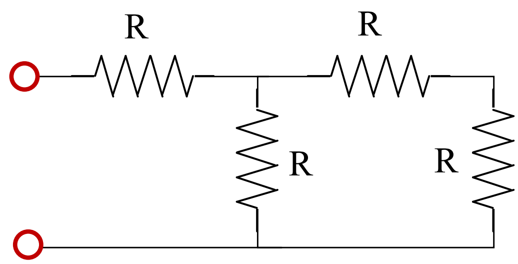
LAB 3 - RESISTIVE CIRCUITS (2h)

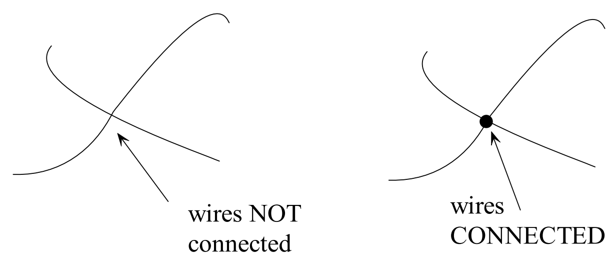


Here we will construct simple circuits with only resistors and power. We will learn to use the DMM to take resistance and voltage measurements. **REFER** to the **CT GUIDE** on resistors, breadboard, and DMM use.

Always verify issued components are correct (check R color band & measure on DMM).

For this lab, "theory" (or theoretical) means quantities are idealized. Use nominal values for components (e.g., red-black-red resistor is exactly 2k ohms) and perfect settings (e.g., Vapplied = 10 exactly, even if the actual applied voltage with 9.95v). "Actual" means measured quantities (usually measured on DMM).

Figures shown in this handout may show wires cross each other. The crossing wires are electrically connected only if there is a black dot. If there is no dot, then the wires are NOT electrically connected.

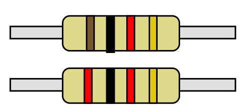


3.1 EQUIPMENT LIST

1. Trainer system (XK-700) (for breadboard (Bb) and power supply)
2. Power supply (10V, & power jack adapter)
3. Solderless Breadboard
4. Wire cutter/stripper
5. Digital multi-meter (DMM)
6. Resistors (measure with DMM & record (***)) — Measured (kΩ)

   R_1 = 1 kΩ (brown – black – red – gold) ________

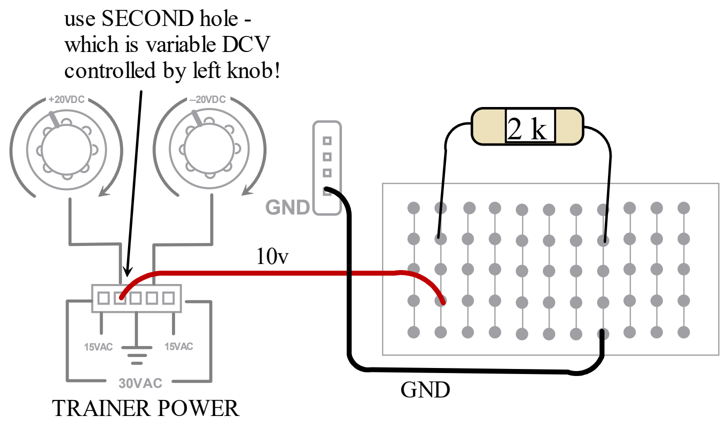
   R_2 = 2 kΩ (x2): (red – black – red - gold) ________ ________



7. Potentiometer (~ 100 kΩ, large to get large Δ's in voltage)
8. Hookup wire (22 AWG, a couple of pieces)
9. Jumper wire kit (22 AWG wire)

3.2 MEASURE R WHILE CONNECTED TO POWER

Is it okay to measure resistance while the resistors are wired to a power supply that is OFF? Let's check!

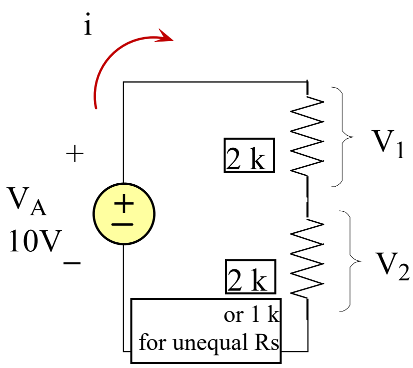


STEPS

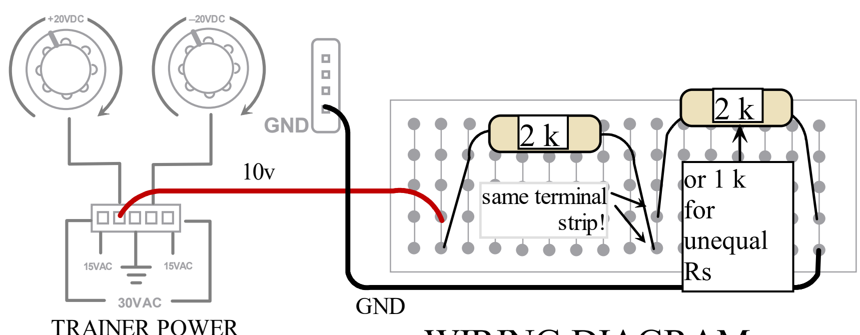
1. Wire the circuit shown
2. (***) Measure resistance (R) with DMM (with power DISCONNECTED - ie, remove either power or GND wire from Rs)
3. (***) Now measure R with power OFF but CONNECTED. If DMM does not settle on a value within 4-5 seconds, record "drifting".
4. (***) Is it okay to measure R with circuit connected to power (even if power is off)?

