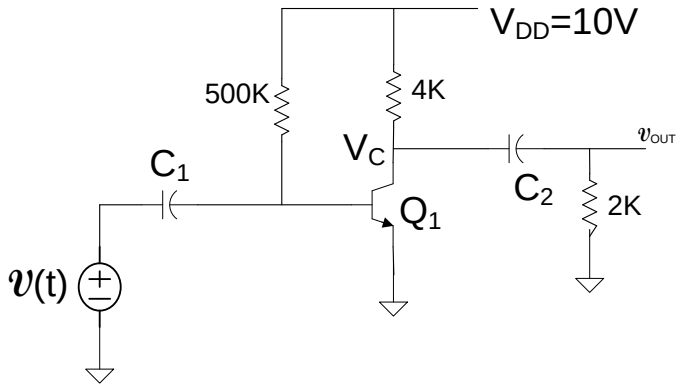
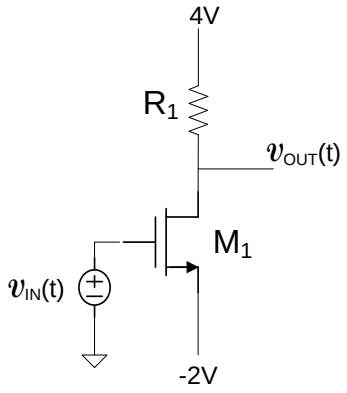
EE 330
Homework 8
Fall 2018
Due Friday October 12

Solve Problem 12 and any 8 of the remaining problems. Each problem is worth 10 points except Problem 12 which is worth 20 points. Unless stated to the contrary, assume all MOS transistors have model parameters $\mu_n C_{OX}=300\mu A/V^2$, $V_{Tn}=0.5V$, $\mu_n/\mu_p=4$, $V_{Tp}=-0.5V$, $C_{OX}=4fF/\mu^2$, $\lambda = 0$, $\gamma = 0$, and all BJT transistors have model parameters $J_SA= 10^{-12}A$, $\beta n=100$, and , $\beta p=30$.

Problem 1 Assume the capacitors are very large. Determine the quiescent value of V_C and V_{OUT}

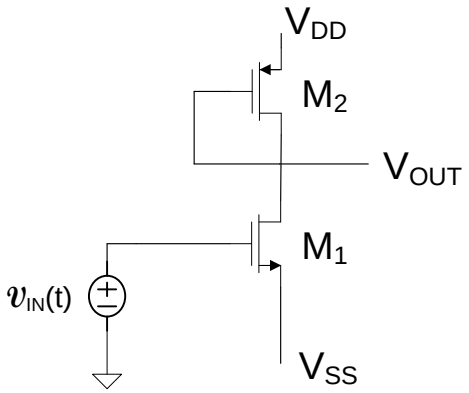


Problem 2 Determine the maximum value of R_1 that will keep M_1 in saturation. M_1 has dimensions W=12u and L=2u.

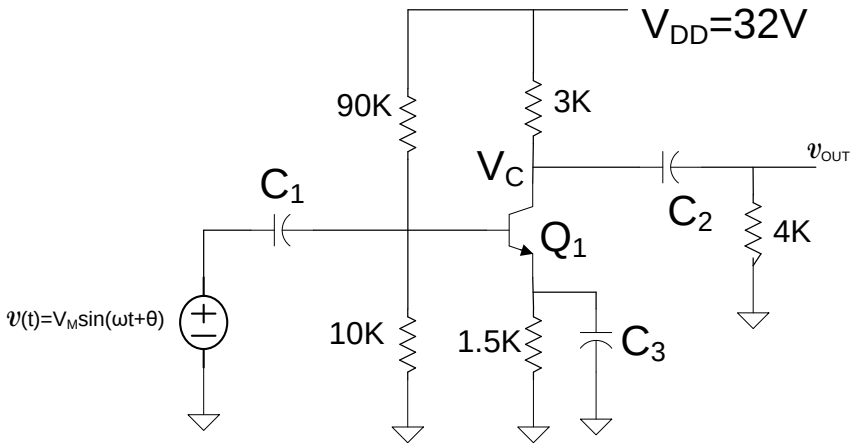


Problem 3 Determine the small-signal voltage gain of the circuit in the previous problem if the value of R_1 is ½ the value needed to keep M_1 in saturation

