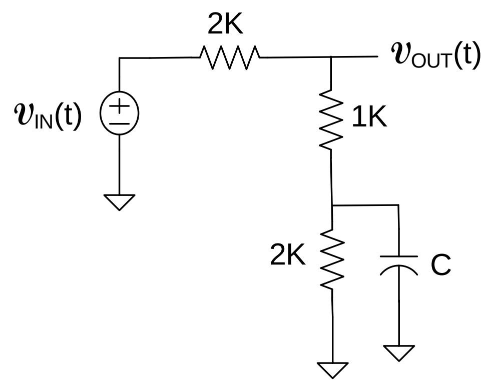
EE 330
Homework 9
Spring 2024
Due Friday March 22 at noon.

Unless specified to the contrary, assume all n-channel MOS transistors have model parameters $\mu_n C_{OX} = 100\mu A/V^2$ and $V_{Tn} = 0.75V$, all p-channel transistors have model parameters $\mu_p C_{OX} = 33\mu A/V^2$ and $V_{Tp} = -0.75V$. Correspondingly, assume all npn BJT transistors have model parameters $J_S = 10^{-14} A/\mu^2$ and $\beta=100$ and all pnp BJT transistors have model parameters $J_S = 10^{-14} A/\mu^2$ and $\beta = 25$. If the emitter area of a transistor is not given, assume it is $100\mu^2$. Assume all diodes are characterized by the model parameters $J_{SX}=0.5A/\mu m^2$, $V_{G0}=1.17V$, and m=2.3.

Problem 1

Assume the capacitor C is very large.

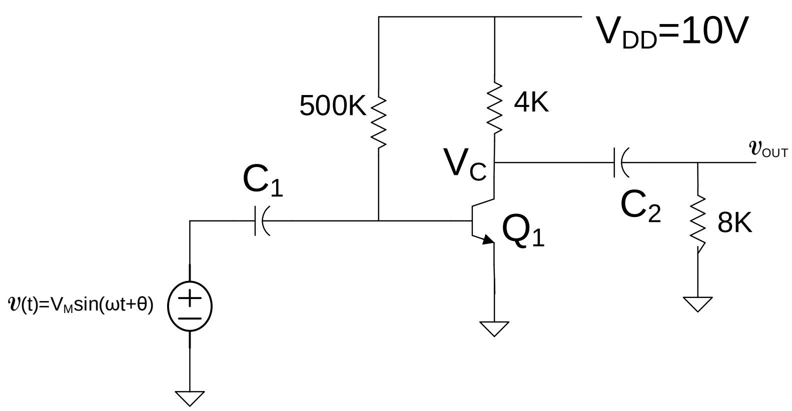
a) Draw the small-signal equivalent circuit
b) Determine the quiescent output voltage
c) Determine the small-signal voltage gain.
d) Determine the output voltage if $v_{IN}(t)=2\sin 500t$



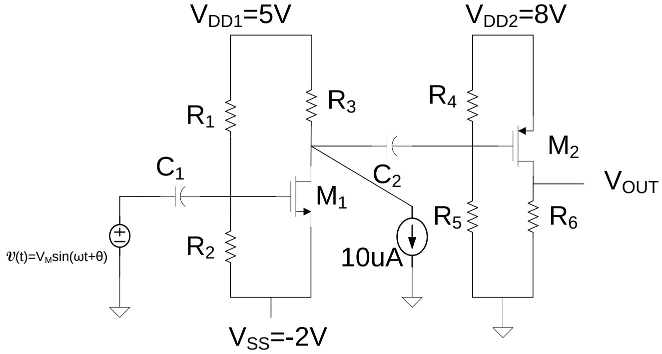
Problem 2

Assume the capacitors are very large and V_M is small.

a) Draw the small signal equivalent circuit for the amplifier shown
b) Determine the quiescent value of V_C and V_{OUT}



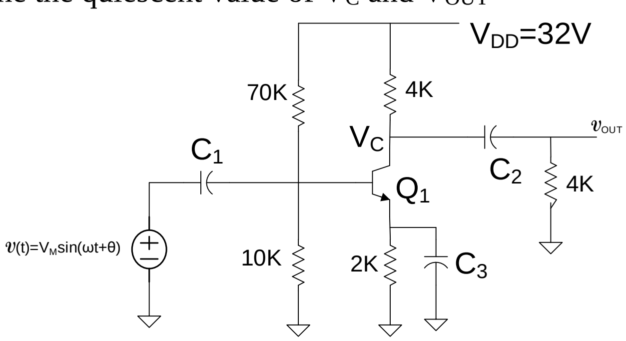
Problem 3 Obtain the small signal equivalent circuit for the following network. Assume the transistors are operating in the saturation region, all capacitors are large, and V_M is small. You need not solve the circuit.



Problem 4 Assume the capacitors are all very large and V_m is small.

a) Draw the small signal equivalent circuit for the amplifier shown

b) Determine the quiescent value of V_C and V_{OUT}



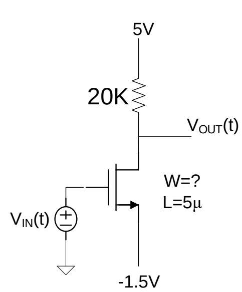
Problem 5 Consider the following circuit

a) Determine the width W so that the quiescent drain current is 0.1mA

b) Draw the small-signal equivalent circuit

c) With the drain current specified in part a), determine the small-signal voltage gain (do not use small-signal device models to solve this part of the problem)

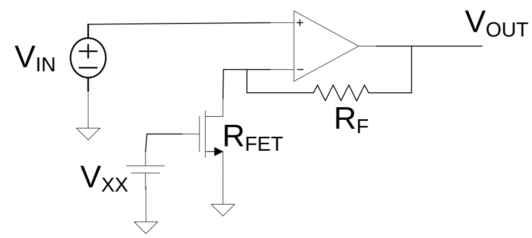
d) Determine the THD if the input is a 1KHz sinusoidal signal of amplitude 200mV 0-p



Problem 6 Assume V_{IN} is a low frequency nearly sinusoidal waveform that is below 10mV 0-P and that W=12µm, L=1µm for the MOSFET.

a) Determine the voltage gain of this circuit if V_{XX}=2.5V.

b) How does the voltage gain change if V_{XX} is swept between 1.5V and 4V?



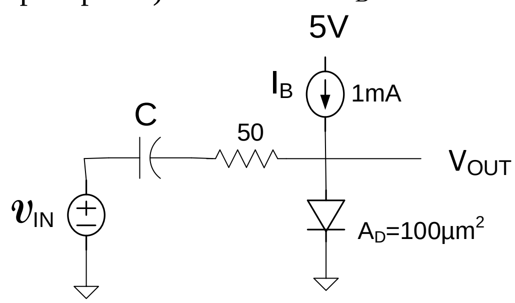
Problem 7 Consider the following circuit operating at T=300K. Assume the capacitor C is very large and the v_{IN} is a small-signal input.

a) Determine the quiescent output voltage.

b) Draw the small-signal equivalent circuit

c) Determine the small-signal voltage gain from the input to the output.

d) Repeat part c) if the current I_B is increased to 5mA



Problem 8 Consider the following circuit operating at T=300K. Assume v_{IN} is a small-signal voltage source.

a) Draw the small-signal equivalent circuit

b) If the voltage V_{BB} is adjusted so that the quiescent diode current is 1mA, determine the small signal voltage gain $A_V = \frac{v_{OUT}}{v_{IN}}$

c) Repeat part b) if V_{BB} is adjusted so that the quiescent diode current is 10mA