1. Solve the circuits below to find $V_G$, $V_D$, and $V_S$. Find the currents in all branches. Assume $\lambda=0$ and $|V_t|=1$, $k_n'(W/L)=100\mu A/V^2$. (DC ANALYSIS)

   \[(a) \quad V_G=+5V \quad I_D=0.584m \quad V_S=.584V \quad V_D=9.71V \]
   \[(b) \quad V_G=+5V \quad I_D=0.469m \quad V_S=.938V \quad V_D=7.655V \]
   \[(c) \quad V_G=+2V \quad V_S=0 \quad I_D=50\mu \quad V_D=9.95V \]
   \[(d) \quad V_{S1}=0 \quad V_{G2}=V_{D2}=5V \quad V_{D1}=V_{S2}=V_{G1}=2.5V \quad I_D=112.5x10^{-6} \]

2. (DC Analysis)
   \[(a) \quad \text{What is the smallest value for circuit 1(a) above that the +10V supply can be reduced to still keep the transistor in saturation mode?} \quad V_{DD(min)}=4.3V \]
   \[(b) \quad \text{What is the largest value that } R_c=1k \text{ of circuit 1(c) above can be increased to keep the transistor in saturation mode?} \quad R_{\text{max}}=180k\Omega \]

3. Use biasing techniques to establish a current $I_E=4mA$ for the circuit below. (Biasing)
   \[(\text{i.e. find values for } R1, R2, R_D, \text{ and } R_S) \lambda=0, |V_t|=2, k_n'(W/L)=100\mu A/V^2 \]
   \[R1=20\text{Meg (arbitrary)} \]
   \[R2=10\text{Meg (arbitrary)} \]
   \[R_s=2,569 \text{ } \Omega \]
   \[R_D=833\text{ } \Omega \]
4. Use: 
\[ V_{\text{in}} = 1 \text{V} \]
\[ V_{\text{tp}} = -1 \text{V} \]
\[ k_{p'} = 20 \mu \text{A/V}^2 \]
\[ k_{n'} = 10 \mu \text{A/V}^2 \]
\[ \lambda = 0 \]

Solve for \((W/L)\) for all three transistors when the desired current is \(I_2 = 3 \text{mA}\) and \(V_{G1} = 2.5 \text{V}\). Make any reasonable assumptions.

5. Find the small-signal parameter, \(g_m\), the input impedance, \(R_{\text{in}}\), and output impedance, \(R_{\text{out}}\), and the overall gain for each type of amplifier (Common-gate, Common-Drain, Common-Source). How could you increase the overall gain? Use \(\lambda = 0.01\), \(|V_t| = 1\), \(k_n'(W/L) = 100 \mu \text{A/V}^2\). If \(V_i = 0.005 \sin \omega t\) draw the total input and the total output on the same graph vs time for 2 periods of this amplifier. (Amplifiers)

\[ \text{Gain} = \frac{V_o}{V_s} = 0.08 \text{V/V} \]

\(R_{\text{out}} = 500 \Omega\)
\(R_{\text{in}} = 12.4 \Omega \quad (12.5 \Omega \text{ if } I_D = .584 \text{m})\)
\(g_m = 169 \mu \text{A}\)
\(\text{Gain} = \frac{V_o}{V_s} = 0.08 \text{V/V} \quad (0.08 \text{V/V if } \lambda \text{ ignored})\)
\( R_{\text{in}} = 2 \text{Meg} \)
\( R_{\text{out}} = 1,981 \)
\( g_m = 153 \mu \) 
\( \text{gain} = 0.103 \text{V/V} \)

\( R_{\text{in}} = 150k \)
\( R_{\text{out}} = 1k \)
\( g_m = 125 \mu \)
\( \text{gain} = 0.06 \text{V/V} \)