ece340_lab3mod

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1 Objective

In this lab, we will investigate the current-voltage characteristics of *pn* junction diodes and several diode circuit configurations.

2 Experiments

2.1 Diode I/V curves

The 1-2-5 sequence is useful for generating evenly log-spaced numbers by hand. Exactly even spacing for 3 numbers per decade is $10^{n/3}$ for $n \in 0, 1, 2, \ldots$. This is a sequence 1.000, 2.154, 4.652, 10.000, $\ldots$. Round these numbers to integers and you get the 1-2-5 sequence. Another rule of thumb is the 3-4-5 right triangle.

Refer to Figure 1. For each of *three* different diode models, measure the I_D vs. V_D curves for currents spanning 3 orders of magnitude, from around $10\mu\mathrm{A}$ to around $10\mathrm{mA}$.

This is a good application for 1-2-5. Choose the desired starting current as $10\mu\mathrm{A}$. Start with the voltage source at $1\mathrm{V}$. Guess a diode voltage V_D of $0.4\mathrm{V}$ (we would calculate, but I_S isn't given). Calculate the resistance required for the initial current of $10\mu\mathrm{A}$. Construct this circuit according to Figure 1.

Record the voltage source's value and the measured V_D. Change the voltage source to $2\mathrm{V}$, then $5\mathrm{V}$, then $10\mathrm{V}$, then $20\mathrm{V}$ while also measuring the resulting V_D. Use Excel to calculate I_D.

The diode voltage does not change much as it goes with $\ln(I_D)$, so I_D roughly increases at the same rate as the voltage source (which we are increasing with log-spacing). All this gives us log-spaced current values without much effort.

Reset the voltage source to $1\mathrm{V}$ and choose a next current that is larger than the last one. Use the last measured value of V_D (our estimate is not blind any longer), and calculate a new resistor value. Repeat the 1-2-5 sequence with the voltage source. Do the procedure again if the ending current isn't in the $10\mathrm{mA}$ range.

Plot the resulting I_D vs V_D curves on both linear and logarithmic scales for the current. Plot all three diode curves on the same figure.

For each diode, find the parameters I_S and n which best fit the diode equation:

$$I_D = I_S \left[\exp \frac{V_D}{n \cdot V_T} \right]$$

Excel's trend line functionality can help with this.

2.2 Diode circuits

Construct each of the circuits in Figures 2-4. Apply a $5\mathrm{V_{p-p}}$ sinusoid at 1kHz and use the `1n914` diodes. For each circuit, sketch V_{in} and resulting V_{out}. Vary the signal generator's amplitude and frequency and observe the behavior of the circuit.

2.3 Report

Refer to the document "DRAFT Lab Report Guidelines 2014.pdf" on Blackboard for the format for your report.