Assignment 5

James Lawton
Physics Department, Virginia Tech,
Blacksburg, Virginia 24061, USA

Abstract: Here we are looking to analyze and simulate the behaviors of a circuit and atomic structures

I. PROBLEM 5-1

Here we look to find the currents in an unbalanced Wheatstone bridge with the following properties: $r_1 = r_2 = 100\Omega$, $r_3 = 150\Omega$, $r_x = 120\Omega$, $r_a = 1000\Omega$, and $r_s = 10\Omega$.

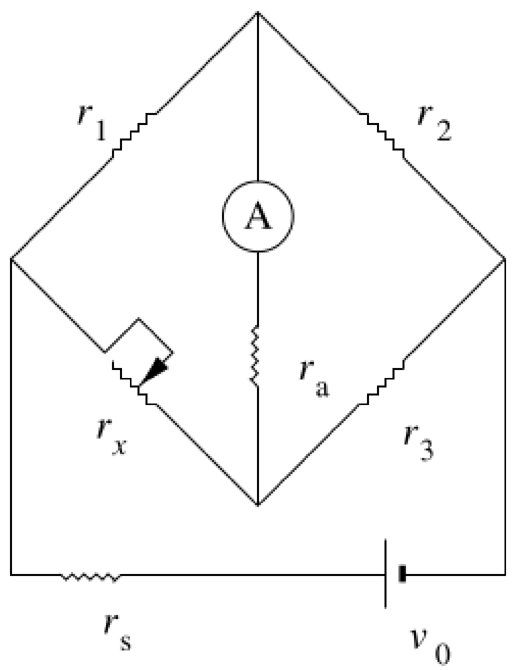

FIG. 1. Circuit Diagram

Utilizing Gaussian Elimination with partial pivoting, we can find and plot our findings with various values for v_0. We solve the following matrix equation for x where x contains the currents.

$$Ax = b \tag{1}$$

$$A = \begin{bmatrix} 10 & 100 & 100 \\ -120 & 1220 & -1000 \\ -150 & -1000 & 1250 \end{bmatrix}, \quad b = \begin{bmatrix} v_0 \\ 0 \\ 0 \end{bmatrix}, \tag{2}$$

The simulation was run with $v0$ ranging from 0 to 100. The results plotted obtained over:

Here we can see that the three currents increase linearly with the voltage.

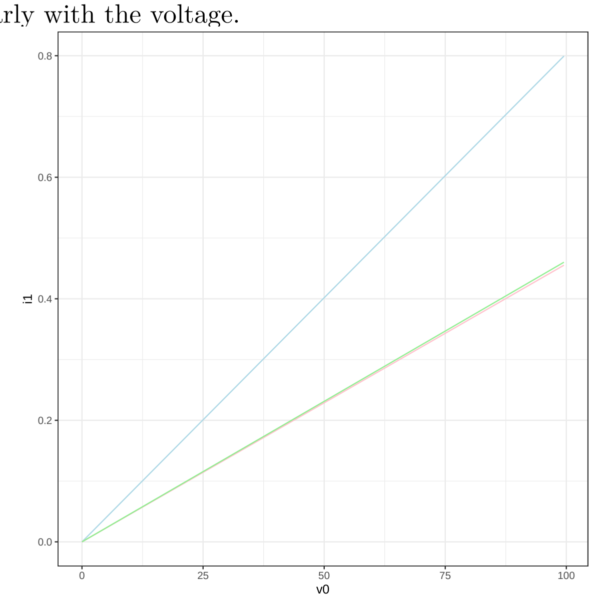

FIG. 2. Secant Method

II. PROBLEM 5-5

Here we look to find a stable geometric structure for clusters of Na+ and Cl- ions by using the Secant method to solve the following equation:

$$V(r_{ij}) = \eta_{ij}\frac{e^2}{4\pi\epsilon r_{ij}} + \delta_{ij}V_0 e^{-r_{ij}/r_0} \tag{3}$$

$$U(r_1, r_2, ...r_n) = \sum_{i>j}^{n} V(r_{ij}) \tag{4}$$

The goal here is to minimize the second equation. We do this by finding where the slope is zero which indicates that there is a stable geometric structure.

[1] T. Pang, *Introduction to Computational Physics*, Cambridge University Press (2006).