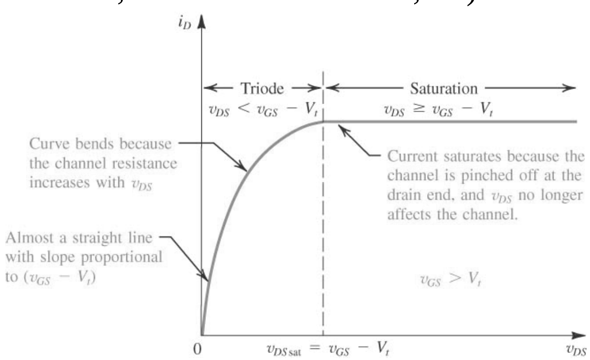
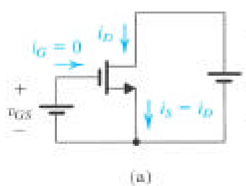
1. Referring to a forward biased pn junction diode, determine the following:
   a) For p-type and n-type material, state the majority and minority carriers (holes or electrons).
   b) Explain what happens as the temperature changes (increase and decreases) to the number of MAJORITY carriers in this p-type and n-type material?
   c) Explain what happens as the temperature changes (increase and decreases) to the number of MINORITY carriers in this p-type and n-type material?
   d) Explain in your own words, how the diffusion current, I_D, is created.
   e) Explain what happens as the temperature changes (increase and decreases) to the diffusion current, I_D?

2. a) Draw the cross section of a mosfet.
   b) Explain in your own words and drawings as needed how, when(under what conditions), and in what direction the current flows in the mosfet.
   c) Explain in your own words all the different regions for Fig. 4.6 by drawing cross-sections of the mosfet to correspond to each region in that figure and explaining how each region operates(i.e. how the channel looks, how the current flows, etc).





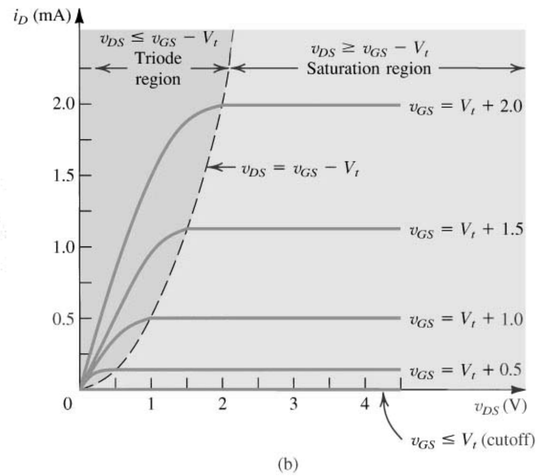


Fig 4.6 **Fig. 4.11**

d) Explain in your own words what the difference between Fig. 4.6 and Fig. 4.11 .

e) What equation and region of operation is graphed in Fig. 4.12.

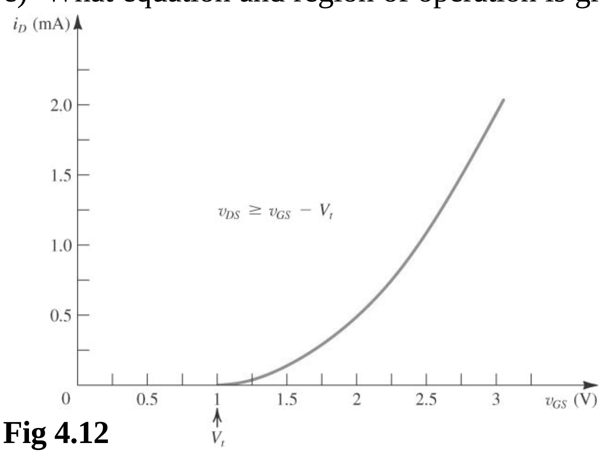
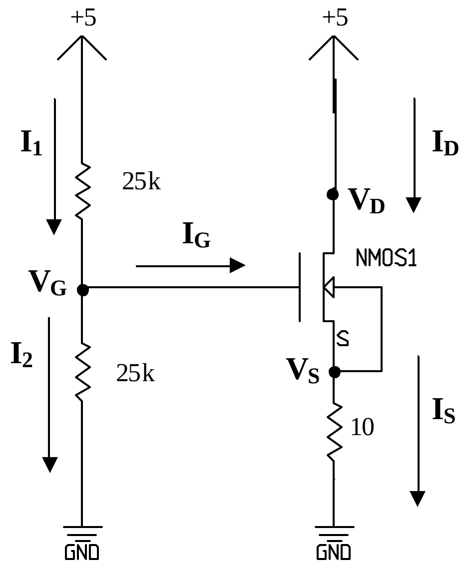


