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Laboratory 3 - Voltage Divider and Meter Loads of Digital Multi-Meter

SPICE Simulation

Problem 1

1. Assuming input voltage V1 to be 5.5V and resistance R2, 10 times the resistance R1, what is the output voltage V if there is no load connected.
2. Calculate the output voltages V for the listed values of R1 and RL and complete the **Table 1**.

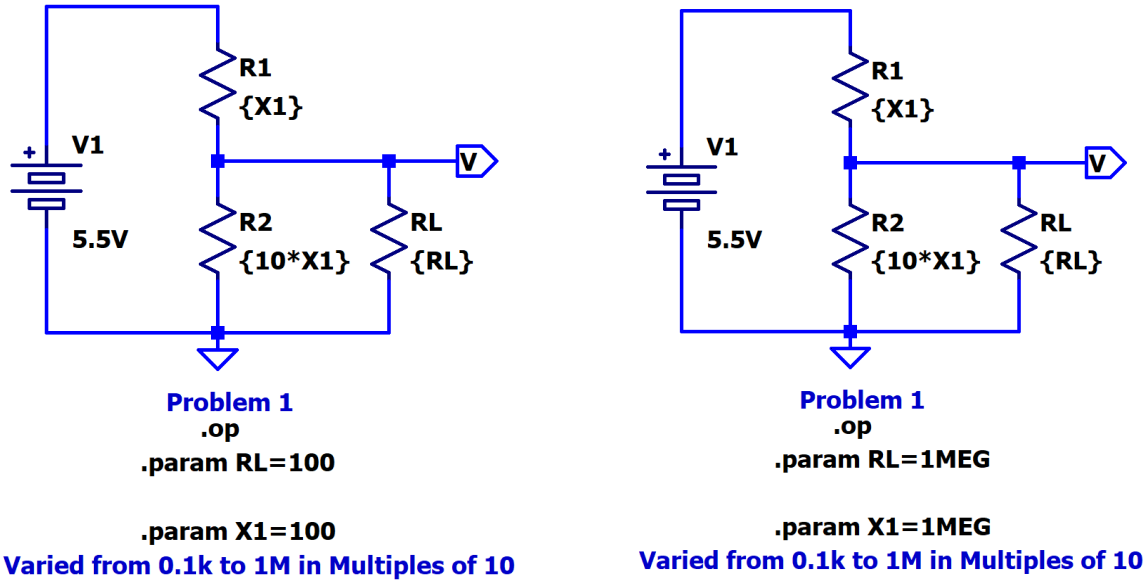

Fig 1. Circuit Diagrams

Table 1

R_{LOAD}	Resistance R_1				
	100Ω	**1kΩ**	**10kΩ**	**100kΩ**	**1MΩ**
100Ω	2.61905	4.5833	4.95496	4.99546	4.99955
1kΩ	0.49549	2.61905	4.5833	4.95496	4.99546
10kΩ	0.054401	0.49549	2.61905	4.58333	4.95496
100kΩ	0.00549	0.054401	0.49549	2.61905	4.58333
1MΩ	0.00054	0.005493	0.054401	0.495495	2.61905

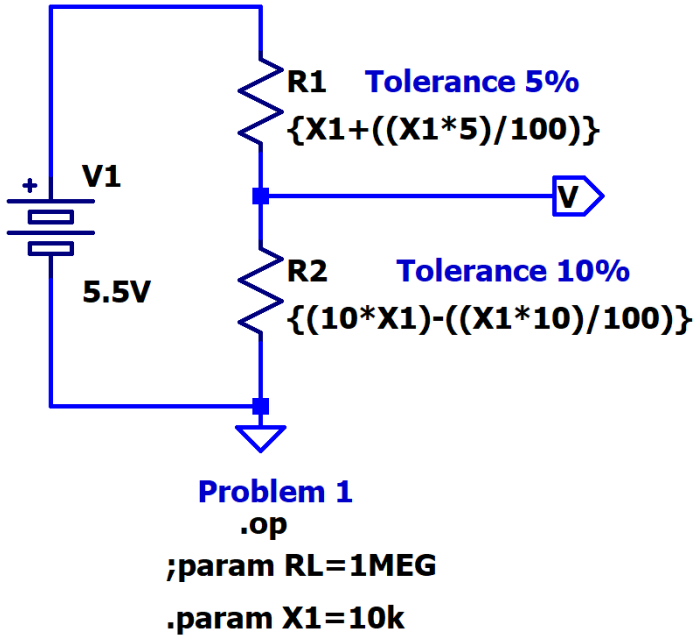

Fig 2. Circuit Diagram

Table 2

3. For the case of resistance R1 10kOhms and no load is connected, if both R1 and R2 have tolerance of 5% and 10%, find the maximum and minimum value of the output voltage and complete **Table 2**.

