ECE 3040 Microelectronic Circuits Quiz 2

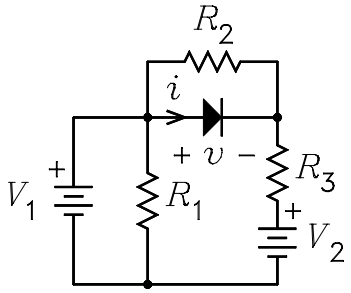
June 1, 2005

Professor Leach Name_____

Instructions. Print your name in the space above. The quiz is closed-book and closed-notes. Draw a box around all numerical answers. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials: _____

1. (a) Sketch the typical graph of i versus v for a Si. junction diode. On the graph, label typical numerical values of the cutin voltage and the forward bias voltage. (This is covered in the class notes.)
   (b) How is the diode small-signal resistance related to the plot of i versus v? (It is the reciprocal of the slope at the Q point.)
   (c) When the current through a forward biased diode is held constant, does the diode voltage increase or decrease as the temperature is increased. Conversely, if the diode voltage is held constant, how would you expect the current to increase or decrease if the temperature is increased? Explain your logic. (For i = constant, v decreases as T is increased. For v = constant, i increases as T is increased.)
   (d) The large signal model of a diode contains an ideal diode. Draw the circuit diagram of the model and show how it approximates the i versus v characteristics of a junction diode. (It consists of and ideal diode in series with a resistor and a dc battery. For $v < V_\gamma$, $i = 0$. For $v > V_\gamma$, it is a straight line that matches the diode curve at 2 points.)
   (e) Draw the circuit diagram of the small-signal model of a diode and show how it approximates the i versus v characteristics of a junction diode. (It consists of a resistor in series with a dc battery. The i versus v characteristics of the circuit is a straight line that is tangent to the diode curve at the Q point.)

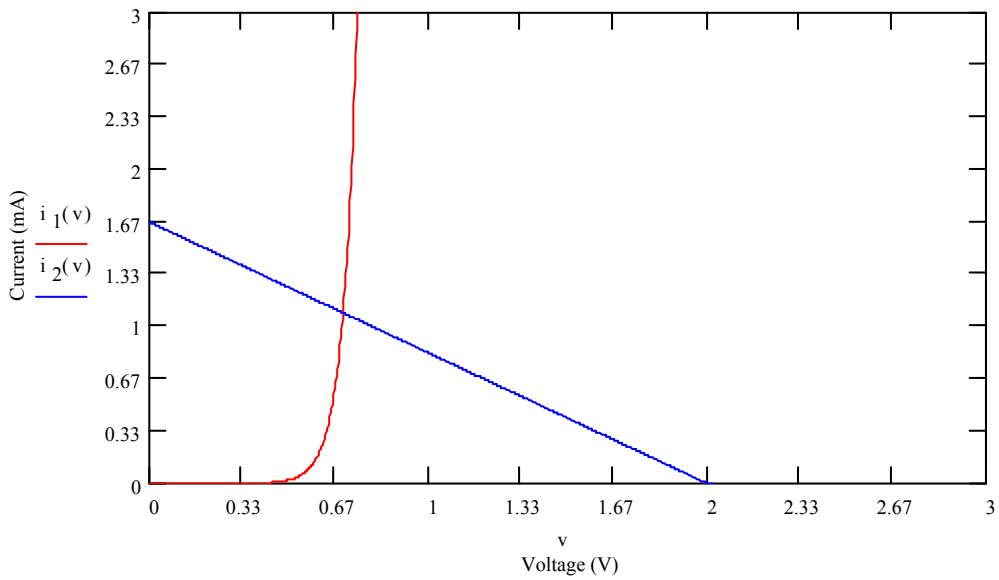
2. It is given that $V_1 = 10\,\text{V}$, $V_2 = 5\,\text{V}$, $R_1 = 1\,\text{k}\Omega$, $R_2 = 2\,\text{k}\Omega$, and $R_3 = 3\,\text{k}\Omega$.
   (a) Solve for the Thévenin voltage V_S and Thévenin resistance R_S seen by the diode.



$$\begin{aligned} V_S &= V_1 \frac{R_2}{R_2 + R_3} - V_2 \frac{R_2}{R_2 + R_3} = 2\,\text{V} \\ R_S &= R_2 \| R_3 = 1200\,\Omega \end{aligned}$$

   (b) Draw the load line for the diode on the characteristics given and estimate the diode voltage and current at the Q point.

$$i_2(v) = \frac{v - V_S}{R_S} = \frac{v - 2}{1.2\,\text{k}\Omega}$$



The intersection occurs at $i \simeq 1.1\,\mathrm{mA}$ and $v \simeq 0.7\,\mathrm{V}$.