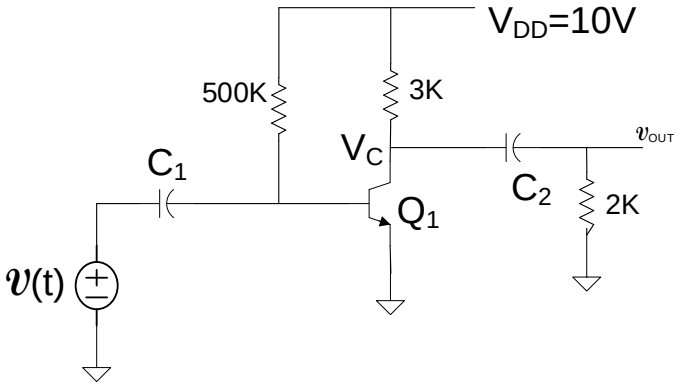
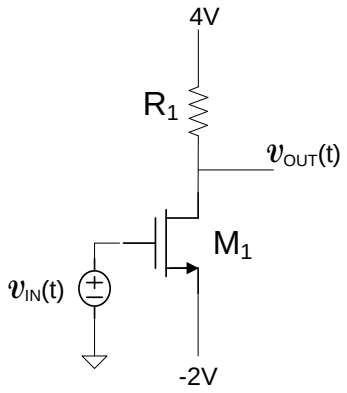
EE 330
Homework 8
Fall 2019
Due Friday October 18

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}

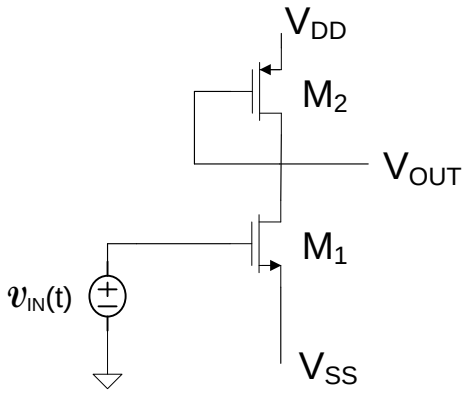


Problem 2 Determine the maximum value of R_1 that will keep M_1 in saturation. M_1 has dimensions W=8u and L=2u.

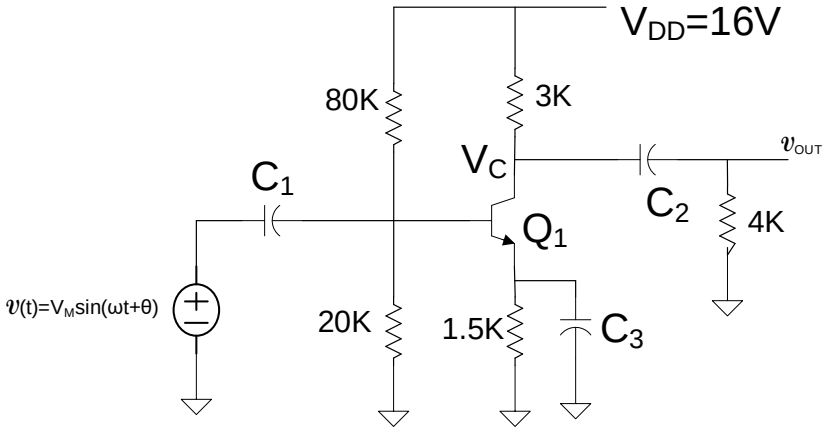


Problem 3 Determine the small-signal voltage gain of the circuit in the previous problem if the value of R_1 is ½ the value needed to keep M_1 in saturation

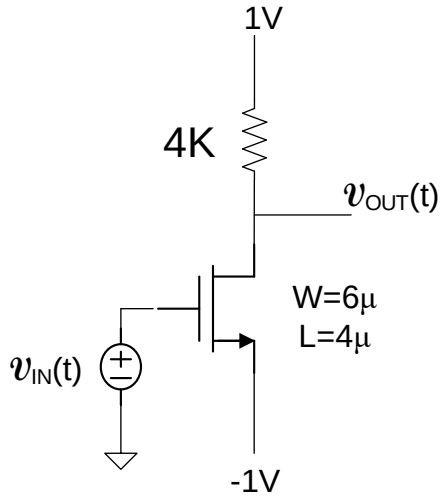
Problem 4 Consider the following circuit. Determine the quiescent output voltage if V_{DD}=1V, V_{SS}=-1V, W_1=8u, L_1=2u, W_2=50u and L_2=1u. Assume the magnitude of the input is arbitrarily small.



