Numerical Analysis HW12: Non-linear Resistor Network

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1 Objective

In this assignment, we are required to solve a resistor network like the following picture with each resistance non-linear.

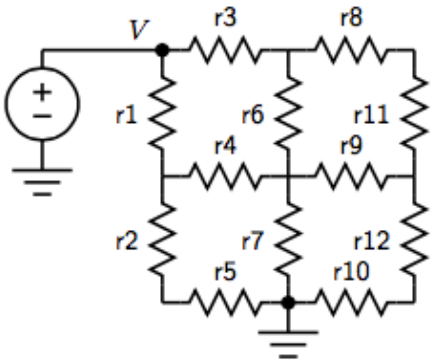


Figure 1: Resistor Network

I implement genJ1(), genJ2(), genF1(), genF2() to generate the Jacobian matrix and the system functions F.

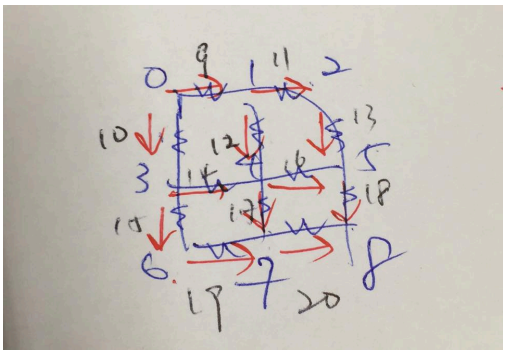
2 Implementation

The framework is like

Algorithm 7.3.2. Newton's Method for *N*-Dimensional Problems.

Given $\mathbf{x}^{(0)}$ and a small $\epsilon \geq 0$, let
$k = 0$, $err^{(0)} = 1 + \epsilon$,
while $(err^{(k)} > \epsilon)$ {
evaluate $\mathbf{F}(\mathbf{x}^{(k)})$,
evaluate $\mathbf{J_F}(\mathbf{x}^{(k)})$,
solve $\mathbf{J_F}(\mathbf{x}^{(k)})\ \delta\mathbf{x} = -\mathbf{F}(\mathbf{x}^{(k)})$,
$\mathbf{x}^{(k+1)} = \mathbf{x}^{(k)} + \delta\mathbf{x}$,
$k = k + 1$,
$err^{(k)} = \|\mathbf{F}(\mathbf{x}^{(k)})\|$,
} .

and in function genJ1() and genJ2(), I just use the stamping method to create the Jacobian matrix. The tricky part is to add entries for resistors to Jacobian matrix in genJ2(). To conquer this troublesome problem, I modify the order of resistors to the following graph:



The blue numbers specify the node number and black numbers indicate the resistor numbers. Then follow the Newton's method, we can easily get the result.

genF1(), genF2() are to calculate the value of system functions, which are composed of Kichkoff's current equations and temperature function given by the assignment.

And my initial guess is like [v0,v1,v2....v8,T1,T2....T12] for question 2, [v0,v1,v2...v8] for question 1.

3 Workflow

Usage: ./hw12.out * δ, where * could be 1 or 2 in this assignment, specifying Question 1 or 2 . For example, ./hw12.out 2

Solve: Newton's method is applied

Desired output: The program shall create data1.txt for Q1 with the first column is the voltage, second column is the total current, third column is the current of resistor 2, fourth column is the current of resistor 7, fifth column is the current of resistor 12 in figure 1. The program shall also create data2.txt for Q2 with the first column is the voltage, second column is the total current, third column is the temperature of resistor 2, fourth column is the temperature of resistor 7, fifth column is the temperature of resistor 12 in figure 1.

4 Result and Plots

In this report, I am not attaching the numerical data for there are too many. One can easily get the numerical data by running my program if interested.

