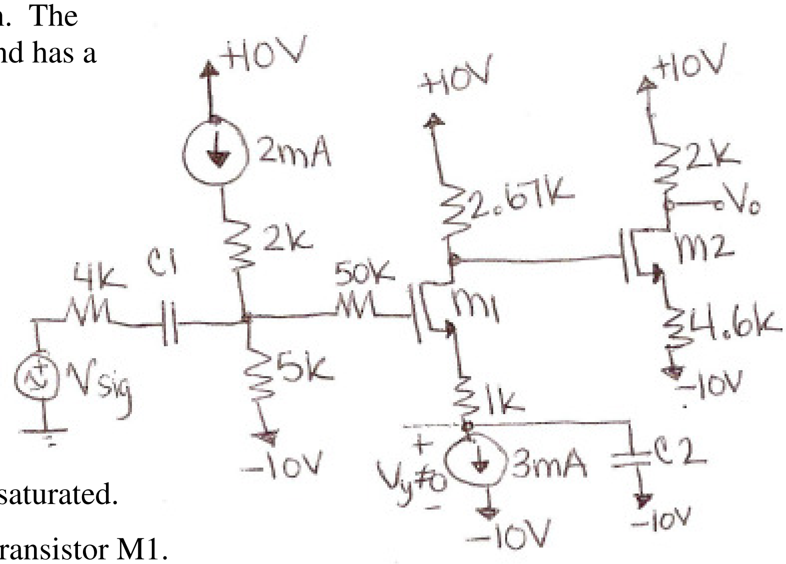
ECE2280 Review For EXAM 2

1. Understand the basic operation of a MosFet:
   - 3 regions of operation: cutoff, triode, saturation and know all current equations associated with them.
   - the I_D versus V_{DS} graph
2. Understand the bias point concept for linear amplification.
3. Be able to separate the DC and AC analysis for a circuit containing MosFets.
4. Be able to analyze a circuit (with or without cap in it) containing MosFets for DC operation.
5. Be able to draw a small-signal model of MosFets in a circuit.
6. Be able to analyze a small-signal circuit to find overall gain, midband gain, input resistance, and output resistance.
7. Determine ω_L and ω_H or f_L and f_H.

Example 1

Use: **V_t=2V**
$k_n'(W/L)$=6mA/V^2
λ=0
V_{sig} = 3+0.002sin(20t)
For DC analysis, assume that the capacitors act as an open. The current source is not ideal and has a voltage drop across it.



(a) Solve for the DC currents:
   a. **I_{D1}= I_{S1} =3mA**
   b. **I_{S2}=ID2=2mA**

(b) Solve for the DC voltages:
   a. **V_{G2} =2V**
   b. **V_{S2} =-0.82V**
   c. **V_{S1} =-3V**

(c) Verify that transistor M2 is saturated.

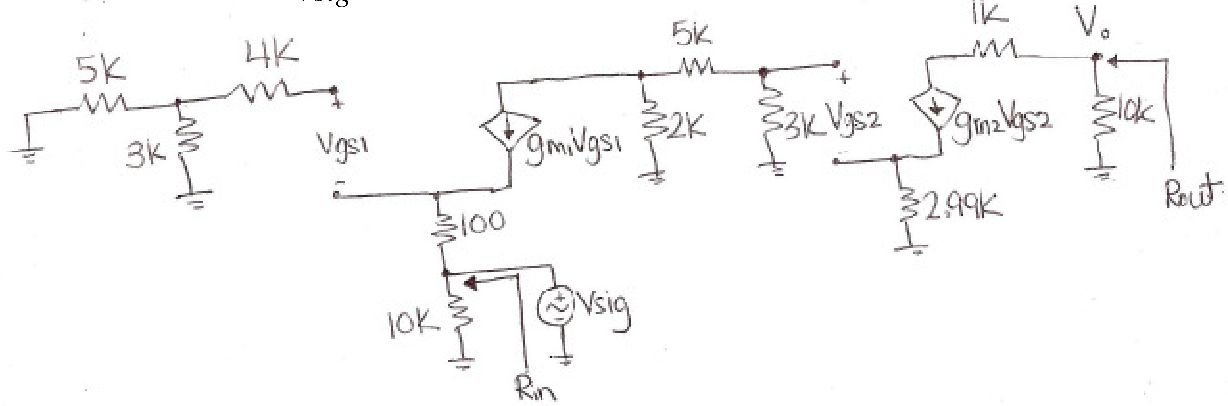
(d) State the DC bias point for transistor M1.

