EXPERIMENT 4
Problem Solving: Nodal and Mesh Analysis

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You will work with your lab instructor to solve several problems related to nodal and mesh analysis. You will also be asked to use MATLAB to solve or verify your answers to these problems. Nodal and mesh analysis are presented in chapter 3 of your circuit's textbook. Please review this material before attending lab.

The application of nodal or mesh analysis will result in a set of linear equations that must be solved for the node voltages (nodal analysis) or the mesh currents (mesh analysis). MATLAB can be utilized to solve a set of linear equations. Let's suppose that the nodal equations for a given circuit are:

$$\begin{bmatrix} 7 & -3 & -4 \\ -3 & 6 & -2 \\ -4 & -2 & 11 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} -11 \\ 3 \\ 25 \end{bmatrix}$$

This equation is of the form: Ax = b. A is an n x n matrix, where n is the number of non-refernce node voltages. The dimension of the both vector x and b is n x 1. The unknown node voltages are contained in vector x. Using MATLAB to solve for the node voltages is illustrated in Figure 1 below. The matrix A is entered first. Note that a semi-colon is utilized to indicate the end of a row. The vector b is entered next. The node voltages are calculated by multiplying the inverse of A by b.This is accomplished with the statement x=inv(A)*b. Alternatively, one could also use x=A\b or x=A^(-1)*b, though this latter form is not preferable.

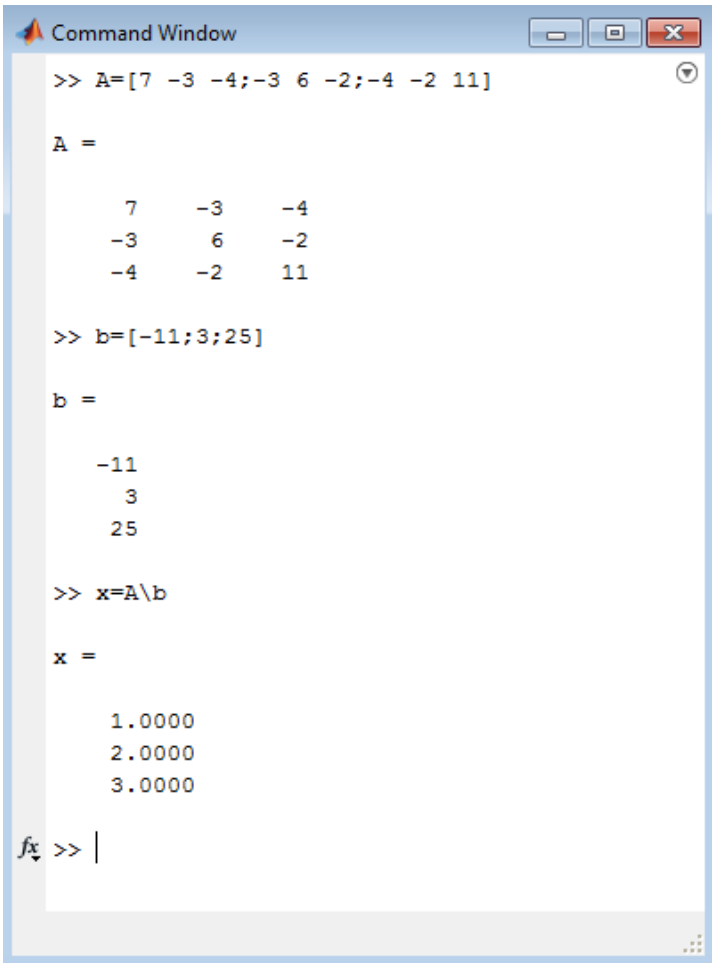

Figure 1: Solution of a Set of Linear Equations Using MATLAB's Command Window

Although the above example uses MATLAB's command window, it is highly recommended that you type out your MATLAB code in an m-file rather than the command window. To open the m-file editor, under the "HOME" tab, click "New" and select "Script" from the dropdown menu (if you're using an older version of MATLAB without the updated GUI, select the "File" dropdown menu in the top-left corner of MATLAB, hover your mouse over "New", then select "Script"). If, when you save your script, it does not default to an MATLAB Code file (or "m-file"), make sure to add ".m" to the end of your filename. When you save your m-file, do not use any white space in the filename.

