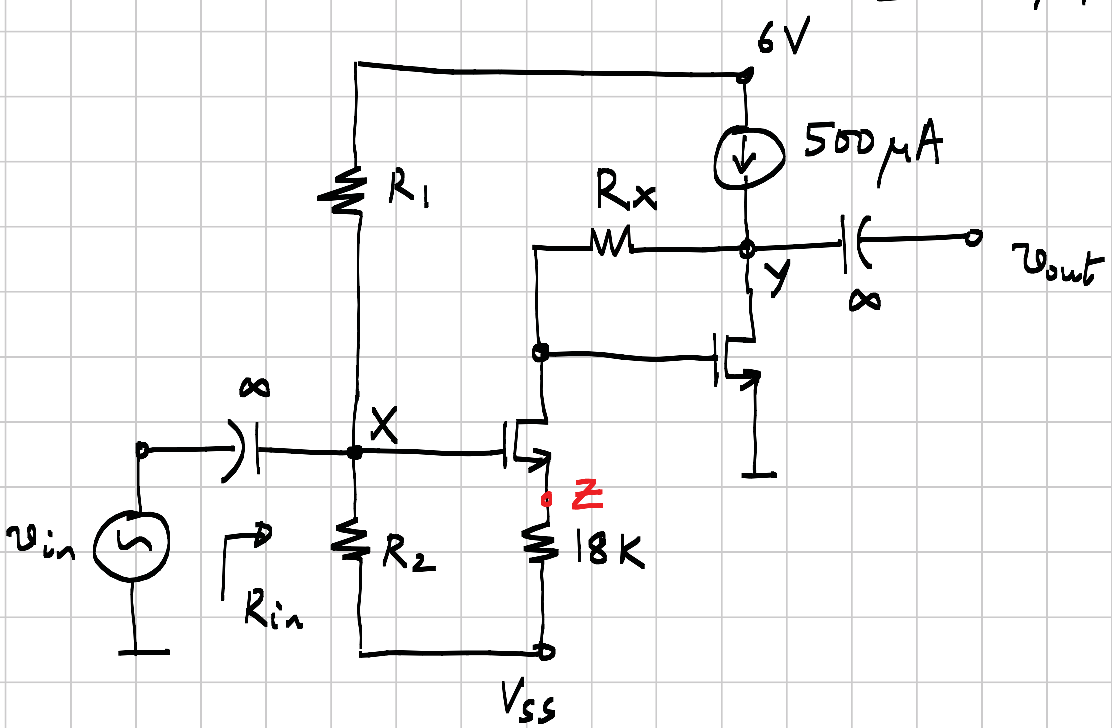
EE5310/EE3002: Analog Circuits
Tutorial 4

Note

Problem 1

* For this problem, both transistors are identical, with $V_T = 0.5\,V$, $\lambda = 0$, $\mu_n C_{ox} \frac{W}{L} = 500\mu A/V^2$.



The quiescent currents through both transistors are equal. Determine R_x, V_{ss}, R_1 & R_2 so that

(a) v_{in} can be coupled without using C_1

(b) $R_{in} = 1\,M\Omega$

(c) $\frac{v_{out}}{v_{in}} = 2$, after accounting for finite g_m of the transistors

After determining the values above, find the quiescent voltage at node Y and the maximum sinusoidal amplitude one can use at the input so that the output is not distorted.

Now, an infinite capacitor is connected from node Z to ground. What is $\frac{v_{out}}{v_{in}}$ now?

