We define $V_m$ to be the network derived from the $m$th level graph of the Sierpinski Gasket by performing $\Delta$-Y transformations on each $m$-cell. Let $R_0, R_1, R_2$ be the resistances on the edges of $V_0$ after restricting a graph $V_m$ with edge resistances 1 except on a cell $F_w$ where $|w| = m$ and the edges have resistance $1 + t$. We would like to calculate their derivatives respectively with respect to $t$. To do this, we come up with a general algorithm of determining the derivatives given some conditions. We look first at a level graph where the edges have resistance one except for the top cell which has resistances $1 + \mathcal{O}(t^2), 1 + bt + \mathcal{O}(t^2), 1 + ct + \mathcal{O}(t^2)$ (we omit the $\mathcal{O}(t^2)$ in the writing, but remind the reader that the functions, though we only write the first two terms of their Taylor expansions, are rarely linear, and these are the expansions of rational functions). Using edge addition and the $\Delta$-Y algorithm, and then expanding the resistances by Taylor expansion, as shown in figure 2, we find that

$$
R'_1(0) = 1 + \frac{2}{9}(b + c), \quad R'_2(0) = \frac{1}{9}(2b - c), \quad \text{and} \quad R'_3(0) = \frac{1}{9}(2c - b).
$$

Suppose further that this $V_1$ cell was actually a subcell of a larger $V_2$ cell. Then we reduce each $V_1$ cell independently and we see that the other two $V_1$ cells, when reduced to $V_0$ cells, all have resistances $\frac{5}{3}$, and our cell in question is reduced as we did before. If we reduce again, we get figure 3, and we can perform the same operation again on the coefficients of the resistances, letting

$$
1 + \frac{2}{9}(b + c) = a', \quad \frac{2}{9}(2b - c) = b', \quad \text{and} \quad \frac{2}{9}(2c - b) = c'.
$$

Also note that the transformation of the derivatives $a, b, c$ was linear, given by the matrix

$$
D_0 = \begin{bmatrix}
1 & \frac{2}{9} & -\frac{2}{9} \\
0 & \frac{2}{9} & -\frac{1}{9} \\
0 & -\frac{1}{9} & \frac{2}{9}
\end{bmatrix}.
$$

In general, if we have a $V_1$ graph with resistances $x^n$ except in the top cell where $x^n + at, x^n + bt, x^n + ct$, where $x = \frac{5}{3}$, then the reduced $Y$ graph will have resistances $x^{n+1} + (a + \frac{2}{9}(b + c)), x^{n+1} + \frac{1}{9}(2b - c)$, and $x^{n+1} + \frac{1}{9}(2c - b)$. Moreover, we can generalize the case to when the nonconstant resistances are in the second or third cells of a $V_1$ graph, in which we just rotate the graph and apply the same transformation as before, where the matrices on the derivatives $a, b, c$ will be

$$
D_1 = \begin{bmatrix}
\frac{2}{9} & 0 & -\frac{1}{9} \\
-\frac{1}{9} & 1 & \frac{2}{9} \\
0 & \frac{2}{9} & \frac{1}{9}
\end{bmatrix}, \quad D_2 = \begin{bmatrix}
\frac{2}{9} & -\frac{1}{9} & 0 \\
-\frac{1}{9} & \frac{2}{9} & 0 \\
\frac{1}{9} & \frac{2}{9} & 1
\end{bmatrix}
$$

where $D_i$ is applied if the nonconstant edges are in the $F_i$ cell. Using these matrices, if we perturb a cell $F_w$ with $|w| = m$ in a graph $V_m$, then the derivatives of the resistances $R_i$ in the reduced $Y$ graph will be

$$
e_i^T D_w \begin{bmatrix}
1 \\
1 \\
1
\end{bmatrix} \quad (1)
$$

respectively, where

$$
D_w = \prod_{i=1}^{m} D_{w_i}.
$$