EE 330
Homework 8
Fall 2020
Due Wednesday October 5 1:00 PM (no late uploads accepted)

Problem 1

Explain, in words, what the goal of a small signal analysis is (hint: linear vs. nonlinear circuits). Why is this useful?

Problem 2

Suppose an arbitrary black-box electrical component has an output current which is dependent upon the device's input voltage. The relationship between output current and input voltage is given as follows:

$$I_{out}(V_{in}) = V_{in}^2 \sin(V_{in}) \cos(V_{in})$$

You will be using this component in a circuit where the input voltage will normally be pinned at $2V$, with small (millivolt range) fluctuations occurring on occasion. Given this information, create a *linear* model for this component. You must show your math, but it is not necessary to show *every* step. If taking a derivative, for example, it is sufficient to show the derivative setup and the final result, without showing the intermediary steps.

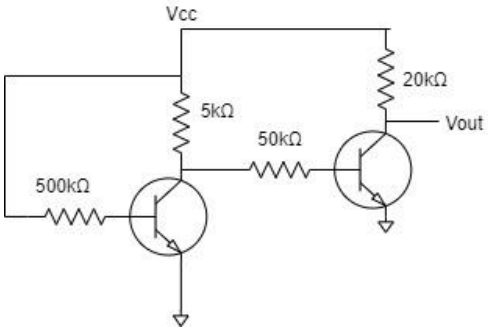
Once you have generated your linear approximation, plot the error of the approximated current: $\left|\frac{I_{approx}(V_{in}) - I_{out}(V_{in})}{I_{out}(V_{in})}\right|$. Comment on how the error changes as the input voltage moves away from the expected operating point, $2V$.

Problem 3

What is the term operating point of a circuit mean and what is its purpose? What are the steps to solve for the operating point of a circuit?

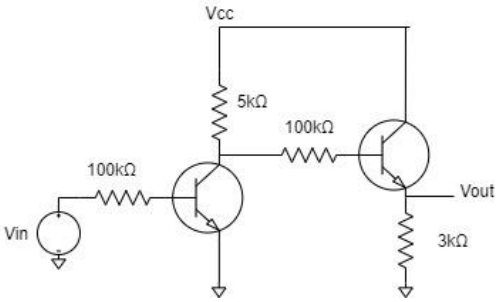
Problem 4

Find the output of the following circuit given Vcc=10V and both BJTs have β=150. What if Vcc=5V and β=50?



Problem 5

Find Vout in the following circuit for Vin = 2V and Vcc of 10V where β=100 for both BJTs.



Problem 6

In the circuit below, discussed in lecture, presume $V_{GSQ} = 2V$ and $V_{DD} = 5V$. What value of R_1 is necessary to obtain a small-signal gain of -1.5? Use the AMI06 process parameters to obtain values for V_T and μC_{ox}. Assume M_1 is minimally sized.