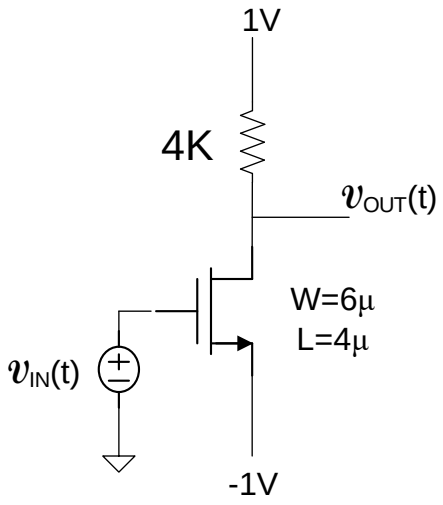
Problem 4 Consider the following circuit. Determine the quiescent output voltage if V_{DD}=1V, V_{SS}=-1V, W_1=10u, L_1=2u, W_2=50u and L_2=1u. Assume the magnitude of the input is arbitrarily small.



Problem 5 Assume the capacitors are all very large. Determine the quiescent value of V_C and V_{OUT}



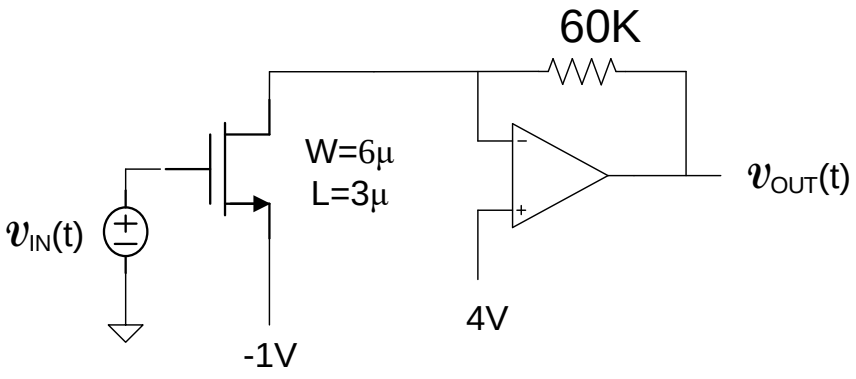
Problem 6 Obtain the quiescent output voltage



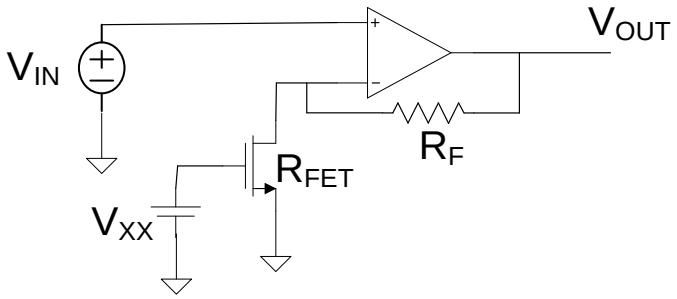
Problem 7

a) Determine the quiescent output voltage

b) If the input is a 1KHz square wave with high and low values of 0V and 25mV, determine the output voltage



