ECE2280 Homework #7

1. The table below lists different cases for an NMOS transistor with V_t=1V. In each case the voltages at the source, gate, and drain (relative to the circuit ground) are specified. You are required to complete the table entries. Note that Vov is called the overdrive voltage and is equal to ($|V_{GS}|$-$|V_t|$).

V_S	V_G	V_D	$\lvert V_{GS}\rvert$	$\lvert V_{OV}\rvert$	$\lvert V_{DS}\rvert$	Region of Operation
+1.0	+1.0	+2.0				
+1.0	+2.5	+1.5				
0	+2.5	+1.0				
-1.0	0	+1.0				

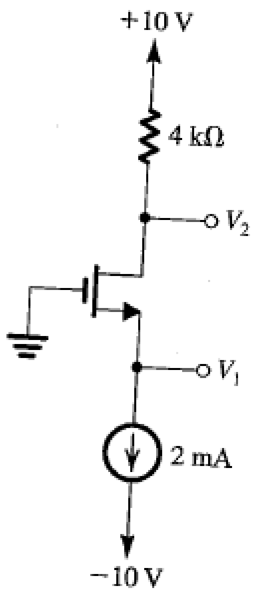
2. The table below lists different cases for a PMOS transistor with V_t=-1V. In each case the voltages at the source, gate, and drain (relative to the circuit ground) are specified. You are required to complete the table entries. Note that Vov is called the overdrive voltage and is equal to ($|V_{GS}|$-$|V_t|$).

V_S	V_G	V_D	$\lvert V_{GS}\rvert$	$\lvert V_{OV}\rvert$	$\lvert V_{DS}\rvert$	Region of Operation
+2.0	+2.0	0				
+2.0	0	0				
+2.0	0	+1.5				

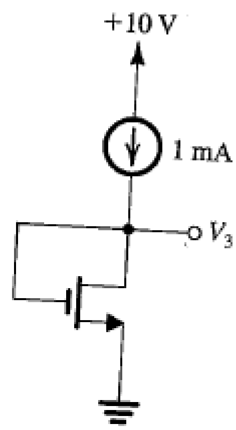
3. Write in your own words the procedure to solve a circuit containing a MosFet transistor for DC currents and voltages.

4. Explain the differences between an NMOS transistor and a PMOS transistor.

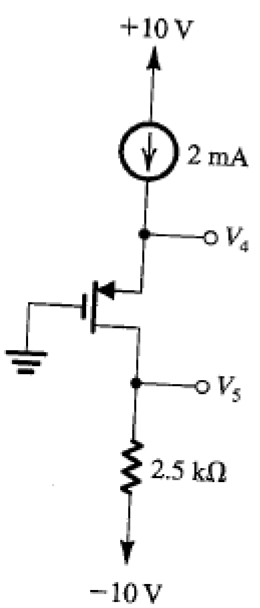
5. In the circuits below, transistors are characterized by $|V_t|$=2V and $k_n'(W/L)$=1mA/V^2, and λ=0.
   - Find the labeled voltages V_1 through V_7.



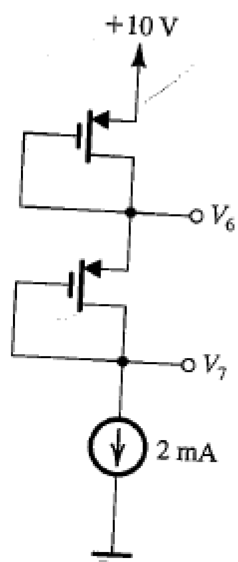
(a)



(b)



(c)



(d)

6. **Use:** **V_t=2V**

k_n'(W/L)=4mA/V^2

λ=0

For DC analysis, assume that the capacitors act as open. Assume saturation.

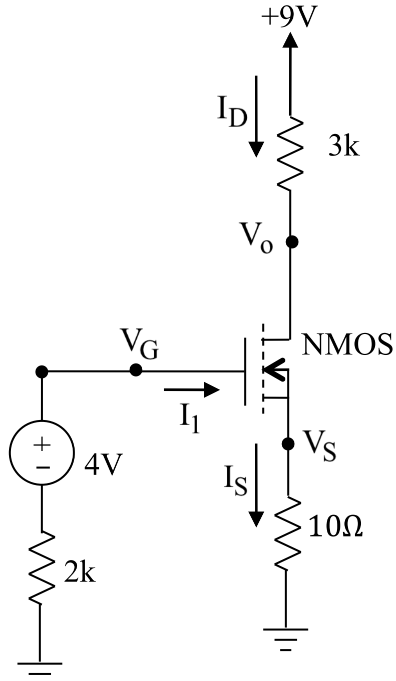
(a) Solve for the DC currents:

a. I_1
b. I_D
c. I_S

(b) Solve for the DC voltages:

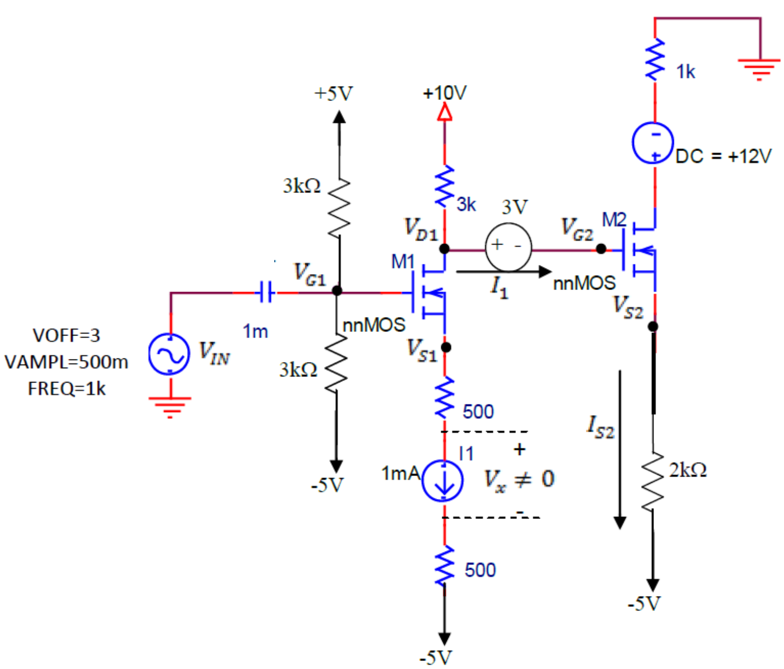
a. V_G
b. V_S
c. V_o

(c) Prove or disprove the transistor is saturated.



7. **Use:** **V_t=2V, k_n'(W/L)=2mA/V^2, λ=0.** For DC analysis, assume that the capacitors act as an open. The current source is not ideal and has a voltage drop across it. Find:

- $I_1, I_{S2}, V_{G2}, V_{S2}, V_{S1}$
- Verify that transistor M1 is saturated



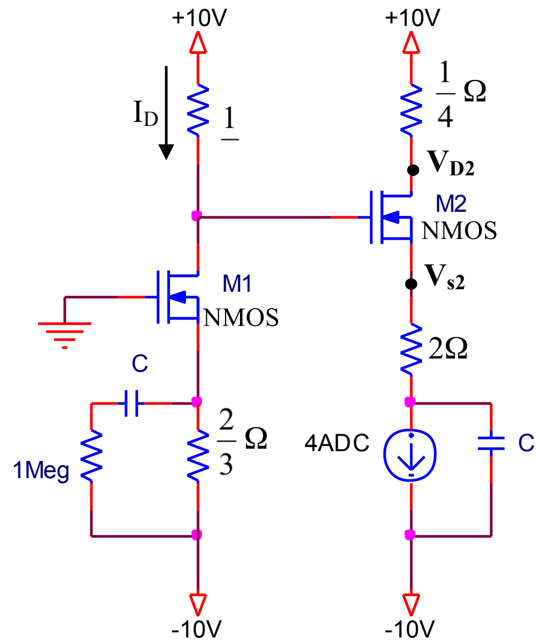
8. Use: V_t=1V

$k_n'(W/L)$=2A/V^2

λ=0 for all transistors

The 4A current source is not ideal and may have a voltage drop across it.

For DC analysis, assume that the capacitors act as open.



Solve the circuit for the **DC** values:

(a) The Q-point for transistor M2

(b) V_{s2}

(c) I_D

(d) V_{D2}

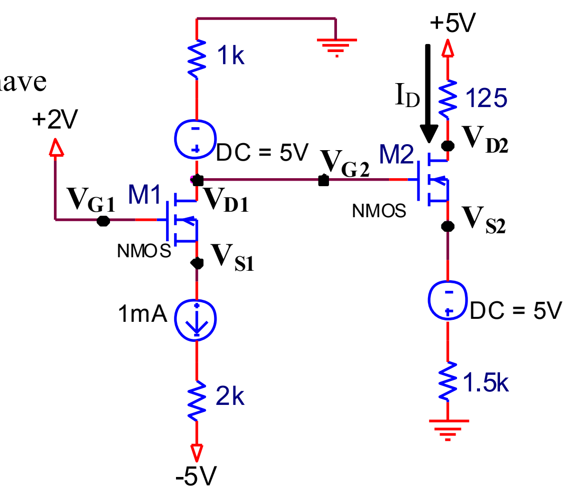
(e) Verify that the transistor M2 is saturated.

9. Use: V_t=1V

$k_n'(W/L)$=2mA/V^2

λ=0 for all transistors

The 1mA current source is not ideal and may have a voltage drop across it.



Solve the circuit for the **DC** values:

(a) The Q-point for transistor M1

(b) V_{s1}

(c) I_D

(d) V_{D2}

(e) Verify that the transistor M2 is saturated.

10. Let V_t=2V, $k_n'(W/L)$=180μA/V^2. Assume $I_D=I_S$=10mA, and λ=0.

(a) Draw the small-signal equivalent circuit using the hybrid-π model and by assuming all capacitors become shorts. Remember to remove all DC sources when drawing the AC. Vin is an AC signal.

(b) Calculate the value for g_m.