3.3 SERIES CIRCUIT

3.3.1 Equal Rs



SCHEMATIC



WIRING DIAGRAM

STEPS

1. Disconnect power from breadboard
2. Wire up only the resistors in circuit shown (don't connect power yet).
3. Compute Rtot (theory).
4. (***) Measure Rtot (actual).
5. Connect power to the circuit (but with power supply OFF).
6. Measure Rtot again.
7. Turn power on
8. (***) Measure voltages (V_A, V_1 & V_2). Record values.
9. Compute theoretical voltages and compare with measured values.
10. Note - we will NOT be measuring CURRENTS. Too many students will blow out the fuses on the DMM's when doing this. The DMM has very low internal resistance in current-measuring mode. If DMM leads are placed in parallel with any component (eg - as with measuring V or R) while in this mode, nearly all the current will pass thru the low internal resistance and the fuse will blow.

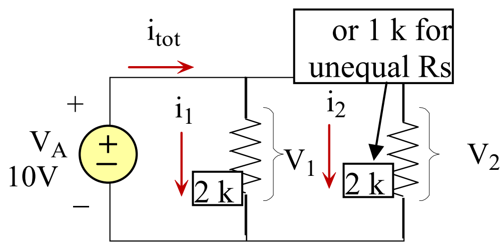
3.3.2 Unequal Rs

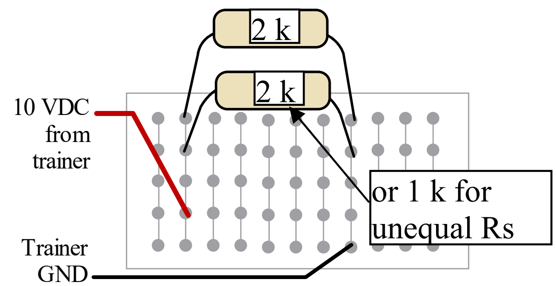
STEPS

11. Turn OFF power. Disconnect power from circuit.
12. Replace the second resistor with R_1 (1 kΩ).
13. (***) Measure Rtot.
14. Reconnect power and turn on power.
15. (***) Re-measure voltages (Vtot, V_1 and V_2).
16. Compute theoretical voltages and compare with measured values.

3.4 PARALLEL CIRCUIT

3.4.1 Equal Rs





STEPS

1. Disconnect power from breadboard
2. Wire up circuit above (power disconnected).
3. Compute Rtot (theory).
4. (***) Measure Rtot (actual).
5. Connect power to the circuit and turn power on.
6. (***) Measure voltages (V_A, V_1, & V_2).
7. Compute theoretical voltages (& currents) and compare.

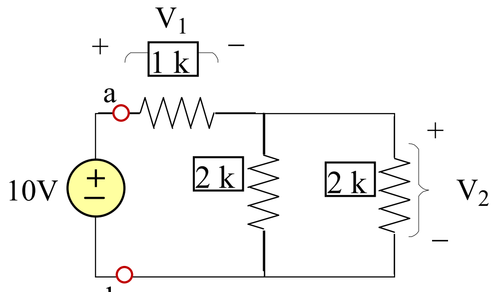
3.4.2 Unequal Rs

STEPS

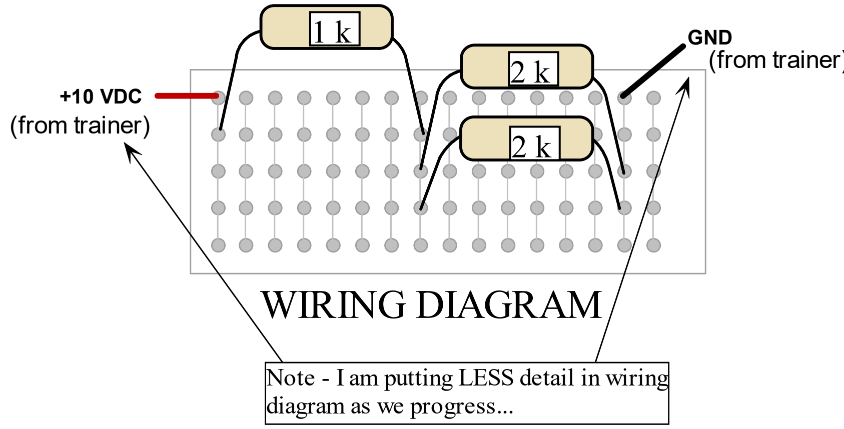
8. Turn OFF power. Disconnect power from circuit.
9. Replace one of the resistors with R_1 (1 kΩ) (it doesn't matter which R is replaced).
10. (***) Re-measure Rtot.
11. Reconnect power and turn on power.
12. (***) Re-measure voltages (V_A, V_1 and V_2).
13. Compute theoretical voltages (& currents) and compare with measured values.

