ECE137A Problem set #1
Problem 1. bipolar transistor biasing. Assume a Vbe(on) of 0.7 volts.

a) 
\[ \beta = 50 \]
\[ V_{cc} = 5 \text{ volts} \]
We want 1mA microamps collector current, and Vce=1.5 Volts
Find Rc and Rb

(this biasing circuit not recommended)

b) Bias stability of the circuit of problem 1(a).

First, keeping the same values for Rb and Rc you found above, compute the collector current and the collector voltage if beta is increased to 200.

Second, keeping the same values for Rb and Rc you found above, compute collector current and the collector voltage if beta is returned back to its original value but Vcc is increased 10%.

Caution: You must consider the possibility of saturation.

c) 
\[ \beta = 50 \]
\[ V_{cc} = 5 \text{ volts} \]
Collector voltage Vc=2 Volts
Emitter voltage Ve=0.5 volts
current in Rb2=100 microamps
collector current =1 mA

Find Rb1, Rb2, Ree, Rc
d) Bias stability of the circuit of problem 1(c).

First, keeping the same values for Rb1, Rb2, Ree and Rc you found above, compute the collector current and the collector voltage if beta is increased by a factor of two.

Second, keeping the same values for Rb1, Rb2, Ree and Rc you found above, compute the collector current and the collector voltage if beta is returned back to its original value but Vcc is increased 10%.

Caution: You must consider the possibility of saturation.
Problem 2 MOS Biasing:

The MOSFET has $v_{th} = 0.3$ Volt, $T_{ox} = 1 \text{nm}$, $\varepsilon_{r,ox} = 3.8$, $\mu = 400 \text{ cm}^2/\text{V-sec}$, $L_g = 22 \text{nm}$, $v_{inj} = 10^7 \text{ cm/s}$, and $W_g = 1 \mu\text{m}$. $R_g1$ is 100 kOhms. $V_{dd}$ is 1.0 Volts. $\lambda = 0$. We would like to bias the MOSFET at 0.3 mA drain current and 0.75 volts between drain and source.

Please find the required values of $R_g2$ and $R_d$.

b) Bias stability of the circuit of problem 2(a).

First, keeping the same values for $R_g1$, $R_g2$, and $R_d$ you found above, compute the drain current and the drain voltage if the oxide thickness decreased 10%.

Second, using the original value of oxide thickness, and keeping the same values for $R_g1$, $R_g2$, and $R_d$ you found in 2(a), compute the drain current and the drain voltage if the power supply voltage is increased 10%.

c) The P MOSFET has a -0.25 V threshold voltage...meaning the gate is 0.25 V negative of the source at the onset of conduction. $T_{ox} = 1 \text{nm}$, $\varepsilon_{r,ox} = 3.8$, $\mu = 400 \text{ cm}^2/\text{V-sec}$, $L_g = 22 \text{nm}$, $v_{inj} = 10^7 \text{ cm/s}$, and $W_g = 2 \mu\text{m}$.

$V_{ss} = 2$ Volts, and $R_g1$ has 1 microamp flowing through it.

We would like to bias the MOSFET at 0.1 mA drain current. We would like to have +1.7 volts source voltage and +0.25 V drain voltage. Find all 4 resistors.
d) Bias stability of the circuit of problem 2(c)

First, keeping the same values for $R_g1$, $R_g2$, $R_s$, and $R_d$ you found above, compute the drain current and the drain voltage if $C_{ox}$ is increased 5%.

Second, using the original value $C_{ox}$, and keeping the same values for $R_g1$, $R_g2$, $R_s$, and $R_d$ you found in 2(c), compute the drain current and the drain voltage if the power supply voltage is increased 10%.