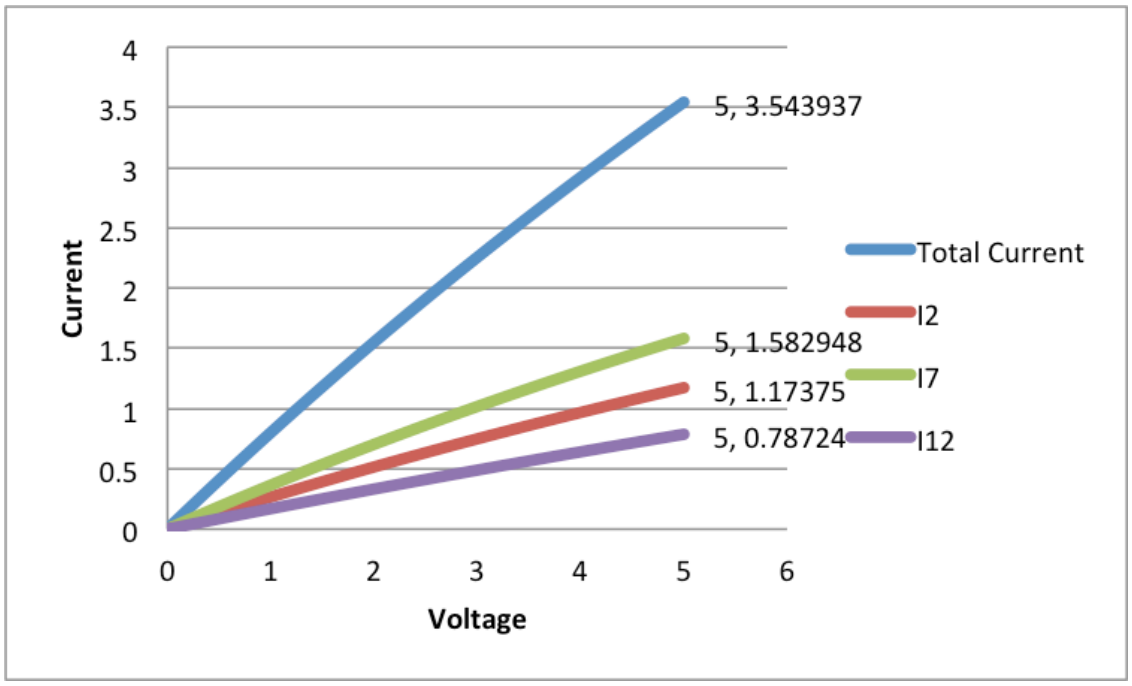


Figure 2: Voltage-Current Plot for Q1

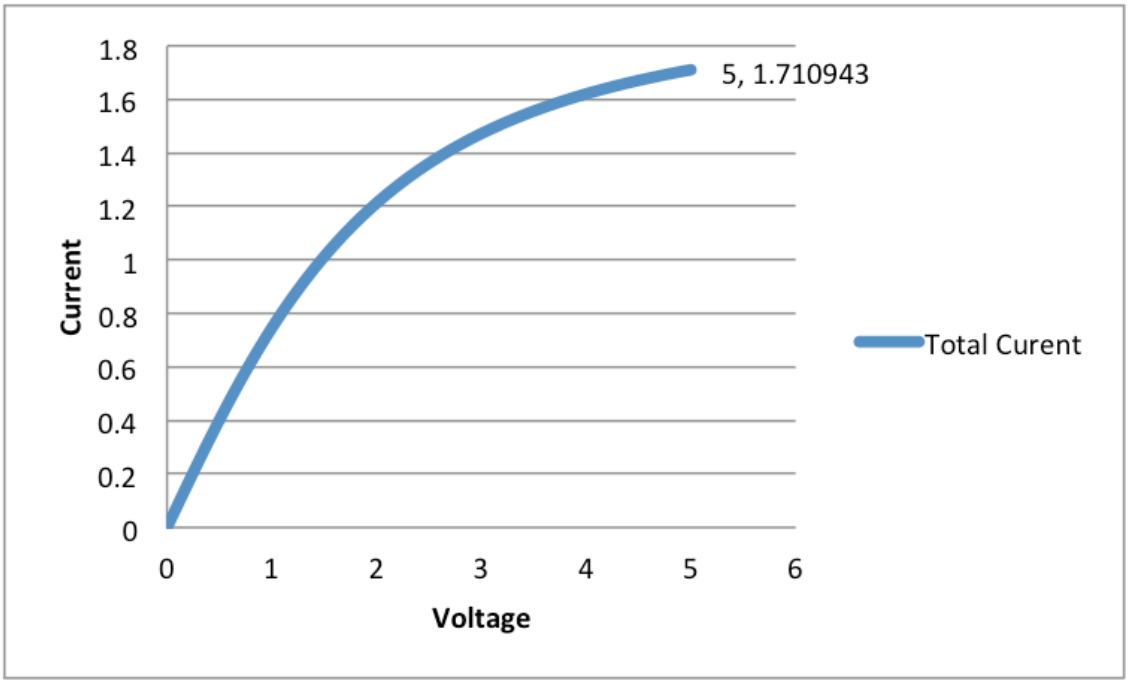


Figure 3: Voltage-Current Plot for Q2

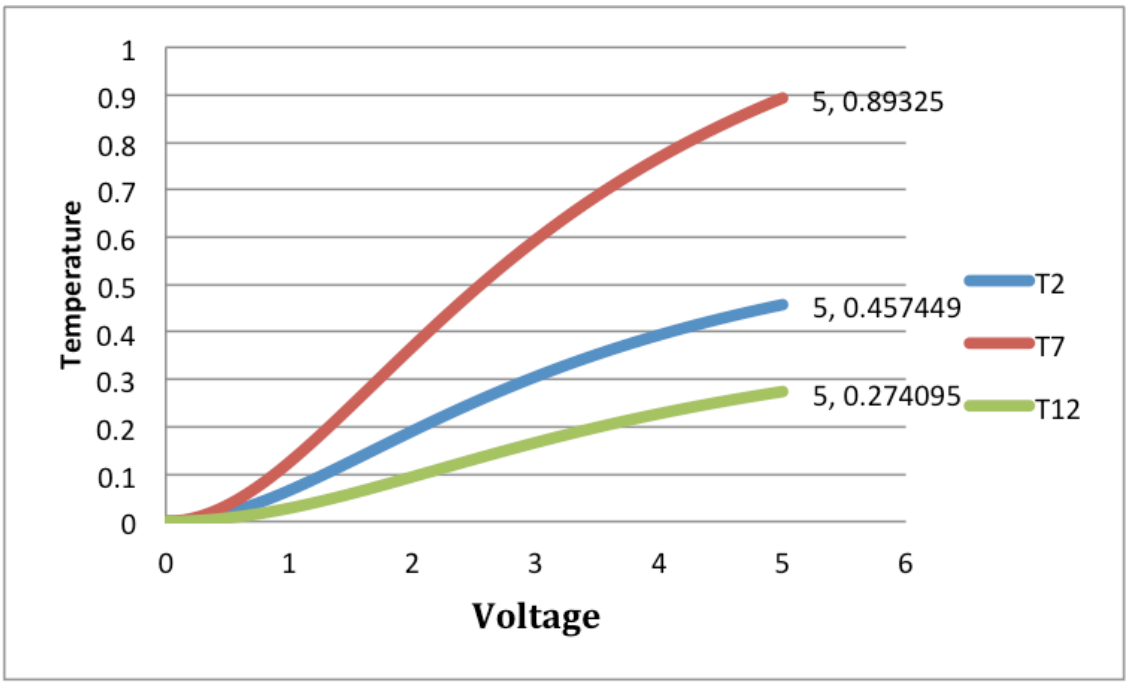


Figure 4: Voltage-Temperature Plot for Q2

5 Observations

When checking the correctness of this assignment, one can check if the total current equals I2 + I7 + I12.

For Q1, the currents tend to increase linearly. I7 is greater than I2 and I2 is greater than I12.

For Q2, the total current will grow . Similarly, the temperature of resistor 7 in fig.1 is greater than resistor 2, resistor 2 is greater than resistor 12.