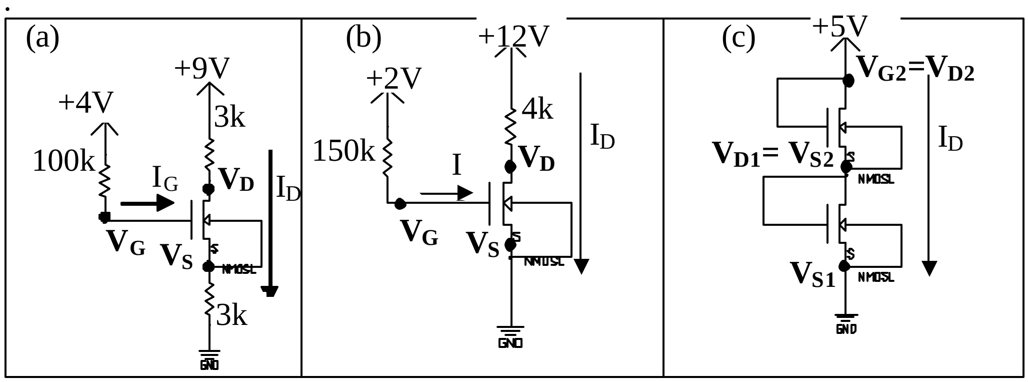
Fig 4.12

f) Explain in your own words how the PMOS differs from the NMOS transistor.

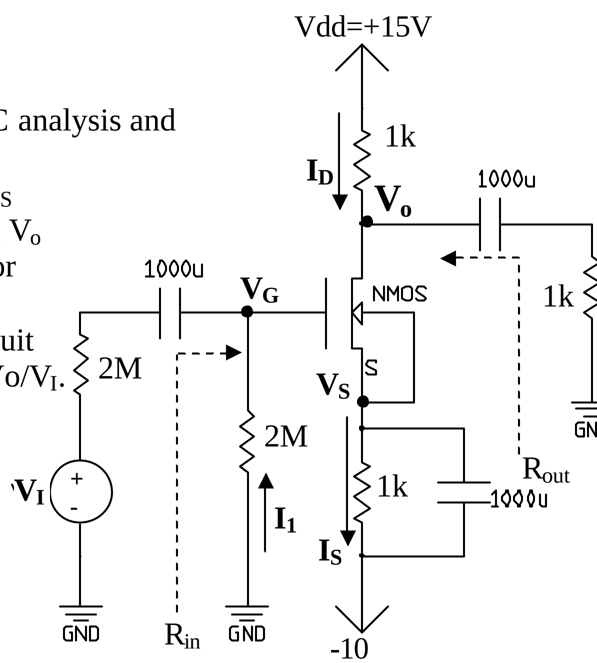
3. Analyze the circuit shown below to determine the voltages (V_D, V_G, V_S) at all nodes and the currents through all branches (5 currents). Let V_t=1.5V and k_n'(W/L)=2A/V^2. Neglect the channel length modulation effect (i.e. λ=0).



4. Solve the circuits below to find V_G, V_D, and V_S. Find the currents in all branches. Assume λ=0 and $|V_t|$=1, k_n'(W/L)=1mA/V^2.



