Numerical Analysis

Homework 11. Diode Networks

Due: May 16, 2017

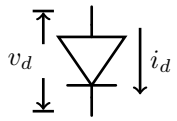


Figure 1. Diode symbol.

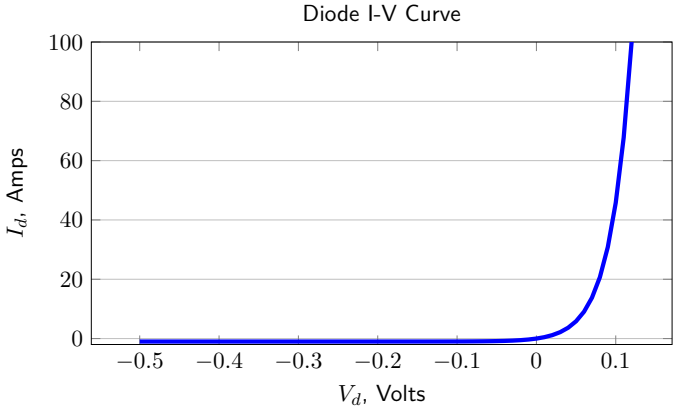


Figure 2. Diode I-V curve.

Diode is one of the most important elements in electronic circuits. It's symbol and the current-voltage (I-V) curve are shown above. The equation describing the diode current as a function of diode voltage is:

$$i_d = I_s(e^{v_d/\phi} - 1), \tag{11.1}$$

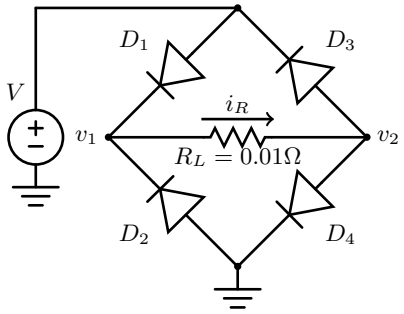
where I_s is a constant known as the saturation current and

$$\phi = \frac{\phi_0 T}{300}, \tag{11.2}$$

is the built-in potential and is a function of temperature. For this homework, we set

$$I_s = 1 \text{ Amps}, \tag{11.3}$$

$$\phi_0 = 0.026 \text{ Volts}. \tag{11.4}$$



1. Given a rectifier circuit above, assuming ambient temperature is fixed at 300 K,

   1.1. Let V=0, 0.02, $\cdots$, 1.0 Volt, please solve for v_1, v_2, i_{D1}, i_{D2}, i_{D3}, i_{D4}, and i_R.

   1.2. Let V=0, -0.02, $\cdots$, -1.0 Volt, please solve for v_1, v_2, i_{D1}, i_{D2}, i_{D3}, i_{D4}, and i_R.

2. Suppose the temperature for each diode is 300 K when $V = 0$ Volts, and it will heat up when current flows through the diode with

$$T_d = 300 + \kappa \cdot i_d \cdot v_d, \tag{11.5}$$

where i_d is the current flows through the diode, v_d is the voltage across the diode, and $\kappa = 2$. (Note that when the diode temperature increases, the diode current will need to be modified since ϕ is a function of temperature.)

2.1. Let V=0, 0.01, $\cdots$, 1.0 Volt, please solve for v_1, v_2 i_{D1}, i_{D2}, i_{D3}, i_{D4}, i_R. T_{D1}, T_{D2}, T_{D3} and T_{D4}.

2.2. Let V=0, -0.01, $\cdots$, -1.0 Volt, please solve for v_1, v_2 i_{D1}, i_{D2}, i_{D3}, i_{D4}, i_R. T_{D1}, T_{D2}, T_{D3} and T_{D4}.

3. Please state your observations.

Notes.

1. For this homework you need to turn in a set of C++ source codes. That includes `hw11.cpp`, which solves question 2 above, `MAT.h`, `MAT.cpp`, `VEC.h` and `VEC.cpp` files.
2. A `pdf` file is also needed. Please name this file `hw11a.pdf`.
3. Submit your files on EE workstations. Please use the following command to submit your homework 11.

```
$ ~ee407002/bin/submit hw11 hw11a.pdf hw11.cpp MAT.h MAT.cpp VEC.h VEC.cpp
```

where `hw11` indicates homework 11.

4. Your report should be clearly written such that I can understand it. The writing, including English grammar, is part of the grading criteria.