Sheet 5: Frequency Response

1) The high-frequency response of an amplifier is characterized by two poles at ω_{p1} and ω_{p2} For $\omega_{p1} = k\omega_{p2}$ find the value of k that results in the exact value of ω_H being $0.99\omega_{p1}$

2) A common source amplifier is designed to have a midband voltage gain of -29, the transistor has $C_{gs} = 0.5pF$ and $C_{gd} = 0.1pF$.
   i. Calculate the lamped capacitance at the input and output terminals
   ii. If the pole at the input terminal is the dominant pole, for what range of source resistances (R_s) can f_H exceed $10MHz$

3) A common source amplifier has $C_{gs} = 2pF$, $C_{gd} = 0.1pF$, $C_{db} = 0.2pF$, $C_L = 1.8pF$, $R_D = 5k\Omega$ and $g_m = 4mA/V$,
   i. Find A_M, f_H, and the gain bandwidth product
   ii. State whether the unity gain frequency is equal to the gain bandwidth product.
   iii. If R_D is changed to be $20k\Omega$, repeat parts (a) and (b).

4) A common gate amplifier is specified to have $C_{gs} = 2pF$, $C_{gd} = 0.1pF$, $C_{db} = 0.2pF$, $C_L = 1.8pF$, $R_D = 5k\Omega$ and $g_m = 4mA/V$ $R_s = 1k\Omega$, and $R_D = 20k\Omega$.
   i. Find the low-frequency gain (A_M)
   ii. Find the frequencies of the poles f_{P1} and f_{P2}, and hence an estimation for f_H.

5) Find the midband gain and an estimation of the 3dB frequency of a MOSFET cascode amplifier operated at $g_m = 1mA/V$ and $r_o = 50k\Omega$. The MOSFETs have $C_{gs} = 30fF$, $C_{gd} = 10fF$, and $C_{db} = C_{sb} = 10fF$. The amplifier is fed from a signal source with $R_s = 100k\Omega$ and is connected to a load resistance $R_L = 2M\Omega$. There is also a load capacitance $C_L = 40fF$.

6) A passive loaded differential amplifier is biased with a current source $I = 200\ \mu A$. The transistors have $W/L = 25$, $k_n' = 200\mu A/V^2$, $V_A = 200\ V$, $C_{gs} = 40fF$, $C_{gd} = 5fF$, and $C_{db} = 5fF$. The drain resistors are $20k\Omega$ each. Also, there is a $100fF$ capacitive load between each drain and ground.
   i. Find V_{ov} and g_m for each transistor.
   ii. Find the differential gain A_d.
   iii. If the frequency response is determined primarily by the output pole, estimate the $3dB$ frequency.
   iv. If the current source has $R_{SS} = 80k\Omega$ and $C_{SS} = 0.1pF$. Find the $3dB$ frequency of the $CMRR$.

7) An active loaded differential amplifier is biased with a current source $I = 0.2mA$. All the transistors are operating at $|V_{OV}| = 0.2V$. The Early voltage for all the transistors is $|V_A| = 10V$. The total capacitance at the input node of the mirror is $0.1pF$ and that at the output node of the amplifier is $0.2pF$.
   i. Find the Midband differential gain A_M
   ii. Find the frequencies of the poles and the zero of $A_d(s)$.