The same code typed out in an m-file is shown in Figure 2. You may execute the m-file by clicking the "Run" button (boxed in red in Figure 2), under the "EDITOR" tab. If this button does not appear, then you have not saved your script as an m-file. If you have not yet saved your file at all, MATLAB will prompt you to do so. If you have saved it previously, it will save it again and execute the code. If MATLAB prompts you that it cannot find your file in the current folder, you can probably fix this by simply clicking "Change Folder" in the MATLAB prompt.

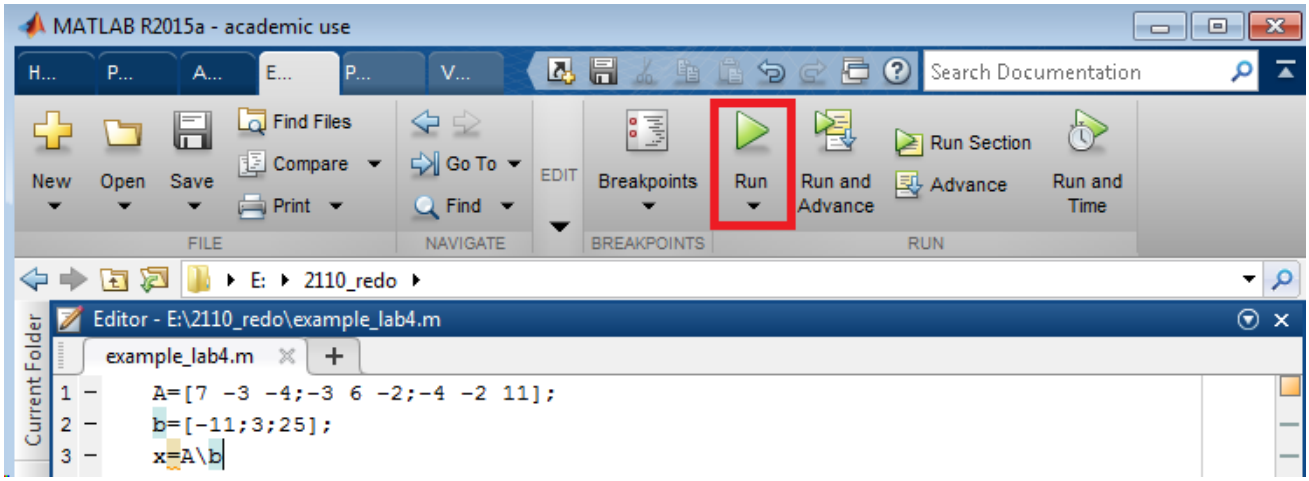

Figure 2: An m-file Example

Remember that, in MATLAB, ending a line of code with a semi-colon instructs MATLAB not to print the results of that line's execution to the command window. By leaving the semi-colon off the last line only, only the solution is printed to the command window (Figure 3).

Figure 3: MATLAB's Command Window After Running the m-file in Figure 2

MATLAB is a very useful and accessible tool for engineers. Anyone with a basic programming background can reference MATLAB's help features and internet resources to teach himself or herself how to utilize MATLAB to assist with an array of engineering problems.

Exercises

For all exercises, include in your report circuit diagrams with all variables clearly labeled, all hand calculations, hand-written matrices consisting of nodal and mesh equations, MATLAB code, and MATLAB results. Be sure that you keep all parts of each exercise together (i.e., do not organize your report by "all hand calculations, all simulations, all MATLAB", but rather "all of #1, all of #2, all of #3, all of #4, all of #5"). Use the node voltage definitions defined in each exercise. It is recommended you also use the defined mesh currents, but that is not a requirement.

1) Write nodal equations in matrix form for the circuit in Figure 4 and solve for V_0. Use MATLAB to solve your equations. Include code or screenshot of MATLAB script and results. Repeat using mesh/loop analysis.

