ELE 215 – Exercise 3 – Circuit Simulation

Objectives

- To observe how variation in device parameters impacts circuit performance.

Notes

- This is a software activity, so each student works individually on this assignment, submitting their own lab summary report.
- The overall exercise is worth 75 points as broken down below.

Procedure

1. Circuit analysis for prescribed components (20 points):

   For the specific resistive circuit shown online for your HW ID write a MatLab script to implement node analysis. Use that script to find the voltage labeled v_0 and the current labeled i_0 in the diagram. I recommend using variables for the resistor values as you will be changing them below for the simulation.

   Enter your answers for both circuit variables into the online grading site for ELE 215; if the grading tool indicates that you are correct, also enter your answers on the summary sheet for part 2; if not correct, redo the work until you get the correct answer. Note that the scoring on the online tool will start at 10 points each for v_0 and i_0 and decrease by 1 for each subsequent trial (hopefully you will not need 10 tries!). The closing date for this portion is 9 AM on Monday March 23, 2026.

2. Variational analysis (55 points):

   Unfortunately, the resistors that you would use in a lab to construct such a circuit do not match the nominal values exactly. The point of this exercise, then, is to observe how v_0 and i_0 change as the resistor values vary randomly. The approach is quite simple and was described in recitation; you are to repeatedly run your MatLab script from part 1 above with different values of the resistors, tabulating and visually observing the results.

   a) As described in recitation, one method to vary a resistor's value is to generate a random number variation and add it to the nominal resistance value. For example, if some resister R_4 was nominally 500 Ω the MatLab command

   ```
   R4 = 500 + 500*0.05*( 2*rand(1) – 1 );
   ```

   starts with the nominal value of 500 and adds to it an offset which is the product of a random number (the MatLab function rand(1) generates a single random number between 0 and 1; multiplying by 2 and subtracting 1 scales it to the range of [–1, 1]), the nominal resistance (500), and the precision of the resistance (e.g. 5% yields precision = 0.05).

Modify your MatLab script to randomly select the actual values of each of the resistors in your circuit, assuming a precision of 5%. Recompute both v_0 and i_0 for this modified circuit. Note that your values should be close to those from part 1, but not exactly the same.

b) Add a FOR loop to your MatLab script, repeating this calculation 1000 times. Keep track of the values of v_0 and i_0 for each trial (in other words, store them in arrays).

c) Compute the means of both the v_0 and i_0 arrays. Record these results on your summary sheet. Note that your mean values should be quite close to the perfect answers of part 1; if not, check your code.

d) Let's consider another statistic of your stored voltage data:
   - What range of voltage contains 90% of your answers? Specifically, find the value of x so that 90% of your answers (900 of them) are within $\pm x$ of the correct value computed in part 1 above. Record this range on your summary sheet. For example, if the nominal value for v found in part 1 above was 200 volts and the 90% range was 192-208 volts then $x = 8$ volts.
   - What percentage change of v does this 90% actual range suggest? Continuing the example with nominal value of 200 and $x = 8$, this answer would be 4% .

e) Generate separate histograms of the results for both v_0 and i_0 (use MatLab's hist command; try MatLab's help function if you do not know how to use hist); set the parameters of this command so that you see 10 bins in the histogram; you should see bell-shaped results. Copy the two histograms onto a single page; it's probably easiest to use Word here to create this page. Clearly label the two plots to tell them apart (v or i) and provide clear axis labels including units on these, please.

3. Reporting:

a) Scan both pages to a single 2-page pdf document; the first page should be the summary form and the second page should show both histograms. This second page should read normally, and NOT be rotated. Upload this single document to the ELE 215 Brighspace site.

b) Please use the following convention for the filename, substituting the last 3 digits of your HW ID number in place of 789:

Exercise_3_789.pdf