Problem 2

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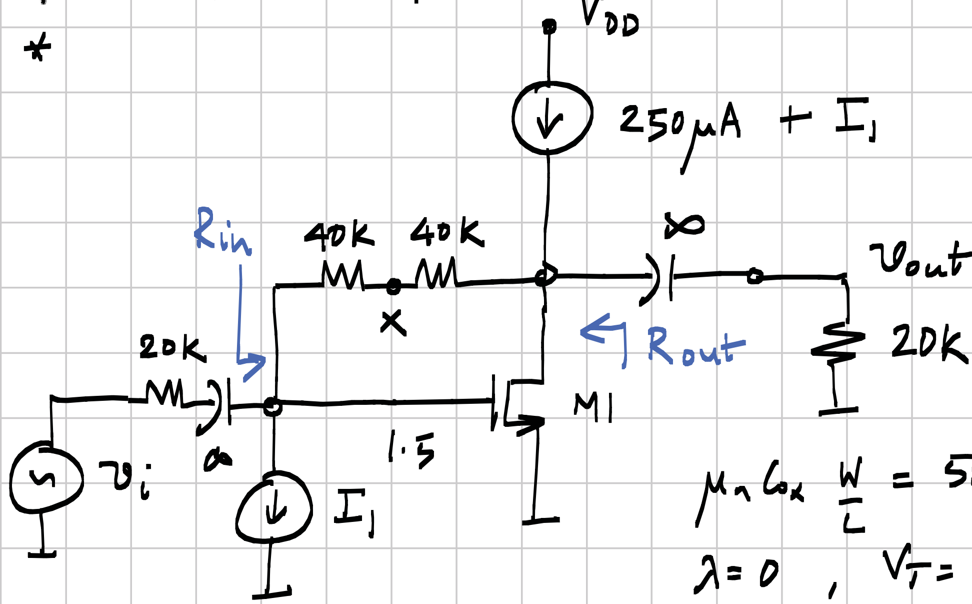


$\mu_n C_{ox} \frac{W}{L} = 500\mu A/V^2$

$\lambda = 0$, $V_T = 0.5V$

(a) Determine the quiescent current of M1.

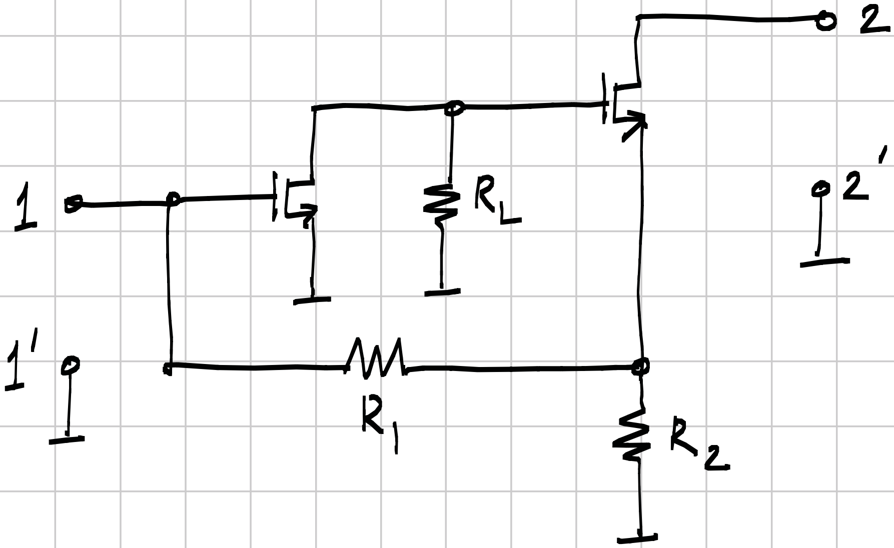
(b) Assuming large g_m, what gain do you expect from v_{in} to v_{out}? What is the actual gain?

(c) Determine the input & output impedances R_{in} & R_{out}.

(d) Determine I_1 so that the output sinusoid just clips at both extremes for an input amplitude of 1 V. For this part, assume g_m is very large.

(e) An infinite capacitor is now connected between the node marked X and ground. Determine the incremental gain from v_i to v_{out}.

* Problem 3



The circuit above is the incremental equivalent of an amplifier. The transistors have transconductances denoted by g_m.

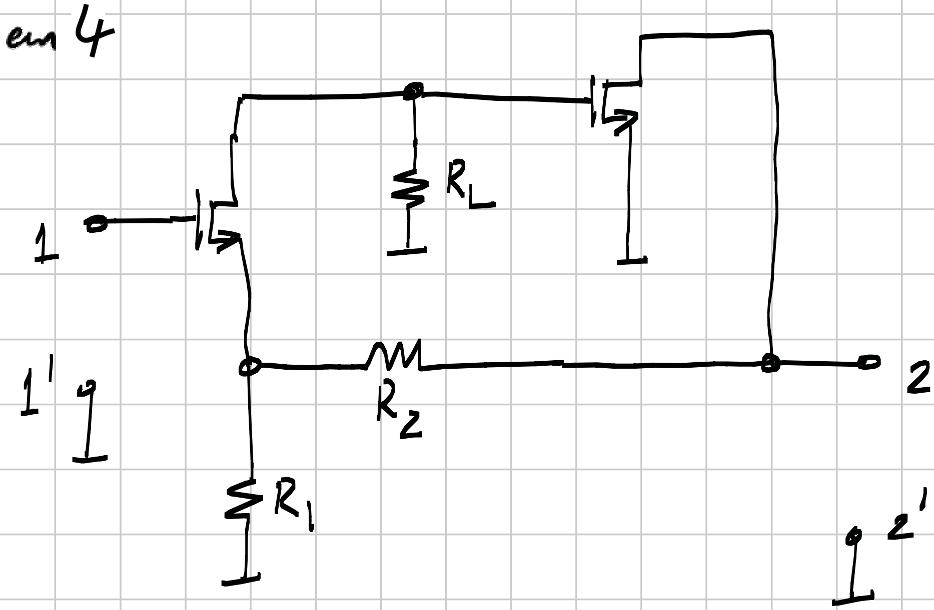
(a) Determine the input impedance @ port 1 when port 2 is shorted.

