Class #12: Constrained Design - Nodal Voltages

Purpose: The objective of this experiment is to apply previously learned concepts to design circuits with specific output voltages

Background: Before doing this experiment, students should be able to

- Analyze simple circuits consisting of combinations of resistors
- Measure the voltage at a node in a circuit using a Voltmeter
- Build simple circuits consisting of combinations of resistors
- Apply series and parallel resistance characteristics to simplify circuit analysis.
- Use voltage divider concepts to find the voltage across a resistor(s) and at a node
- Apply KCL to a circuit to generate a linearly independent system of equations
- Perform matrix mathematics

Learning Outcomes: Students will be able to

- Build and circuits based on a set of design restrictions
- Verify their circuit design using circuit analysis

Equipment Required:

- M1K Board (with Alice software) or Analog Discovery (with Waveforms Software)
- Voltmeter (Alice)
- Parts Kit
- LTspice
- Pencil

Helpful links for this experiment can be found on the course website under Class #13

Pre-Lab

Required Reading: Before beginning the lab, at least one team member must read over and be generally acquainted with this document.

Part A – Design Challenges

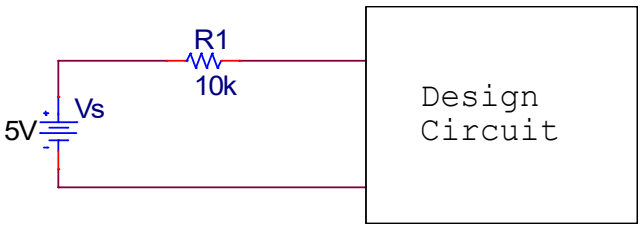

Figure A-1: Starting Circuit

A basic circuit consists of a 5V source in series with a 10kΩ resistor. You will design a circuit to output specific nodal voltages. All of the designs must have one 5V source (M1K pinout) connected to the 10kΩ resistor. Your circuit designs should use resistors found in your parts kit. In LTspice simulations, use your exact circuit design. When implementing the circuit on the protoboard, try to make the circuit as close as possible to your design, though you don't have to be perfect. For example, if your design has a 6.6kΩ resistor, you can use the 6.8kΩ resistor in your parts kit and consider it close enough. On the other hand, if your design uses a 8kΩ, the same 6.8kΩ is not close enough.

The additional constraints for your designs follow.

- Include a schematic of each circuit design in your report
- Include LTspice simulation results verifying your design for each challenge
- Implement your circuit design on the protoboard and note how the measured results compare to the design criteria
- For design challenge 3, apply KCL to get a 3x3 matrix and verify your results by using the matrix mathematics

Design Challenge 1:

Using at least two resistors (including the R1 shown in Figure A-1), complete the above circuit such that a node has voltage of 3.33V.

Design Challenge 2:

Using at least three resistors (including the R1 shown in Figure A-1), complete the above circuit such that there is one node with 3.33V and another node with 2.22V.

Design Challenge 3:

Using at least five resistors (including the R1 shown in Figure A-1), complete the above circuit such that there is one node with 3.33V, another node with 2.22V and a third node with 1.48V. Experiment demonstration required for this design challenge. Details provided in the experiment 12 template.