ELEC 401 Chapter 7 Quiz, Fall 2014 Name *Key*

1. An N channel FET has the following parameters:
   K_n=2mA/V^2
   V_{TN}=0.5V
   λ=0V^{-1}
   C_{gd}=15fF
   C_{gs}=50fF

   If V_{GSQ}=1V, determine the unity gain bandwidth of the device.

$$g_m = 2K_n(V_{GSQ} - V_{TN}) = 2(2)(1-0.5) = 2\ mA/V$$

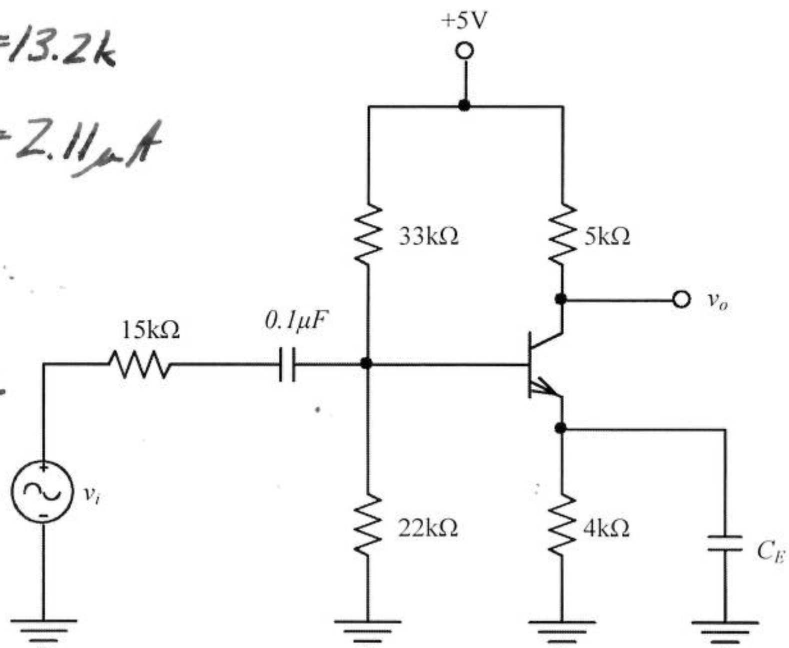
$$f_T = \frac{g_m}{2\pi(C_{gs}+C_{gd})} = \frac{2\times10^{-3}}{2\pi(65fF)} = \underline{4.90\ GHz}$$

With a 20kΩ load attached.

$$C_m = C_{gd}(1+g_m \cdot R_L) = 15fF(1+2(20)) = 15 \cdot 41 fF = \underline{615fF}$$

$$f_T = \frac{2\times10^{-3}}{2\pi(50+615)\times10^{-15}} = \underline{479\ MHz}$$

2. For the common-emitter circuit in the figure below, assume the emitter bypass capacitor C_E is very large, and the transistor parameters are: $\beta_o = 150$, $V_{BE}(\text{on}) = 0.7$ V, $V_A = \infty$, $C_\mu = 0.45$pF, and $f_T = 800$ MHz. Determine the mid-band gain and the lower and upper 3 dB frequencies for the small-signal voltage gain.



DC/ $5\cdot\frac{22}{55} = 2V$, $R = 13.2k$

$I_B = \frac{1.3}{13.2+4(151)} = 2.11\mu A$

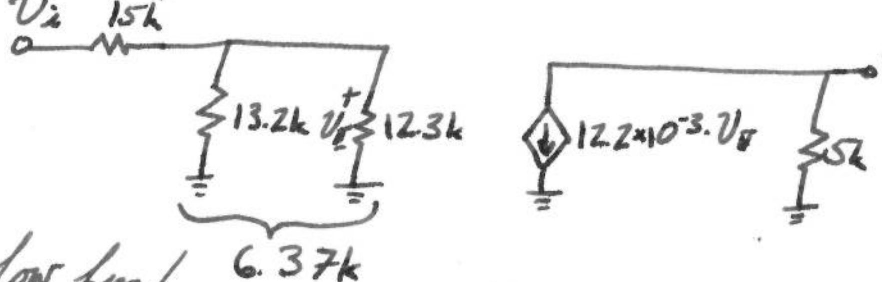
$I_C = 0.317 mA$

Model/

$r_\pi = \frac{150\cdot 26}{.317} = 12.3k\Omega$

$g_m = \frac{.317}{26} = 12.2 mA/V$

mid-band/



$V_\pi = V_i \cdot \frac{6.37}{21.37} = 0.298 V_i$

$V_o = 0.298 V_i \cdot 12.2 \cdot 5$

$V_o = 18.17 V_i$

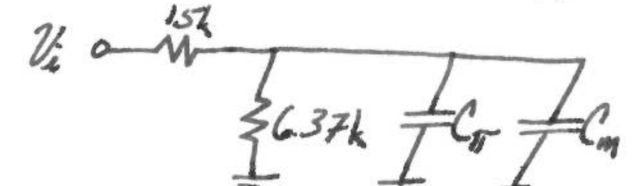
low freq/

$f_L = \frac{1}{2\pi \cdot 0.1\mu F \cdot R_{TH}} \Rightarrow R_{TH} = 15k + 6.37k = 21.37k\Omega$

$f_L = 74.5 Hz$

high freq/ $f_T = \frac{12.2\times10^{-3}}{2\pi\cdot(C_\mu + C_\pi)} \Rightarrow 800\times10^6 = \frac{12.2\times10^{-3}}{2\pi(0.45p + C_\pi)} \Rightarrow C_\pi = 1.98pF$

$\therefore C_m = C_\mu(1+12.2\times10^{-3}(5k)) = 0.45(62) = 27.5pF$



$f_{3dB} = \frac{1}{2\pi(15k\|6.37k)(27.5p+1.99p)} = 1.21MHz$