(b) Determine the output impedance @ port 2 when port 1 is shorted.

(c) What kind of controlled source is this?

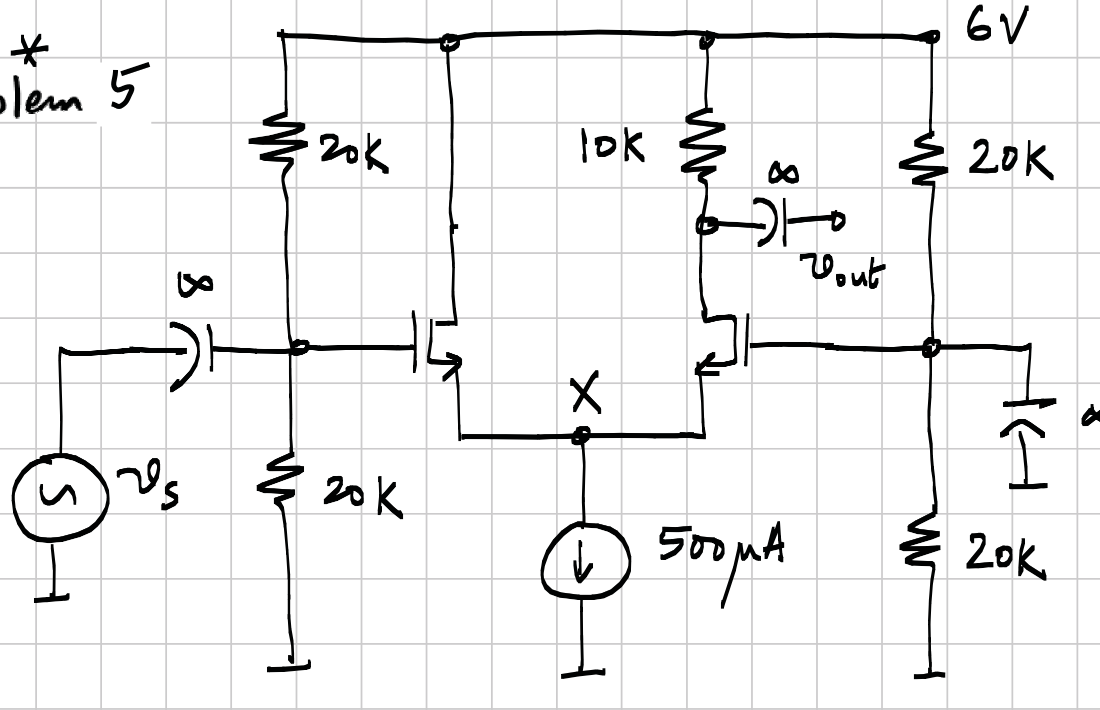
(d) If $g_m \to \infty$, determine the transfer function of the above controlled source.

* Problem 4



Repeat the previous problem for the incremental circuit shown above.