3.5 SERIES-PARALLEL RESISTIVE CIRCUIT

Here we will construct a simple series-parallel resistive circuit and take voltage measurements on it. We will record these measured values and compare them to theoretical values. Notice the wiring diagram now shows less detail (the power supply is not shown). Get used to building circuits without being given every little detail. Eventually you should be able to construct these circuits with only a schematic.



SCHEMATIC

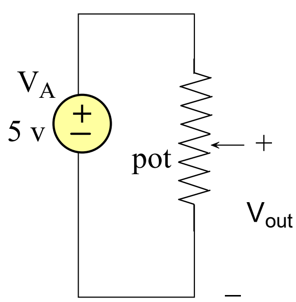


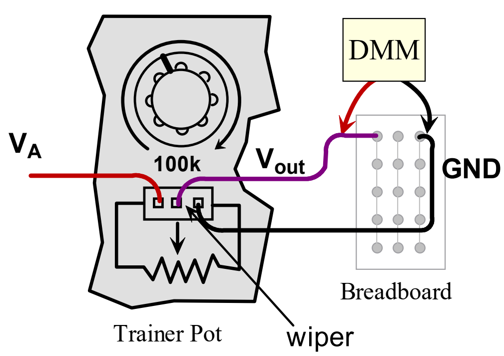
STEPS

1. Turn OFF power and disconnect power from circuit.
2. Construct the circuit above.
3. (***) Measure Rtot (resistance across points a and b with power disconnected).
4. Reconnect power and turn on power.
5. (***) Re-measure voltages (V_1 and V_2). Record. Compare against theoretical values.

3.6 VARIABLE RESISTANCE & VOLTAGE

Here we use the DMM to show continual changes in resistance on a potentiometer ("pot") as we turn its dial. REFER to the **CT GUIDE** on pots, section 6.4). A pot is a 3-terminal resistor whose middle terminal connects to its WIPER. As you turn the dial the wiper moves along a resistive element. We will first measure the smooth changes in resistance as we turn the dial. Then we'll hook up DCV to the pot and show that we can also get smooth changes in voltage. If your trainer pot is damaged (R or V does not change smoothly) inform the instructor. He may issue you a surface-mount pot.





STEPS

1. Construct circuit shown. Use trainer pot (or optionally another pot) & dedicated 5V supply on trainer.
2. But then disconnect V_A so we can measure R.
3. Measure R across the outer terminals. Overall pot R should match trainer label (eg - 1kΩ for 1k)
4. Now hook up DMM to wiper and one outer pot terminal. Turn dial.
5. Is R changing smoothly between roughly 0 and the overall pot value? If not the pot may be damaged.
6. Report the damaged pot to the instructor.
7. Reconnect and turn on power (V_A).
8. Turn the pot slowly from one extreme to the other extreme while measuring V.
9. Is the voltage changing smoothly?

10. (***) Record the range of values for V.
11. Do the above steps with both pots on trainer
12. (***) Report whether any of the trainer pots are no good.

LAB 3 – ANSWER SHEET

RESISTIVE CIRCUITS

Team Number: ___________

Name 1: ______________________________   Name 2: ______________________________

3.1 Equipment List

Resistors	Nominal value (kΩ)	Measured (kΩ)	
R_1 =	___________.	___________.	
R_2 =	___________.	___________.	___________.

3.2 Measuring R while connected to Power

___________.   R w/o power connection
___________.   R w/ power connection (even power off)
___________.   Is it OK to measure R with power connected & OFF?

3.3 Series Rs

	EQUAL Rs Theory	EQUAL Rs Measured	UNEQUAL Rs Theory	UNEQUAL Rs Measured
R_{TOT} =	___________.	___________.	___________.	___________.
V_A =	___________.	___________.	___________.	___________.
V_1 =	___________.	___________.	___________.	___________.
V_2 =	___________.	___________.	___________.	___________.
i =	___________.	(not measured)	___________.	(not measured)

3.4 Parallel Rs

	EQUAL Rs Theory	EQUAL Rs Measured	UNEQUAL Rs Theory	UNEQUAL Rs Measured
R_{TOT} =	___________.	___________.	___________.	___________.
V_A =	___________.	___________.	___________.	___________.
V_1 =	___________.	___________.	___________.	___________.
V_2 =	___________.	___________.	___________.	___________.

3.5 Series-Parallel Circuit

	Theory	Measured
R_{TOT} =	___________.	___________.
V_A =	___________.	___________.
V_1 =	___________.	___________.
V_2 =	___________.	___________.

3.7 Variable resistance & voltage

_________. 1k pot   _________. 100k pot   Pot R changes smoothly?
_________. 1k pot   _________. 100k pot   Range of voltages