(e) Assuming that the transistor amplification is V_o/V_{sig} = 3V/V. Assume the input frequency is operating within the circuits operating range. What is the **total** (AC and DC) instantaneous output for V_o using the V_{sig} value stated above.
   Vo_{total}= 6+6msin(20t)

Example 2

Use: V_t=2V
k_n'(W/L)=10mA/V^2
V_{sig} is an AC source
Transistor 1 has DC values: V_{GS}=3V
Transistor 2 has DC values: V_{GS}=12V
λ=0 (for all transistors) and assume all transistors are saturated

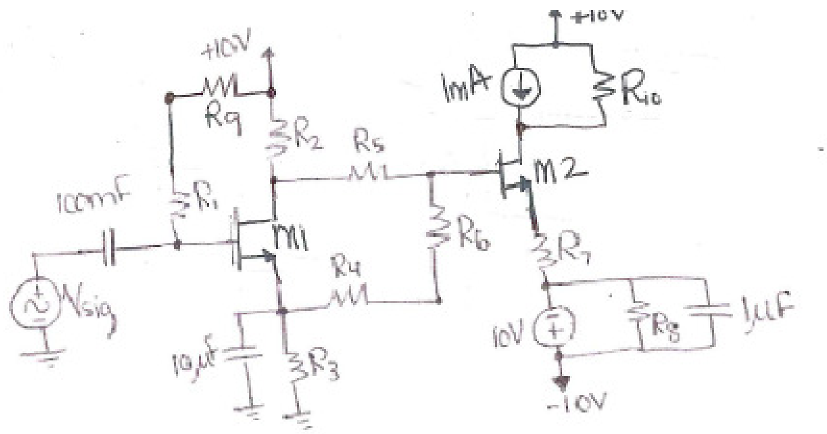
For the following hybrid-π equivalent circuit, find the following values:
(a) R_{in} (input resistance –ignore the input source, Vsig)
(b) R_{out} (output resistance-ignore R_L{no load is connected})
(c) ideal midband gain, $\frac{Vo}{Vsig}$



Rin=98ohms, Rout=10k, Vo/Vsig=10V/V

Example 3

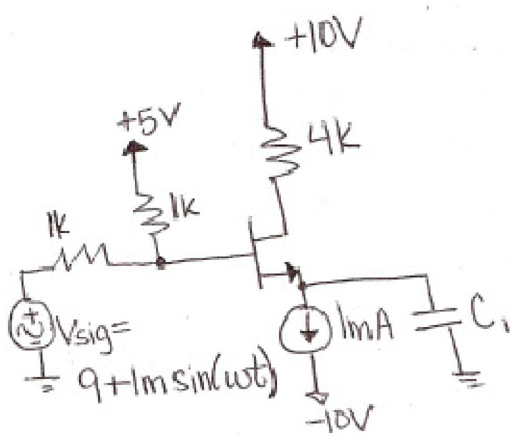
For the circuit shown below, **draw** the AC small-signal equivalent circuit(use hybrid-π or model T). Make sure that everything is labeled in terms of the transistor number. (e.g. g_{m1}, v_{gs2}, r_{o1}, etc.). $\boldsymbol{\lambda \neq 0}$ for all transistors.(i.e. draw the small-signal with r_o included). v_{sig}=0.005sin(20t) AC. Draw the small-signal equivalent circuit **WITH** capacitors shown.



Example 4

Use: gm=2.2mA/V, λ=0, and Cgs=Cgd=5pF.

What is the operating range for the amplifier below(in Hz)?

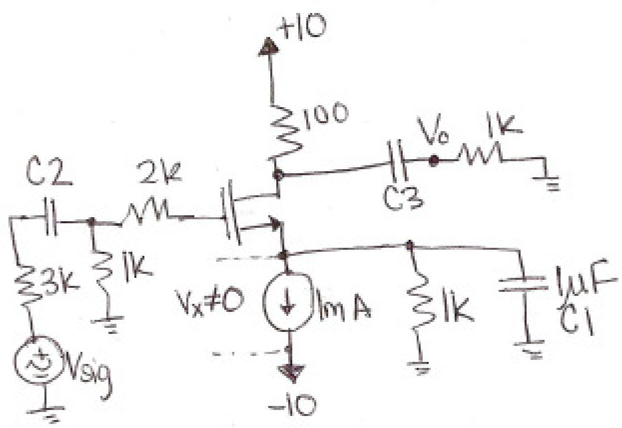


478Hz to 5.3MHz

Example 5

V_t=2V, λ=0, k_n'(W/L)=2mA/V^2. Does this circuit operate as a **linear** AC amplifier? If so, what is the gain, $\frac{Vo}{Vsig}$, of the following circuit? If not, explain why.

Vsig = 2.5+sin(ωt).(assume that ω is in the operating range of the circuit). If not, explain why.



No, does not amplify.