* Problem 5



$V_T = 0.5\,V \qquad \mu_n C_{ox} \frac{W}{L} = 500\,\mu A/V^2$

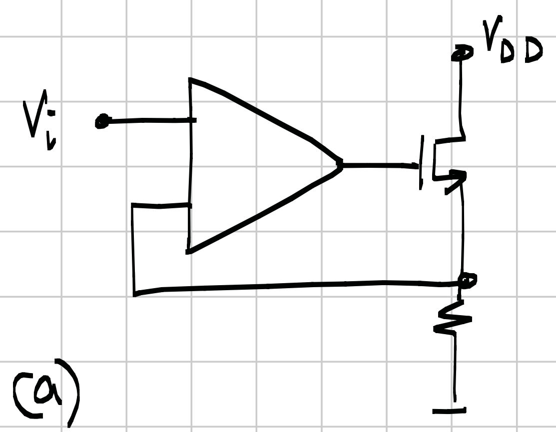
$\lambda = 0$

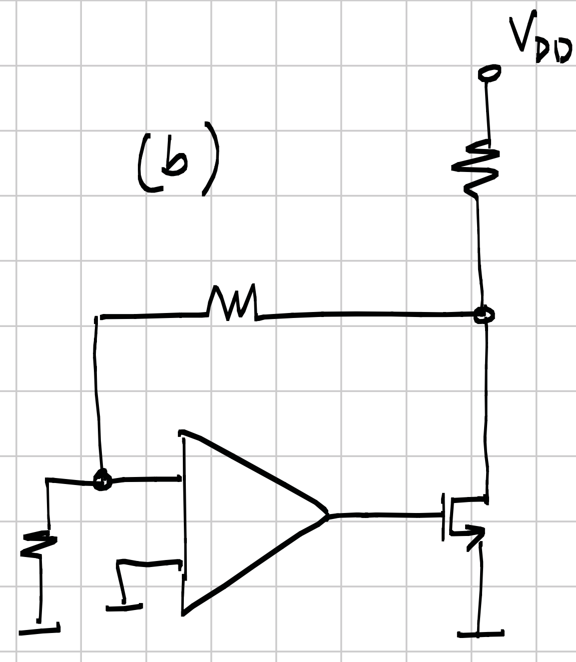
In the circuit above

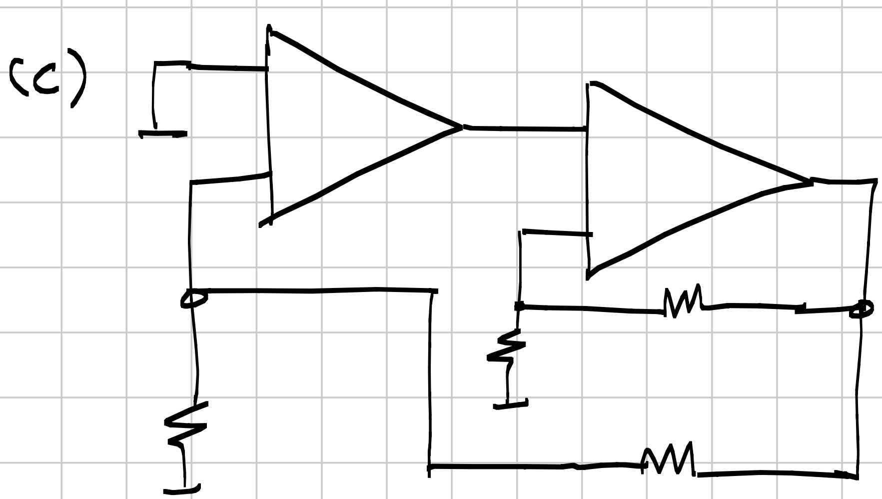
(a) Find the operating point.

(b) The incremental gain v_{out}/v_s.