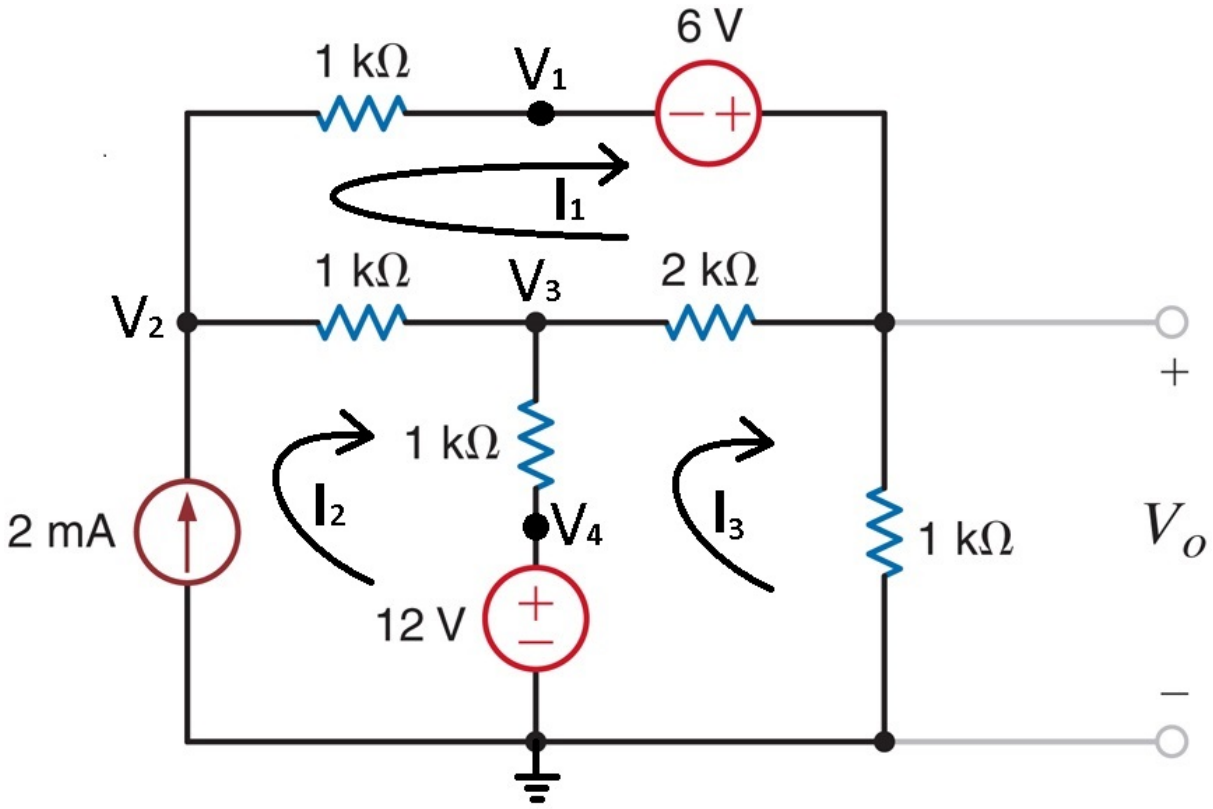

Figure 4: Circuit for Exercise 1

2) Write nodal equations in matrix form for the circuit in Figure 5 and solve for V_0. Use MATLAB to solve your equations. Include code or screenshot of MATLAB script and results. Repeat using mesh/loop analysis.

