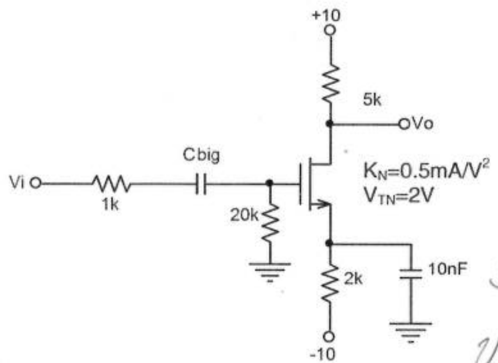
$f_L = \frac{1}{2\pi R_{TH} \cdot C} = \frac{1}{2\pi(4k)(5\mu F)} = \underline{7.96\ Hz}$

*note if a 1V source is placed @ the 100pF, V_π still $= 0V$

$\therefore R_{TH} = 5k$

$f_h = \frac{1}{2\pi \cdot 5k \cdot 100pF} = \underline{318\ kHz}$

3. Determine the *two* midband break frequencies for the amplifier shown below. You do not need to determine any other break frequencies or gain values.

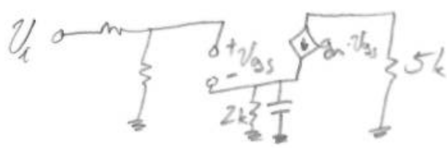


$$\left.\begin{array}{l} 10 = V_{GS} + 2kI_D \\ I_D = 0.5(V_{GS}-2)^2 \end{array}\right\} \begin{array}{l} 10 = V_{GS} + V_{GS}^2 - 4V_{GS} + 4 \\ V_{GS}^2 - 3V_{GS} - 6 = 0 \end{array}$$

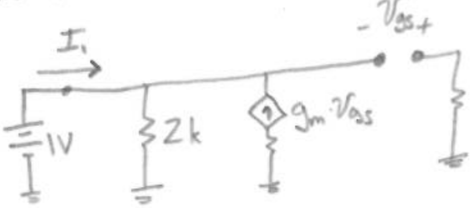
$$V_{GS} = -\cancel{1.37}, \underline{4.37}$$

$$g_m = 2(0.5)(2.37) = \underline{2.37\ mA/V}$$

Small signal model



From 10nF:



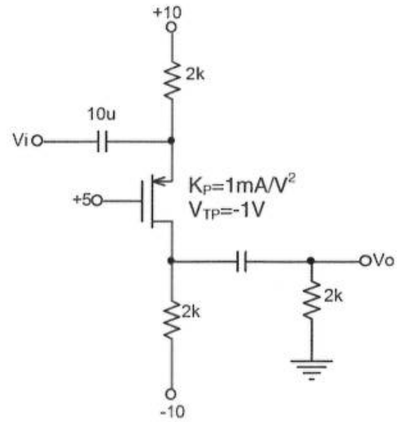
$$I_1 = \frac{1V}{2k} + g_m$$

$$R_{TH} = 2k || \frac{1}{g_m} = 348\Omega$$

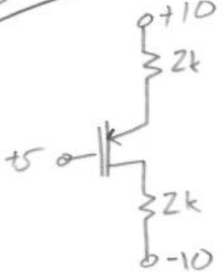
$$f_{m_1} = \frac{1}{2\pi(2k)(10nF)} = \underline{7.96kHz}$$

$$f_{m_2} = \frac{1}{2\pi(348)(10nF)} = \underline{45.7kHz}$$

4. For the common gate circuit below, determine the midband gain and the low frequency breakpoint. Assume the coupling capacitor on the output is very large.



DC



$5 = V_{SG} + 2k I_D$

$I_D = 1(V_{SG}-1)^2$

$5 = V_{SG} + 2(V_{SG}^2 - 2V_{SG} + 1)$

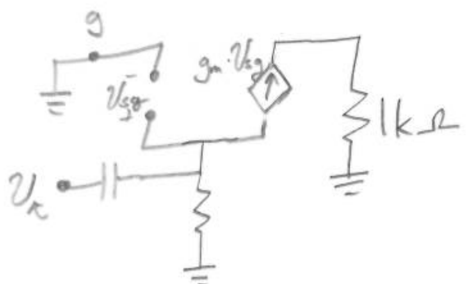
$2V_{SG}^2 - 3V_{SG} - 3 = 0$

$V_{SG} = -\cancel{0.686},\ 2.186$, $I_D = 1.41mA$

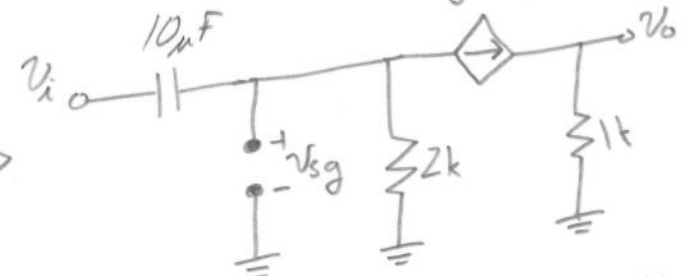
Small-Signal Model

$g_m = 2(1)(2.186-1) = 2.37\ mA/V$

AC circuit

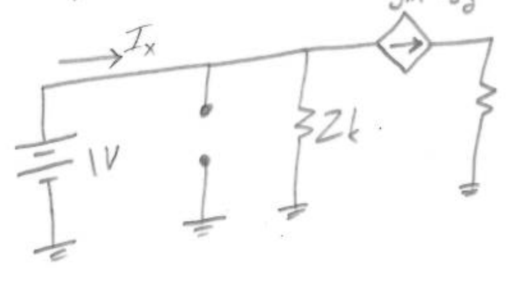


$\Rightarrow$



$v_o = 2.37(v_i)(1) = 2.37 \cdot v_i \Rightarrow A_v = 2.37$

R_{TH} from 10µF



$I_x = \frac{1V}{2k} + g_m$

$R_{TH} = 2k \| \frac{1}{g_m} = 348\Omega$

$\therefore f_L = \frac{1}{2\pi(348)(10\mu F)} = 45.7Hz$