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



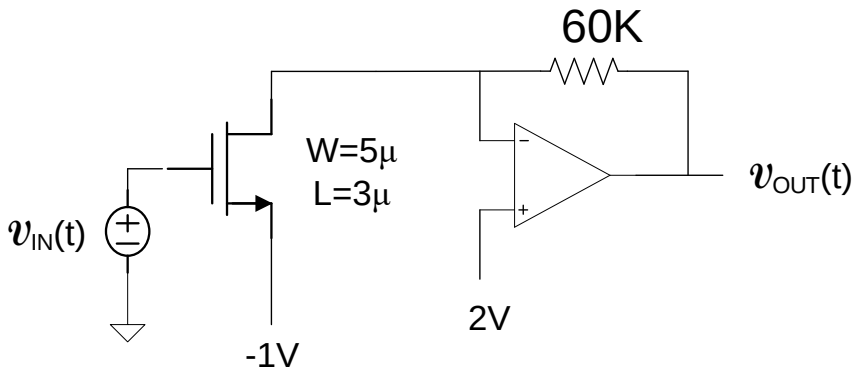
Problem 6 Obtain the quiescent output voltage



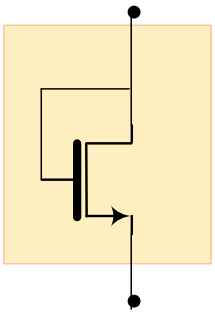
Problem 7

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



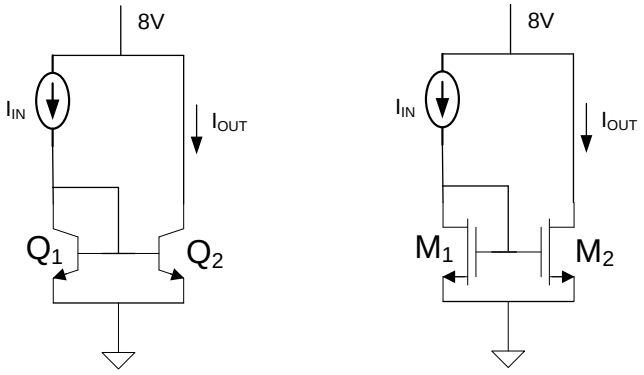
Problem 8 The circuit shown has been proposed as a rectifier. Compare the dc performance of this circuit to that of the pn junction. Does it behave as a rectifier?



Problem 9 Consider the two circuits shown.

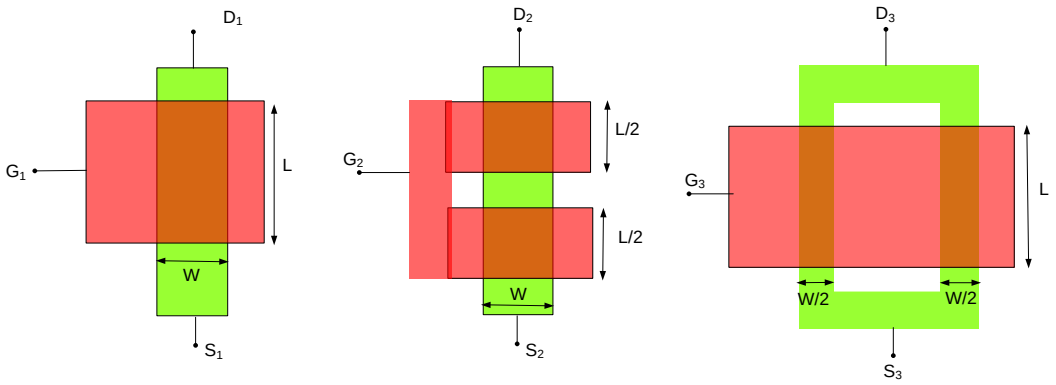
a) Determine the output current for the bipolar circuit if $A_{E1}=300u^2$ and $A_{E2}=600u^2$ and $I_{IN}=1mA$.. Assume β is very large.

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 Using Modelsim, create a Clock Divider with the D Flip-Flop you made for the last homework and a 2-1 Multiplexor. The inputs should be a Clock with a frequency of 1MHz, a reset, and one select bit. The output should be a new Clock signal with a frequency of 500kHz when SEL=0 or 250kHZ when SEL=1. If the reset is high, the output should be low, and vice versa. Create a test bench to verify that your Clock Divider functions properly for all input states. Include screenshots of your Verilog code and simulation waveforms. Please create your own code and testbench. Do not turn in the same screenshots another student is using.