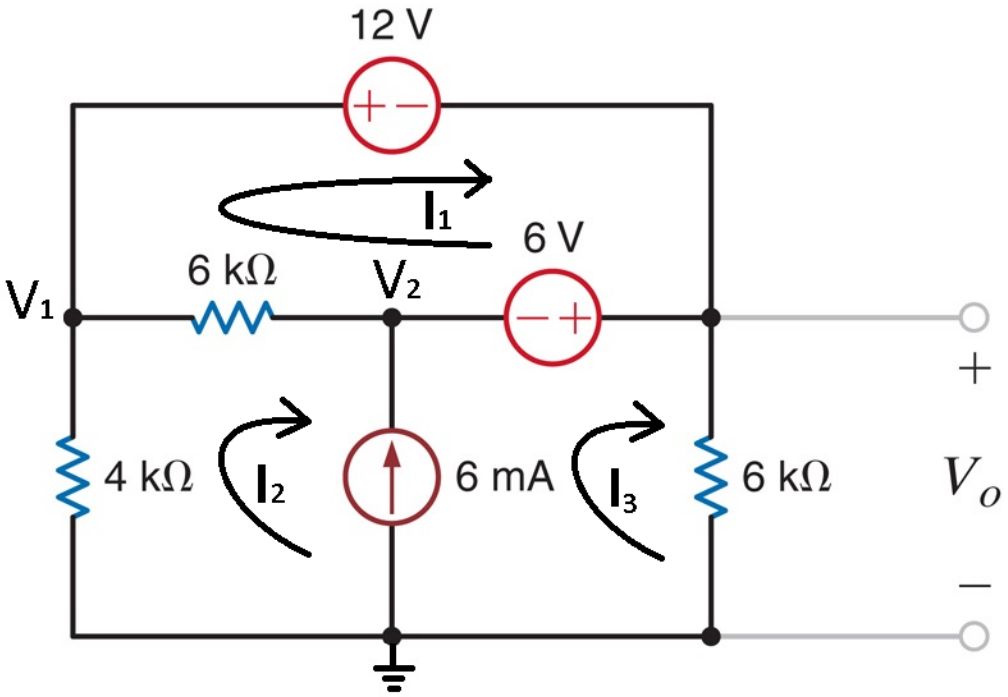

Figure 5: Circuit for Exercise 2

3) Write nodal equations in matrix form for the circuit in Figure 6 and solve for V_0. Use MATLAB to solve your equations. Include code or screenshot of MATLAB script and results. Repeat using mesh/loop analysis.

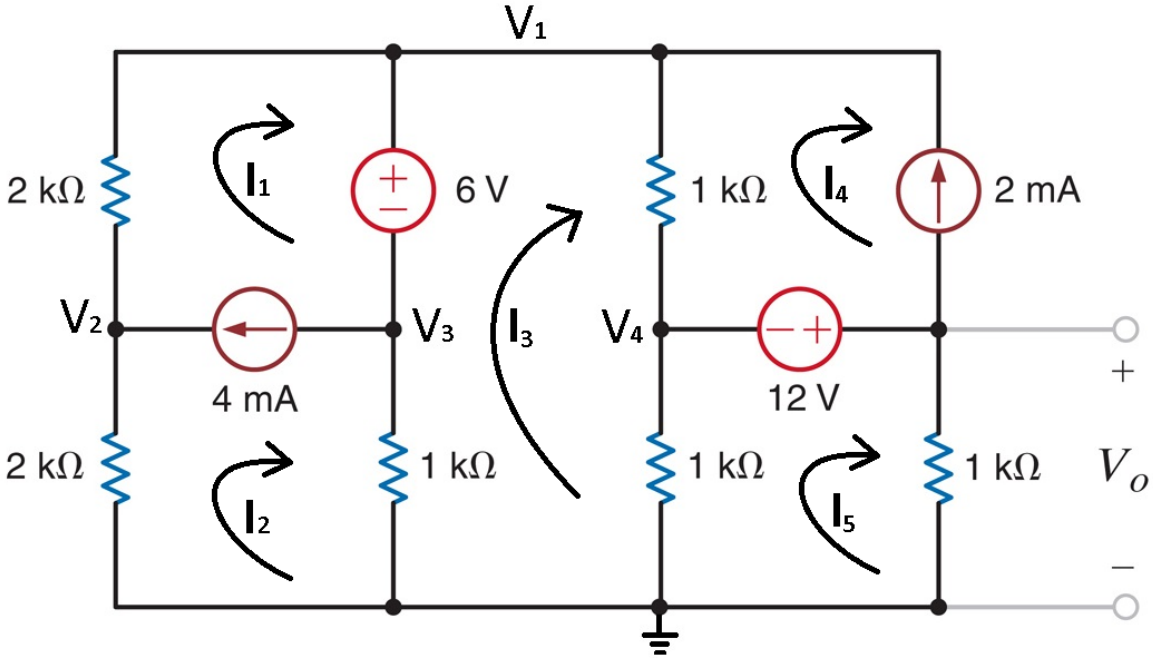

Figure 6: Circuit for Exercise 3

4) Write nodal equations in matrix form for the circuit in Figure 7 and solve for V_0. Use MATLAB to solve your equations. Include code or screenshot of MATLAB script and results. Repeat using mesh/loop analysis.