5. Use: V_t=2V, K_n'(W/L)=50μA/V^2, λ=0
   V_I = 5+0.001sin(10t)
   Assume all capacitors are open for DC analysis and shorted for AC analysis
(a) Solve for the DC currents: I_1, I_D, and I_S
(b) Solve for the DC voltages: V_G, V_S and V_o
(c) State the operating point, bias point, or quiescent point for this amplifier
(d) Draw the small-signal equivalent circuit
(e) Analyze the small-signal circuit for V_o/V_I.



6. For the following hybrid-π equivalent circuit, find the following values:

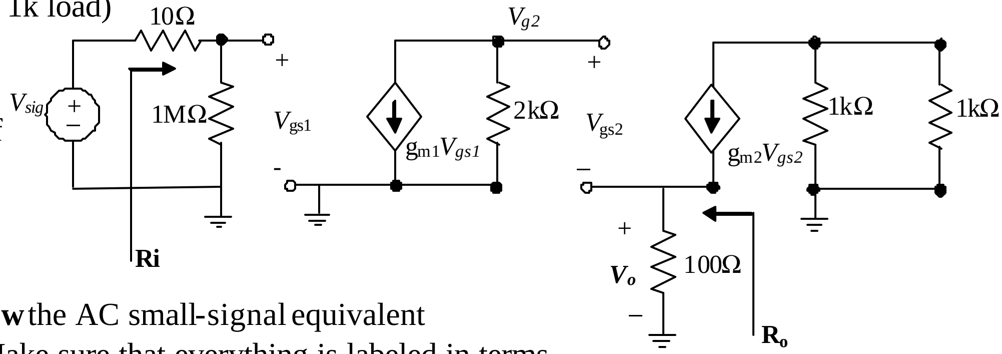
(a) R_i (input resistance – ignore the 10Ω and Vsig)

(b) Ro (output resistance-ignore the 1k load)

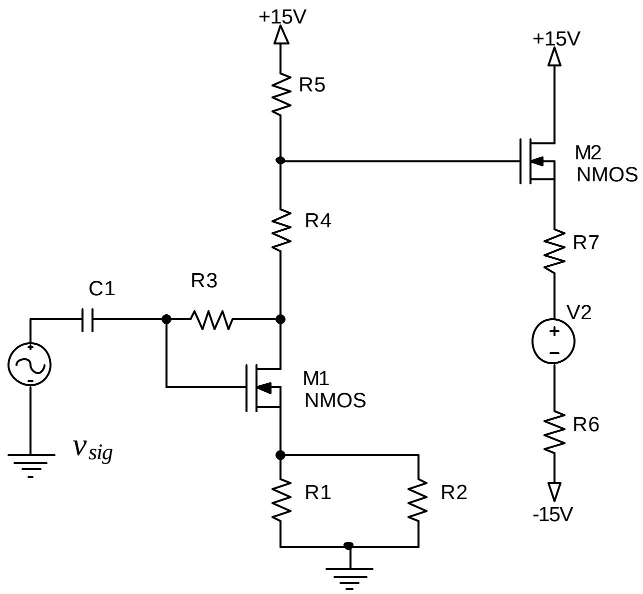
(c) gain, $\frac{Vo}{Vsig}$

(d) Draw the transistor schematic of this circuit

Use: V_t=1V, $K_n'(W/L)$=2mA/V^2, V_{sig} is an AC source
Transistor 1 has DC values: VGS1=2V, ID1=1mA
Transistor 2 has DC values: VGS2=3V, ID2=4mA
λ=0 (for all transistors)



7. 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}, etc.). λ=0 for all transistors. v_{sig}=0.001sin(10t) AC and V2=10V DC.



8. v_{sig} ={8+0.01sin(ωt)}Volts. Does this circuit operate as a **linear** AC amplifier? If so, what is the gain, $\frac{Vo}{Vsig}$, of the following circuit in terms of VDD, Vsig, Rsig, k'(W/L)? If not, explain why. The graph below shows measurements for this circuit.