**The Breadboard; DC Power Supply; Resistance of Meters; Node Voltages and Equivalent Resistance; Thévenin Equivalent Circuit**

**Reference:** C.W. Alexander and M.N.O Sadiku, *Fundamentals of Electric Circuits*
Chapters 2, 3 and 4

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**The Breadboard**

1. a) Sketch on the left breadboard lines that illustrate pattern of short connections on the breadboard. It is enough to draw several examples for each type of connections.
   b) Sketch the circuit below on the right breadboard in the manner you would do it with actual components. Use lines to represent wires, familiar symbols for resistors. Mark the A, B, C, D and E points of the circuit.

\[ \text{Example:} \]

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a) Pattern of short connections

b) Connecting the circuit
RESISTANCE OF METERS

2. a) A voltmeter is an instrument for measuring the difference in potential energy (voltage) between two points. Voltage is measured in units of volts (V).
   What should be the value of internal resistance of an “ideal” voltmeter (low / medium / high)?
   \[ R_V = \] ________________
   Why is such voltmeter called ideal? Sketch and explain.

   b) An ammeter is an instrument for measuring the current, or rate of flow of charge, through a circuit. Current is measured in units of amperes (A).
   What should be the value of internal resistance of an “ideal” ammeter (low / medium / high)?
   \[ R_A = \] ________________
   Why is such ammeter called ideal? Sketch and explain.

d) By Ohm’s Law, \( I_1 = \frac{V}{R} \).
   If we insert a real (not ideal) ammeter, as shown, with internal resistance \( R_A \), the current in the circuit will change to \( I_2 \). Assume that real ammeter may be substituted with \( R_A \) in series with the ideal ammeter.

   ![Diagram of circuits with ammeters and voltages](image)

   e) Derive an expression for \( I_2 \) in terms of the previous \( I_1 \), \( R \) and \( R_A \).
   \[ I_2 \text{ (expression)} = \] ________________

f) Determine the value of \( R_A \) for which \( I_2 = 0.5 I_1 \).
   \[ R_A \text{ (for } 0.5 I_1) = \] ________________
ECE 202 - Experiment 3 - PreLab Homework

g) By Ohm’s Law $V_1 = IR$.
If we insert a real voltmeter into the circuit, as shown below, with internal resistance $R_V$, the voltage will change to $V_2$. Assume that real voltmeter may be substituted with $R_V$ in parallel with the ideal voltmeter.

h) Derive an expression for $V_2$ in terms of $V_1$, $R_V$ and $R$.

$$V_2 \text{ (expression)} = \frac{V_1}{1 + \frac{R}{R_V}}$$

i) Determine the value of $R_V$ for which $V_2 = 0.5 \ V_1$.

$$R_V \text{ (for 0.5 } V_1) = \frac{V_1}{0.5 - 1}$$
3. You will build the following circuit in the lab. Calculate all node voltages using method of your choice. You will later compare your calculations to measured values.

![Circuit Diagram](image)

Show your work here:

Calculated circuit variables using nominal resistor values: (include units)

\[ V_A = \quad V_B = \quad V_C = \quad \]
\[ V_D = \quad V_E = \quad \]
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**Equivalent Resistance**

4. The idea of equivalent resistance is that, as viewed from the external terminals, a circuit consisting of a number of interconnected resistors can be replaced by one equivalent resistor having a value equal to the combined effect of all the original resistors. At the external terminals, this equivalent resistor will be indistinguishable from the original circuit.

Consider the resistor combination within the box in the circuit from part 3. It can be replaced with a single equivalent resistor $R_e$. In the lab you will do this and observe any change in the remaining node voltages of the circuit. Calculate the equivalent resistance of the resistor combination inside the dotted box using their nominal values. Show your work here:

$$R_e = \text{__________ (k}\Omega\text{)}$$

**Thévenin Equivalent Circuit**

5. The resistors in the dashed box have been replaced by their equivalent $R_e$ and we will now focus on the elements that were formerly outside the box.

![Thévenin Equivalent Circuit Diagram]

Calculate the Thévenin equivalent circuit of everything to the left of $R_e$. Show your calculations here:

$$V_{Th} = \text{__________ (Volt)} \quad R_{Th} = \text{__________ (Ohms)}$$
RESISTOR COLOR CODES

Although every effort is made that resistors are placed in the correct bins in the lab, you should always check their nominal values before using them. Write 5-band colors for the resistors you will be using in the first lab.

Note #1: In a 5-band resistor notation, band allocation is:
- bands 1-3: significant digits (value)
- band 4: order of magnitude
- band 5: tolerance (in percents)

Note #2: Assume 5% tolerance (although resistors in the lab may have different tolerances).

4.7kΩ _________________________________________________________________

10kΩ _________________________________________________________________

2.6kΩ _________________________________________________________________

1kΩ _________________________________________________________________

800kΩ _______________________________________________________________

400kΩ _______________________________________________________________

*Tech Notes: Resistors have nominal resistance values which are written on them or indicated by the color code. The actual resistor value, however, can be determined only by measurement. In this homework, use nominal values; in the experimental part, you will use measured values.

http://en.wikipedia.org/wiki/Electronic_color_code