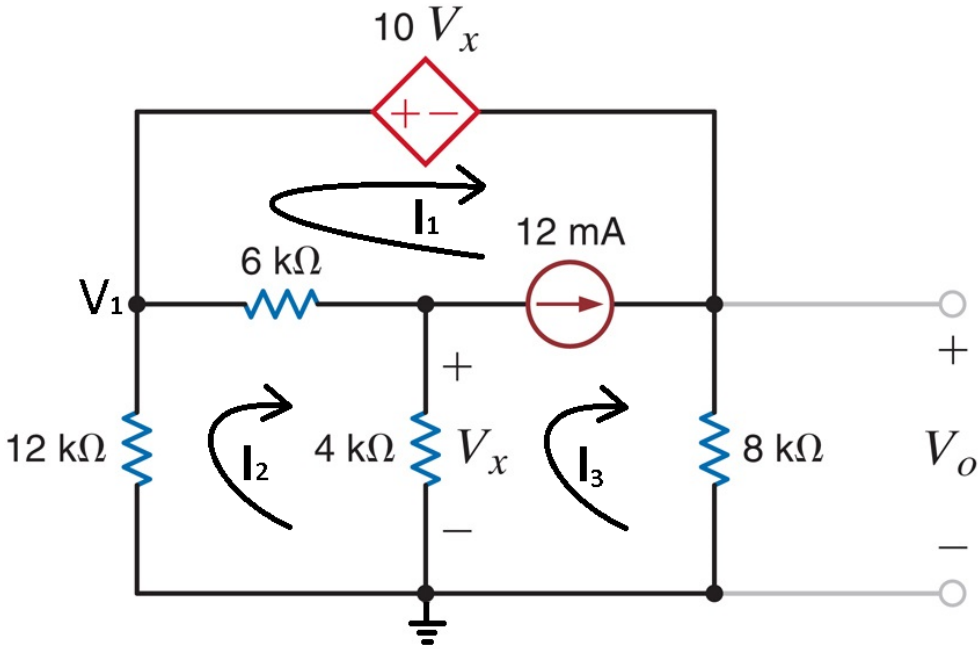

Figure 7: Circuit for Exercise 4

5) Write nodal equations in matrix form for the circuit in Figure 8 and solve for I_0. Use MATLAB to solve your equations. Include code or screenshot of MATLAB script and results. Repeat using mesh/loop analysis.

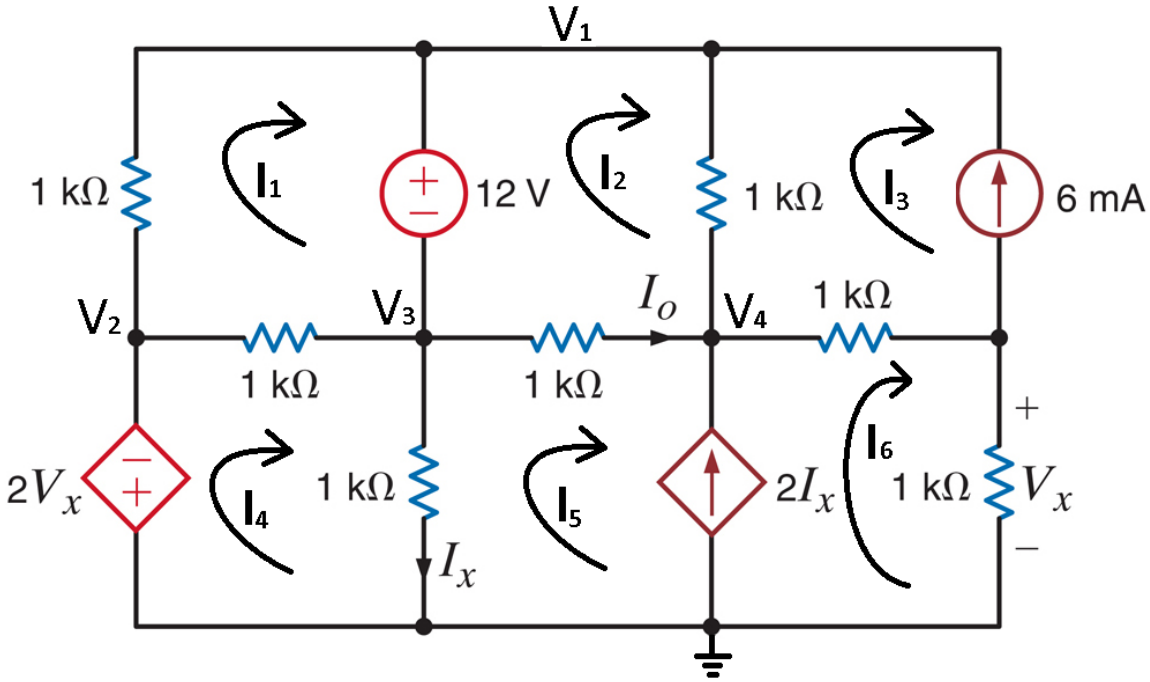

Figure 8: Circuit for Exercise 5