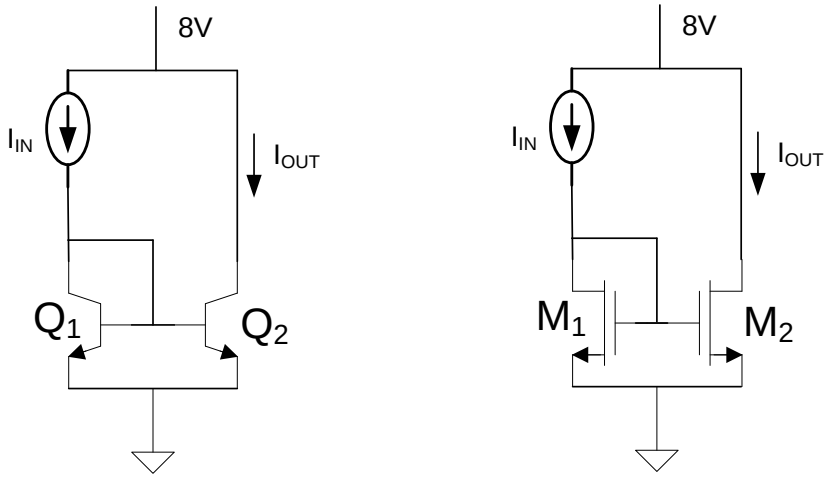
Problem 8 Assume V_{IN} is a low frequency sinusoidal waveform given by the expression V_{IN}=.025sin1000t and assume that W=4μm, L=1μm for the MOSFET. The output voltage of this circuit should be a sinusoidal waveform of the same frequency as the input. Define the voltage gain to be the ratio of the p-p value of the output sinusoidal signal to the p-p value of the sinusoidal input signal. With this definition of gain, determine the voltage gain of this circuit if V_{XX}=1V.



Problem 9 Consider the two circuits shown.

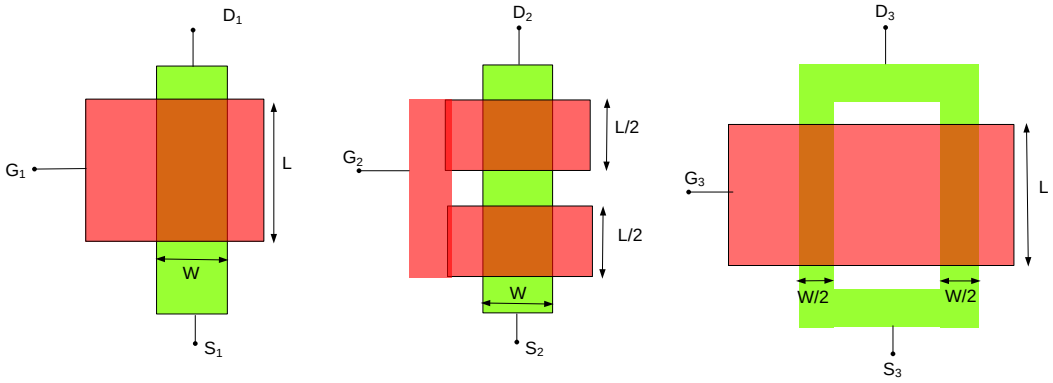
a) Determine the output current for the bipolar circuit if A_{E1}=300u^2 and A_{E2}=1200u^2 and I_{IN}=1mA.. Assume β is very large.

b) Determine the output current for the MOS circuit if W_1/L_1=10 and W_2/L_2=20 and I_{IN}=1mA.



Problem 10 Express the output current for the bipolar circuit in terms of the input current and the emitter areas for the circuit of Problem 9. Assume β is very large. Also express the output current for the MOS circuit in terms of the input current and the "W/L" ratios for the circuit of Problem 9. What conclusion can be drawn about the relative performance between these two circuits?

Problem 11 Three devices are shown. The color green is used to denote n-active and the red denotes polysilicon. Relative device dimensions are as indicated. Make a comparison of the performance of these structures.



Problem 12 (Counts as 2 problems) Using the adders, gates, flip-flops, etc. from past homework assignments to create the following consisting of three registers, two holding the inputs A and B, and one holding the output S. When the select bit for the MUX is high send $\mathrm{ADD}(A, B)$ to the output, when the select bit is low send $\mathrm{AND}(A, B)$ to the output.