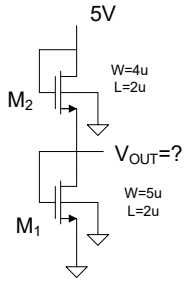
EE 330
Homework 8
Spring 2024
Due Wednesday March 6 at noon (no late submissions this week)

Unless stated to the contrary, assume all MOS transistors have model parameters $\mu_n C_{OX}$=100μA/V^2, V_{Tn}=0.75V, μ_n/μ_p =3, V_{Tp}=-0.75V, C_{OX}=4fF/μ^2 , $\lambda = 0, \gamma = 0$ and all BJT transistors have model parameters J_s= 10^{-15} A, β_n=100 , and , β_p=30.

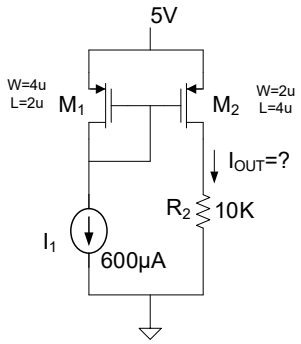
Problem 1

Find V_{OUT} in the following circuit.



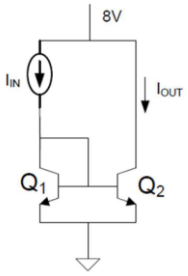
Problem 2

Find I_{OUT} in the following circuit.



Problem 3

Determine the output current, I_{OUT}, of the below circuit if $A_{E1} = 100\mu m^2$, $A_{E2} = 600\mu m^2$, and $I_{IN} = 1mA$.

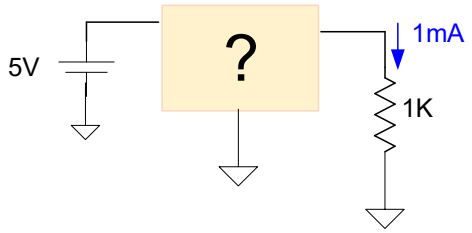


Problem 4

Design a circuit that has an output voltage of 2.0V relative to ground. You have available any number of MOS transistors of any size and one 5V dc voltage source.

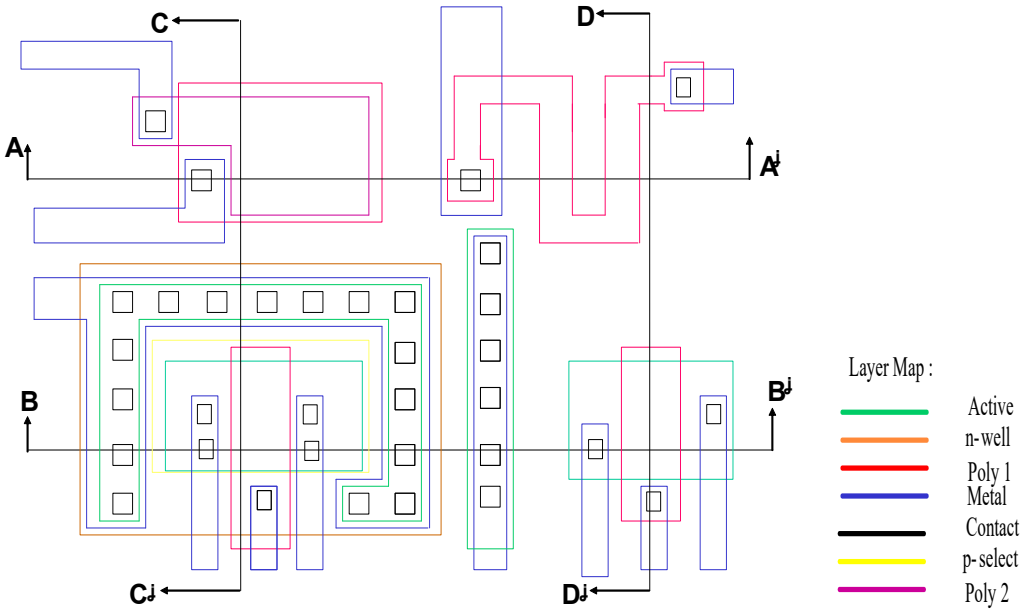
Problem 5

Design a circuit that will force a current of 1mA into a 1K resistor with one terminal of the resistor connected to ground. For your design you have available one 5V dc power supply, any number of MOS transistors of any size, and the single 1K resistor shown.



Problem 6

Sketch a cross-sectional view along the BB' cross-section for the CMOS layout shown below. Assume a basic CMOS process in which the n-select mask is generated from the compliment of the p-select mask.



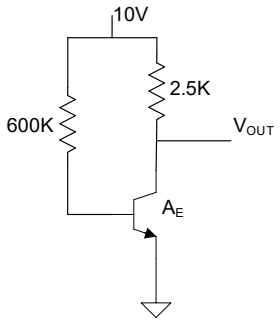
Problem 7

Sketch a cross-sectional view for the DD' cross-section for the CMOS layout given in the previous problem. Assume a basic CMOS process in which the n-select mask is generated from the compliment of the p-select mask.

Problem 8

Consider the following circuit that was designed to have a fixed output voltage when the transistor has an emitter area if $A_E=200\mu^2$ and $\beta=200$.

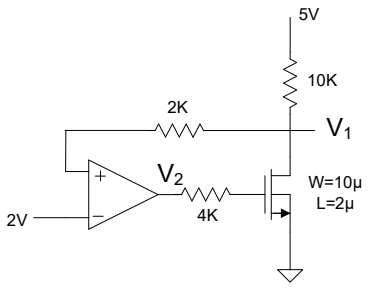
a) What is the desired output voltage?
b) How much will that output voltage change if the β of the transistor drops to 50?
c) How much will that output voltage change if A_E is reduced to 100 μ^2
d) How much will that output voltage change if the process parameter J_S decreases by 50%?



Problem 9

Assume the op amp in the following circuit is ideal.

a) Determine the voltage V_1
b) Determine the voltage V_2



Problem 10

Determine the maximum value of R_1 that will keep M_1 in saturation. M_1 has dimensions W=6μ and L=3μ and is in a process with μ_nC_{OX} = 350μA/V², μ_pC_{OX} = 70μA/V², V_{Tn} = 0.5V, V_{Tp}= -0.5V, C_{OX}=8fF/μ², λ = 0, and $\gamma = 0$. Assume v_{IN} (t) is very small.