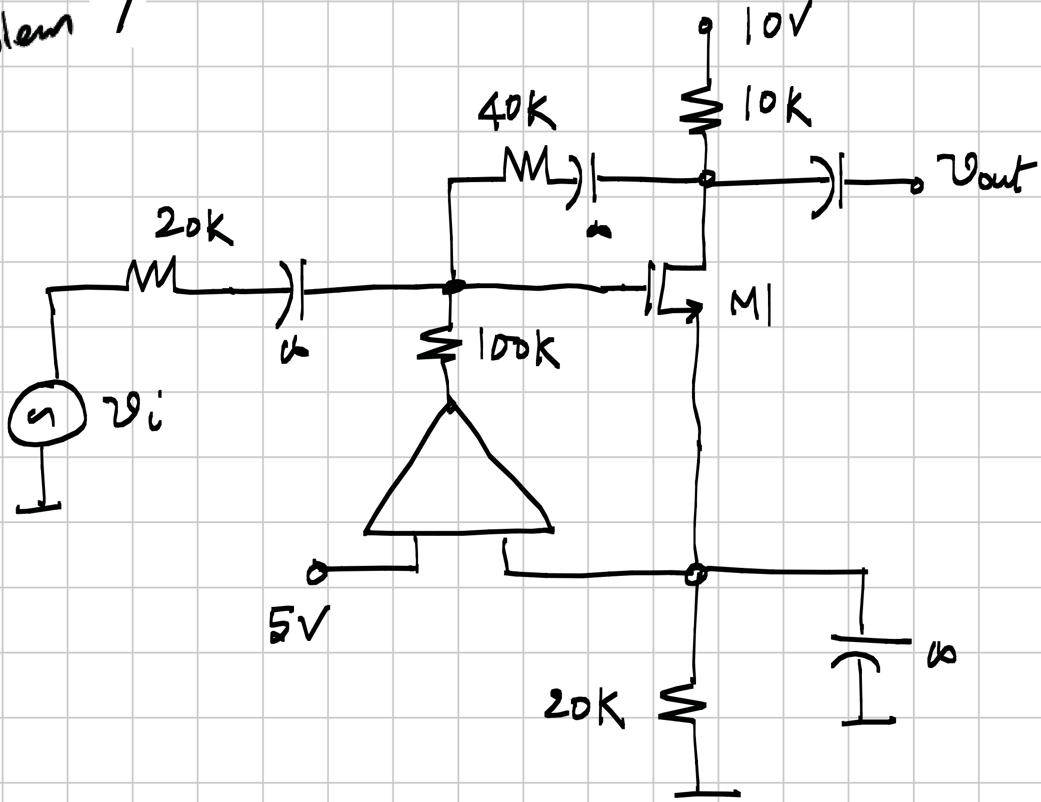
Prob 6* Determine the signs on the opamps for negative feedback operation.







* Problem 7

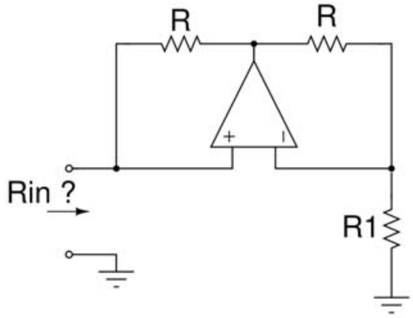


(a) Determine the signs on the opamp for negative feedback operation

(b) Determine the quiescent potential @ the gate of M1.

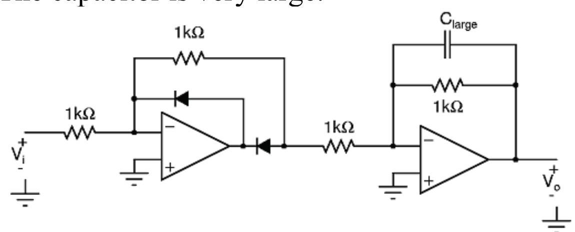
(c) What is the incremental gain $\frac{v_{out}}{v_i}$?

8) The opamp in the circuit shown below is ideal. Determine Rin.



Circuit for Problem 8

9) In the circuit shown below, the input voltage V_i = 5V + 2π cos(2π·(1kHz)·t); Determine V_o. The capacitor is very large.

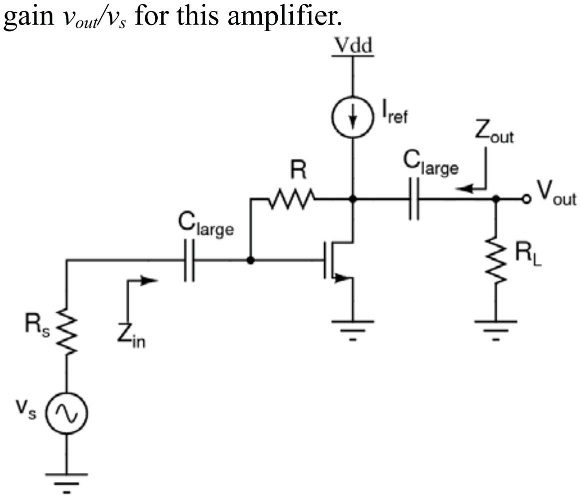


Circuit for Problem 9

10) In the circuit shown in the figure below, the capacitors (C_{large}) may be assumed to be infinite.

(a) Determine the input impedance Z_{in} and the output impedance Z_{out}.

(b) Determine the overall small-signal voltage gain v_{out}/v_s for this amplifier.



Circuit for Problem 10