

Example 3: Linear Algebraic Nodal Analysis Algorithm

Circuit with 10 Resistors, 3 Voltage Sources, 2 Current Sources

Example 3: Ideal schematic diagram

In this example, we build an electric circuit that includes nine $1\text{k}\Omega$ resistors, five 5V dc voltage sources, and one 2.5mA dc current sources. Figure 1 provides a complete description of this circuit in the form of an ideal circuit diagram. Notice that in this diagram, we label and enumerate each ideal circuit element and assign associated values.

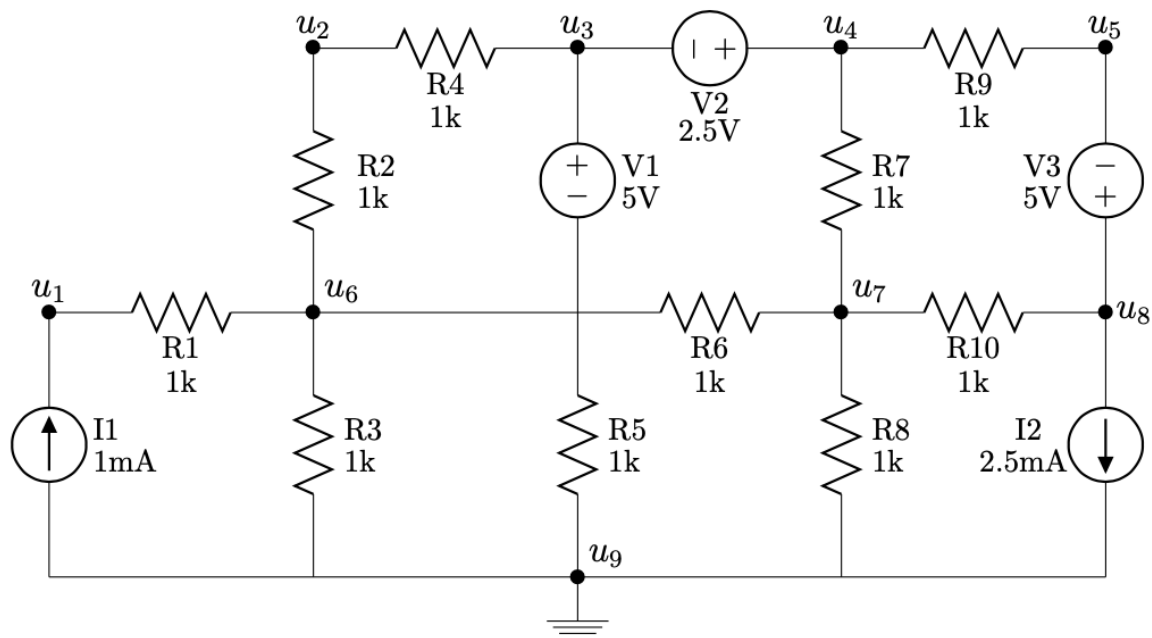


Figure 1: Ideal circuit schematic diagram

Example 3: Parts needed for this circuit

To build this circuit, we need the following parts:

- | | |
|---|--|
| <input type="checkbox"/> One half-size 2.2"x 3.4" solderless breadboard | <input type="checkbox"/> Five fully-charged 9V batteries |
| <input type="checkbox"/> Ten $1\text{k}\Omega$ resistors (brn-brn-blk-blk-brn) | <input type="checkbox"/> One red 0.2" jumper wire |
| <input type="checkbox"/> Two 5V sources (red/black wires on bottom) | <input type="checkbox"/> One orange 0.3" jumper wire |
| <input type="checkbox"/> One 2.5V source (white/black wires on bottom) | <input type="checkbox"/> One blue 0.6" jumper wire |
| <input type="checkbox"/> One 2.5mA source (red/black wires on side) | <input type="checkbox"/> One grey 0.8" jumper wire |
| <input type="checkbox"/> One 1.0mA source (white/black wires on side) | |

Example 3: Get started with a picture of the physical circuit

In Figure 2, we see a wiring diagram for the circuit we build in this example. The reader can find detailed instructions on how to prototype this circuit at the bottom of this page under the “Example 3: Build this circuit” section.

