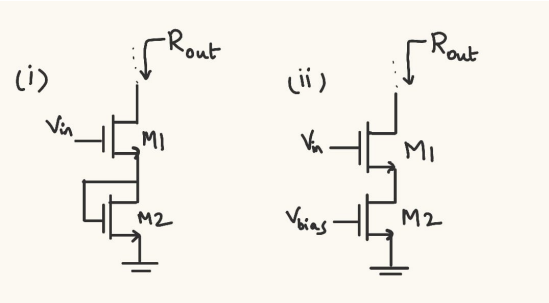
AEC Assignment 4

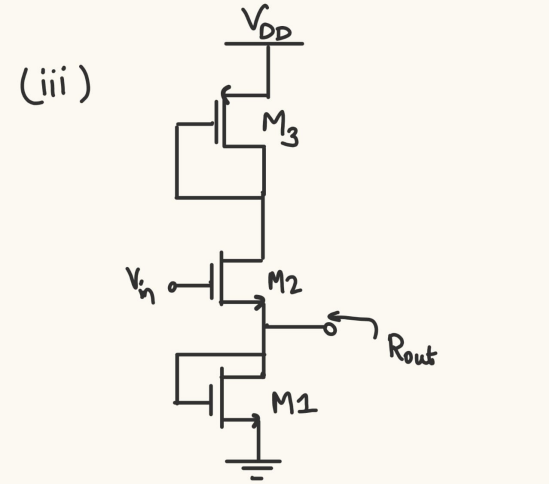
MOSFET Amplifier Design and Analysis

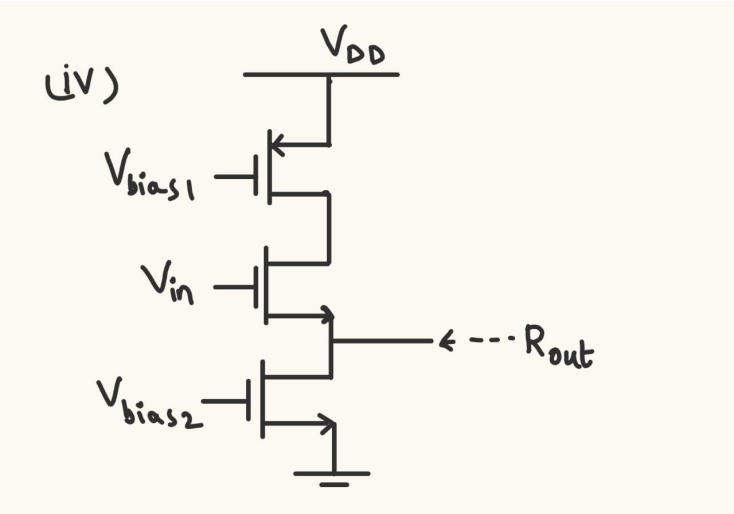
April 17, 2025

Question 1: Output Impedence

Find the output impedance for the following circuits:

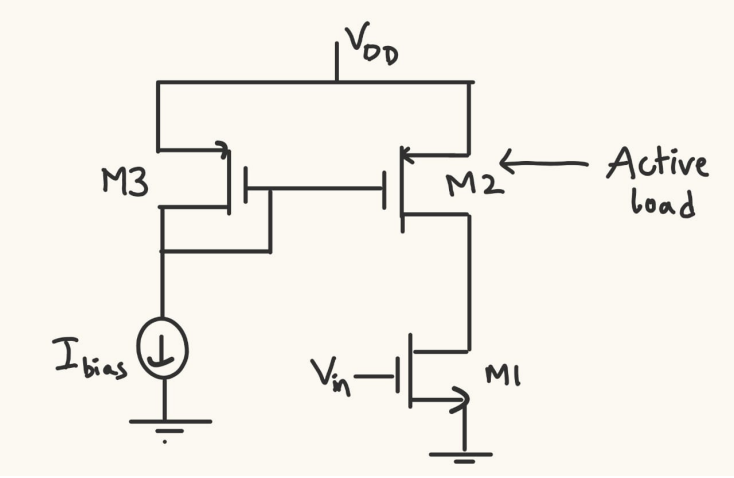






Question 2: PMOS CS Amplifier

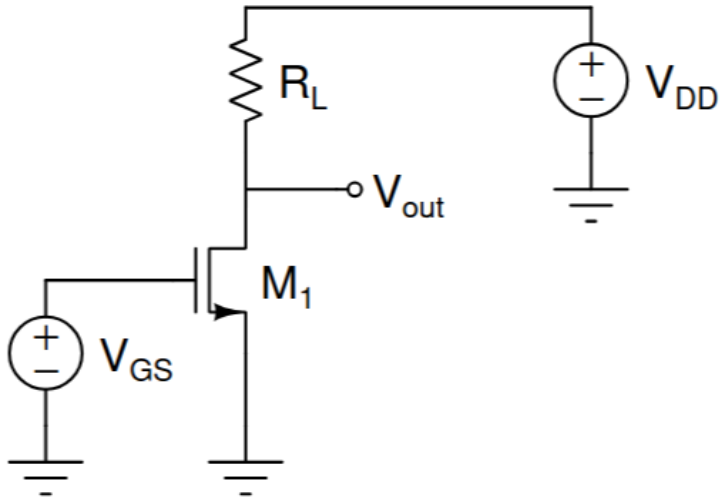
Draw the schematic of a PMOS common-source amplifier with NMOS current mirror active load. If it is designed using the same bias currents and the same size transistors as the NMOS common-source amplifier in the figure below, which is likely to have the higher gain? Why?



Question 3: Amplifier Diesgn 1

(a) From simple MOS models discussed in class, find out V_T, $\mu_n C_{OX}$ for NMOS and PMOS devices ($\frac{W}{L} = \frac{1\mu}{1\mu}$), with the help of I_D vs V_{GS} simulations.

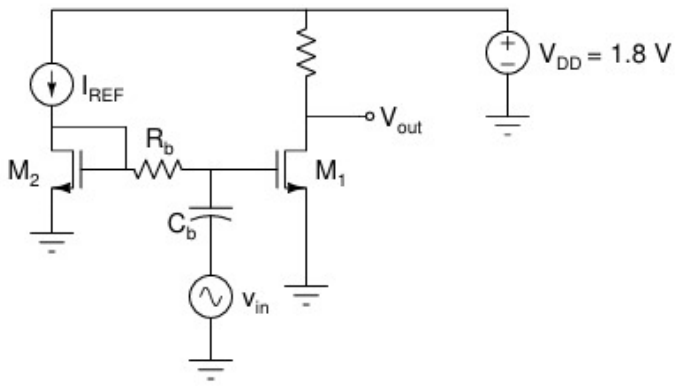
(b) Consider the amplifier shown in Figure below. It is given that $\frac{W}{L} = \frac{1\mu}{1\mu}$, $V_{DD} = 1V$, and $R_L = 5k\Omega$. Sweep V_{GS} from V_T (calculated earlier) to V_{DD} in steps of 0.01V and plot the g_m vs V_{GS}. Clearly mark the regions of MOSFET operation on the curve. What is the maximum value of g_m and the corresponding V_{GS} value?



(c) Plot g_m vs V_{GS} for $\frac{W}{L} = \frac{5\mu}{1\mu}$. As compared to the previous case, which amplifier parameters (gain, swing, bandwidth) gets affected? Discuss the trade offs.

Question 4: Amplifier Design 2

Design a common source amplifier (shown in below Figure) with a resistive load of 15 $k\Omega$ for a voltage gain ≥ 10 and an overdrive voltage (of input transistor) of 200 mV. The minimum input signal frequency is 100 Hz. Design for the minimum power consumption. Clearly write your assumptions (if any).



(a) Show the design procedure with calculations for sizes of transistors, I_{REF} , C_b and R_b. What will happen if we increase or decrease them by 10%. Determine the overall power consumption. Mention reason clearly from the observed simulations before and after the changes. (Change only one parameter at at time keeping the other two as obtained fom the calculations).

(b) Give the transient (4-5 cycles) simulations plots showing the gain and considering $v_{in} = 10sin(2\pi(1000)t)mV$.

(c) Show the AC response plots ($20log|Av|$ vs frequency) and find unity bandwidth frequency(f_u). Vary the frequency from 1 Hz to 1 GHz for AC simulations.