R_1	R_2	Output Voltage
-5%	-10%	5.01843
-5%	+10%	5.02715 (Maximum)
+5%	+10%	4.98206
+5%	-10%	4.9726 (Minimum)

Problem 2

1. Provide detailed design and explain how the circuit is used for measuring internal resistance measurement.
2. Clearly explain how to choose the values of voltage source and resistors used in the circuit and sequential steps to perform the measurements.

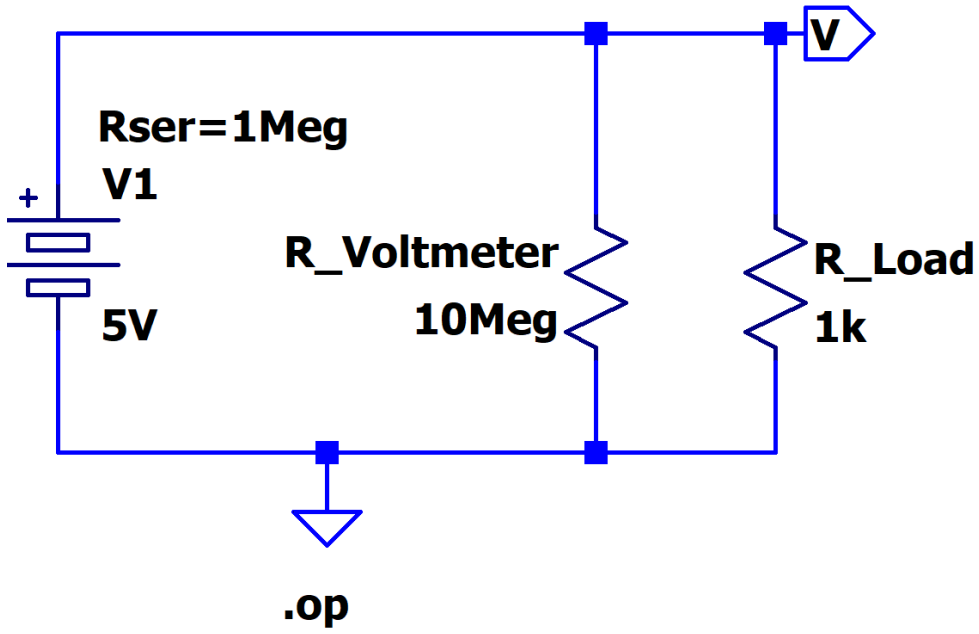

Fig 3a. Circuit Diagram

Resistance greater than 10% of the internal resistance of the voltmeter then the measurement will not reflect the actual voltage.

Voltage

For an ideal voltmeter that is place in parallel the internal resistance should be high, tending towards InF.

For an ideal voltage source the internal resistance should be zero.

Current

For an ideal ammeter that is place in series the internal resistance should be zero, providing zero effect on the current.

For an ideal current source the internal resistance should be InF.

Fig 3b. Thumb Rules

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        --- Operating Point ---

V(v):           0.00499451     voltage
I(R_load):      4.99451e-006   device_current
I(R_voltmeter):                -4.99451e-010  device_current
I(V1):          -4.99501e-006  device_current
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Fig 3c. Operating Points

$$\text{Internal Resistance (r)} = \frac{\text{Voltage Source (E)} - \text{Voltage Delivered to Load(V)}}{\text{Current (I)}}$$

Here the voltmeter resistance modelled as $R_{VOLTMETER}$ follows the thumb rule 10% higher than the measuring voltage so, the current flow through that path is negligible.

$$r = \frac{5 - 0.00499451}{4.99451 * 10^{-6}} = 1000099.207 \approx 1\text{M}\Omega$$