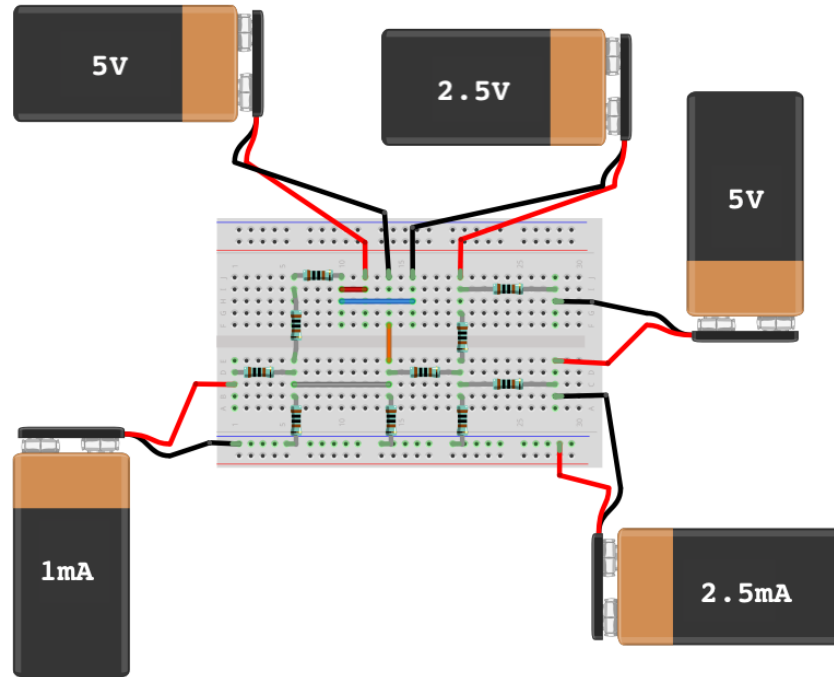


Figure 2: Digital Wiring Diagram for the Real Circuit.

Example 3: Build this circuit

To build the circuit, please grab all the necessary parts described in the “Example 2: Parts needed for this circuit” section on the first page of this document. Then, follow the instructions below:

1. ☐ Disconnect batteries from dc sources
2. ☐ Insert red 0.2" jumper across i10 and i12
3. ☐ Insert orange 0.3" jumper across e14 and f14
4. ☐ Insert grey 0.8" jumper across c6 and c14
5. ☐ Insert blue 0.6" jumper across h10 and h16
6. ☐ Insert resistor R1 across d1 and d6
7. ☐ Insert resistor R2 across e6 and i6
8. ☐ Insert resistor R3 across j6 and j10
9. ☐ Insert resistor R4 across b8 and LN6
10. ☐ Insert resistor R5 across b14 and LN11
11. ☐ Insert resistor R6 across d14 and d20
12. ☐ Insert resistor R7 across e20 and g20
13. ☐ Insert resistor R8 across b20 and LN16
14. ☐ Insert resistor R9 across i20 and i28
15. ☐ Insert resistor R10 across c20 and c28
16. ☐ Insert red lead of V1 in j12 and blk lead in j14
17. ☐ Insert white lead of V2 in j20 and blk lead in j16
18. ☐ Insert red lead of V3 in e28 and blk lead in h28
19. ☐ Insert white lead of I1 in c1 and blk lead in LN1
20. ☐ Insert red lead of I2 in LN24 and blk lead in b28
21. ☐ Connect the batteries to the dc power sources

Example 3: Measure Circuit Variables

In the table below, please write all the measurements you took for the fundamental circuit variables associated with the LANA Example 3 circuit. Notice that for each circuit element, we have two physical measurements.

LANA Example 3, Table I: Observed Circuit Variable Values

Circuit Element	Voltage Variable	Measured voltage (V)	Current Variable	Measured current (mA)
R1	v_{r_1}		i_{r_1}	
R2	v_{r_2}		i_{r_2}	
R3	v_{r_3}		i_{r_3}	
R4	v_{r_4}		i_{r_4}	
R5	v_{r_5}		i_{r_5}	
R6	v_{r_6}		i_{r_6}	
R7	v_{r_7}		i_{r_7}	
R8	v_{r_8}		i_{r_8}	
R9	v_{r_9}		i_{r_9}	
R10	$v_{r_{10}}$		$i_{r_{10}}$	
V1	v_{v_1}		i_{v_1}	
V2	v_{v_2}		i_{v_2}	
V3	v_{v_3}		i_{v_3}	
I1	v_{i_1}		i_{i_1}	
I2	v_{i_2}		i_{i_2}	

Example 3: Measure the node voltage potentials

Using the digital multimeter, please measure the voltage potential at the nine nodes of our LANA Example 3 circuit. We begin by connecting the negative lead of our multimeter to node nine. Then, we connect the positive lead of the multimeter to each of the nine nodes, one by one, to capture the voltage meter. In figure 3, we enumerate the node locations on the wiring diagram for this circuit.

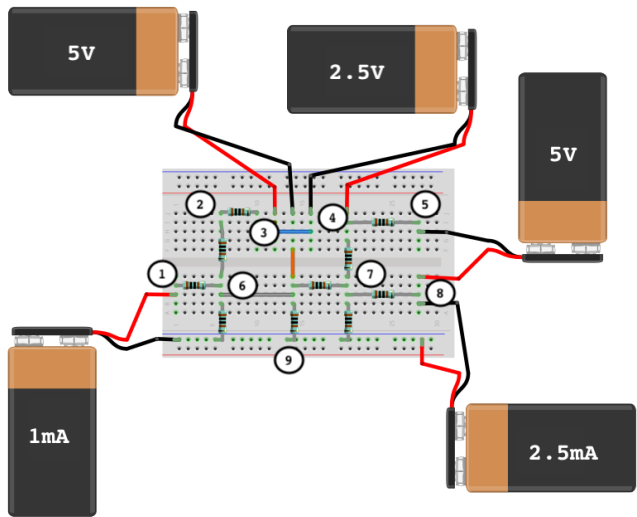


Figure 3: Nodes on Physical Circuit

Table 2:Node potential measurements

Node	Node Variable	Measured value (V)
1	u_1	
2	u_2	
3	u_3	
4	u_4	
5	u_5	
6	u_6	
7	u_7	
8	u_8	
9	u_9	