1. The amplifier in the figure below is biased to operate at $g_m = 1 \text{mA/V}$. Neglecting $r_o$, find the midband gain. Find the value of $C_s$ that places $f_L$ at 20 Hz.

![Amplifier Circuit Diagram](image)

2. The NMOS transistor in the discrete CS amplifier circuit shown below is biased to have $g_m = 5 \text{mA/V}$. Find $A_M, f_{p1}, f_{p2}, f_{p3}, \text{and } f_L$.

![CMOS Amplifier Circuit Diagram](image)

Ignore parasitic capacitances of the transistor and assume $r_o$ to be sufficiently large.

**Hint:** The resistance seen by $C_s = 10 \mu F$ is approximately $2k \Omega \parallel \frac{1}{g_m}$. 
3. A discrete MOSFET common-source amplifier has $R_G = 1M\Omega$, $g_m = 5mA/V$, $r_o = 100k\Omega$, $R_D = 10k\Omega$, $C_{gs} = 2pF$, and $C_{gd} = 0.4pF$. The amplifier is fed from a voltage source with an internal resistance of $500k\Omega$ and is connected to a $10k\Omega$ load. Find:

a) The overall midband gain $A_M$

b) The upper 3-dB frequency $f_H$

Refer large and small signal circuits to Figs a and b. In Fig a, $C_{c1}, C_{c2}, \text{and } C_5$ are short circuited in mid and high frequency bands.

Hint: In part b), find $f_H$ using Miller’s theorem.
4. The analysis of the high-frequency response of the common-source amplifier is based on the assumption that the resistance of the signal source, $R_{sig}$, is large and, thus, that its interaction with the input capacitance, $C_{in}$ produces the ‘dominant pole’ that determines the upper 3-dB frequency $f_H$. In some situations, however, the CS amplifier is fed with a very low $R_{sig}$. To investigate the high-frequency response of the amplifier in such a case, the figure below shows the equivalent circuit when the CS amplifier is fed with an ideal voltage source $V_{sig}$ having $R_{sig} = 0$. Note that $C_L$ denotes the total capacitance at the output node. By writing a node equation at the output, show that the transfer function $V_o/V_{sig}$ is given by

$$\frac{V_o}{V_{sig}} = -g_m R_L' \frac{1 - s \left( \frac{C_{gd}}{g_m} \right)}{1 + s (C_L + C_{gd}) R_L'}$$

At frequencies $\omega = \left( \frac{g_m}{C_{gd}} \right)$, the s term in the numerator can be neglected. In such case, what is the upper 3-dB frequency resulting?Compute the values of $A_M$ and $f_H$ for the case: $C_{gd} = 0.4 \text{ pF}$, $C_L = 2\text{ pF}$, $g_m = 5mA/V$, and $R_L' = 5k\Omega$. 

![Equivalent Circuit Diagram]
5. Consider the common-emitter amplifier in the following figure, with \( \beta = 100, V_A = 100V, C_n = 25fF, C_\mu = 10fF \).

a) Draw the small-signal model of this circuit. Apply Miller’s theorem to split \( C_\mu \) to input and output nodes. Calculate the time constants at the input and output nodes, \( \tau_{in} \) and \( \tau_{out} \).

b) Based on the time constants from part a), calculate the input and output pole frequencies, \( f_{in} \) and \( f_{out} \). What is the dominant pole of this amplifier?