Problem #1. Draw the hybrid-π circuit for the following circuit: (include $r_o$ for all transistors) reduce the circuit by knowing that if a voltage across a dependent current source with value $g_m v_{gs}$ that is dependent on that same voltage, $v_{gs}$, can be replace with a resistor with value $1/g_m$. ($v_{gs}=I*R \Rightarrow$ where $I=g_m v_{gs}$ so $R=1/g_m$)

Problem #2. $V_t=1V$, $k_n'(W/L)=1mA/V^2$

(a) Draw the hybrid-π circuit
(b) Determine the Q point for the amplifier. (Hint: find the equivalent graph of Fig. 4.26 for this circuit and determine points A and B and then Q)
(c) Pick values for R1 and R2 to give you the desired Q pt. DC value.
(d) Find the gain $\frac{V_o}{V_t}$ ($V_t$ is an AC source)
(e) Find $R_{in}$ (node to right of capacitor to ground - ignore the circuit to the left of cap)
(f) Find $R_{out}$ (node to left of capacitor to ground – ignore the circuit to the right of cap)
Problem #3. Use: $V_i=2V$ and $k_n(W/L)=4mA/V^2$

(a) Solve for the DC currents:
$I_1, I_D \{\text{round to nearest tenth}\}, I_S, \text{and } I_L$

(b) Solve for the DC voltages:
$V_G, V_S, V_o$

(c) Draw the AC small-signal circuit (i.e. the hybrid-$\pi$ or model T)

(d) Solve the AC circuit for the following AC values:
   a. $R_{in}$
   b. gain: $A_v=\frac{V_o}{V_i}$

(e) Without changing $I_D$, or $R_L$ - what resistor can be changed and to what maximum or minimum VALUE can it be changed to increase the overall gain?

(f) Explain what happens to the circuit if the source resistor (=3500) of M1 is changed to 10k. \(\text{[The quadratic solution for this resistance: } I_D=0.739m \text{ or } 0.866m]\)

(g) If $V_i$ is the graph below, sketch the total output (DC and AC) at $V_o$ on the same graph. Label all values.

Problem #4. Book problem: 4.88