ELEC 4700
Assignment 4

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1 G and C matrix formulation

The DC simulation of the circuit found in the lab document required only a G matrix. In order to simplify the system, the capacitor was assumed to be an open-circuit, while the inductor was considered a short-circuit. This resulted in a minimum of 6 linear equations to solve the system, as the voltage at Node 2 and 3 were the same. The V vector definition used to solve the problem can be found below.

$$V = \begin{bmatrix} V_1 \\ V_2 \\ I_1 \\ V_4 \\ V_0 \\ I_2 \end{bmatrix}$$

Where V_1, V_2, V_4, and V_0 were the voltages measured at each of their respective nodes. I_1 was the current through the input voltage source, and I_2 was the current through the CCVS. The G matrix used to solve the DC simulation problem can be found below. G_X is used to denote $\frac{1}{R_X}$.

$$G = \begin{bmatrix} G_1 & -G_1 & 1 & 0 & 0 & 0 \\ -G_1 & G_1 + G_2 + G_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & G_4 & -G_4 & 1 \\ 0 & 0 & 0 & -G_4 & G_4 + G_5 & 0 \\ 0 & -\alpha G_3 & 0 & 1 & 0 & 0 \end{bmatrix}$$

The AC simulation of the circuit required both a G and a C matrix. The reactive components were handled by considering their complex impedances, $j\omega L$ for inductors, and $\frac{1}{j\omega C}$ for capacitors, and voltages across all of the impedances similar to the previous matrix. As the inductor was now being considered, 7 equations were used to fully describe the system. The V vector definition used to set up the G and C matrices for the AC simulation can be found below.

$$V = \begin{bmatrix} V_1 \\ V_2 \\ I_1 \\ V_3 \\ V_4 \\ V_0 \\ I_2 \end{bmatrix}$$

All definitions remain the same. The only difference being V_3 being the voltage at the node after the inductor. The G and C vectors were defined as found as follows.

$$G_{AC} = \begin{bmatrix} G_1 & -G_1 & 1 & 0 & 0 & 0 & 0 \\ -G_1 & G_1 + G_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & G_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & G_4 & -G_4 & 1 \\ 0 & 0 & 0 & 0 & -G_4 & G_4 + G_o & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \alpha G_3 & 1 & 0 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} C & -C & & 0 & 0 & 0 & 0 \\ -C & C + \frac{1}{L} & -\frac{1}{L} & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{L} & \frac{1}{L} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

1.1 DC Simulation Results

A DC Simulation using the MNA method was carried out on the circuit schematic found in the lab document. The voltage relative to ground at node 3 in the provided circuit schematic can be found in Figure 1.

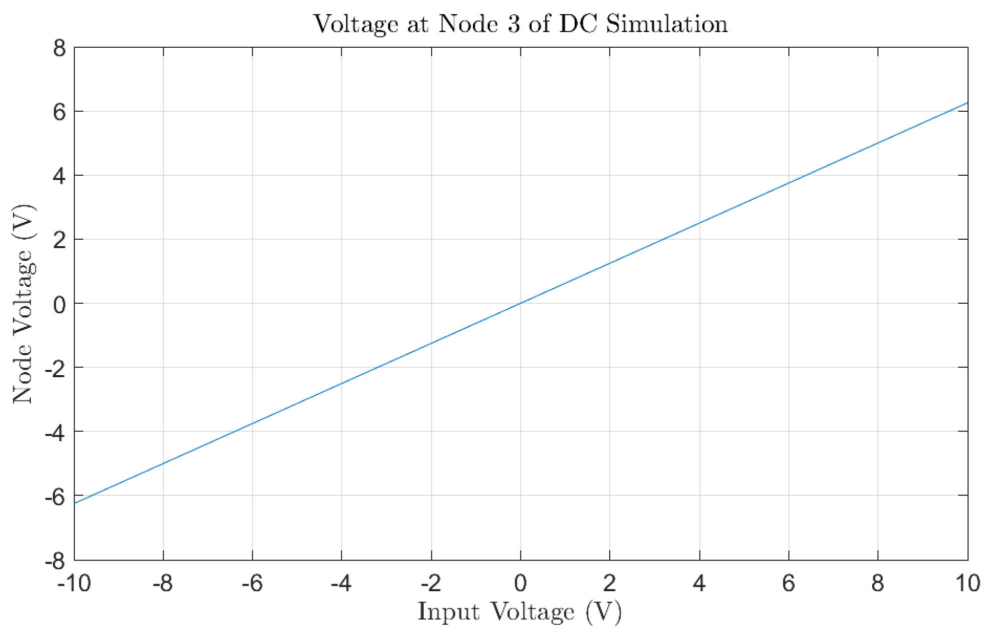

Figure 1: DC voltage at node 3 of provided circuit schematic.

The DC voltage at the output node of the circuit after voltage amplification can be found as a function of the input voltage in Figure 2.

The factor of 10 multiplation of the voltage can be confirmed quickly be noting that the current through R_3 would be 1/10th of the voltage seen at R_3. As the voltage is multiplied by 100 by the source, and the output resistance dominates R_4, the approximate remaining multiplication factor is 10.

1.2 AC Simulation Results

For the AC Simulation results, the input voltage was set to an amplitude of 1 Volt.

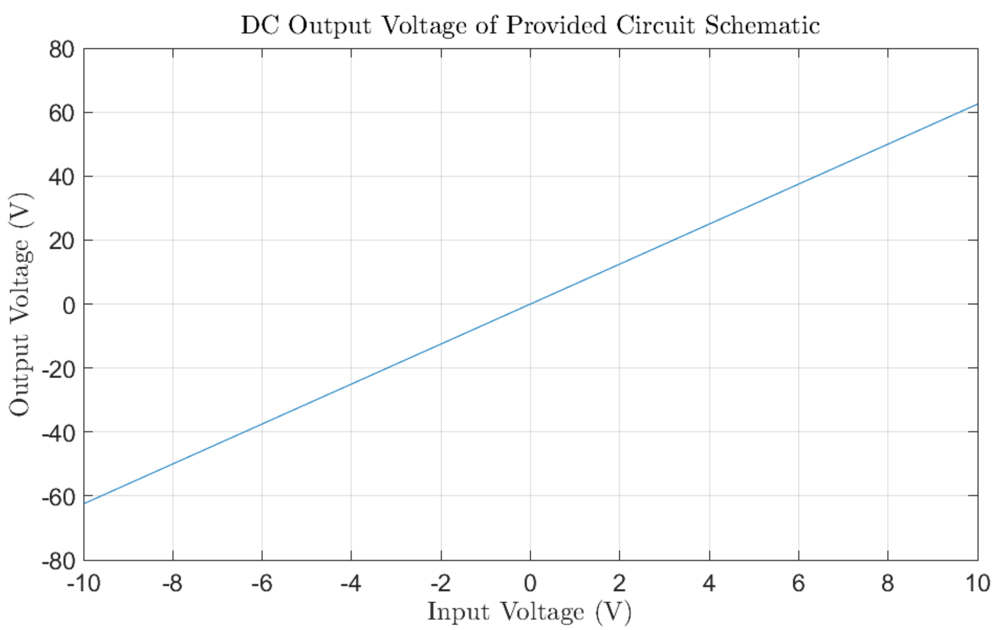

Figure 2: DC voltage at output node of provided circuit schematic.