Announcements

- Bring circuit supplies to lab this week.
  » Scientific Supply Store only takes cash or check
- Be on time to lab
  » Labs start at 1pm or 3pm depending on section
  » 5 min late – miss the lab quiz
  » 10 min late – counted absent
- Labs are building blocks to design process and documentation.
- Work problems at the end of Chapter 6 for practice. Solutions on web site.
- Read Chapter 6 before next lecture.

Extracurricular Professional Mtgs

- Memos
  » Refer to web site before attending.
  » Turn in hard copy to me in lecture only!
    – Memos cannot be turned in any other time.
- Meetings
  » Look out for meetings on your own.
  » I will announce IEEE meetings when I hear about them.

Circuit Basics

- Electricity flows through a circuit just like water through a pipe.
  » charge -- water in a pipe
  » current -- water flow
  » voltage -- pressure
  » resistance -- resistance to flow (inverse of pipe cross-sectional area)
  » capacitance -- water stored under pressure (e.g. a balloon)

A Key Difference

This can’t happen with a wire!

Units

- charge -- coulombs (C)
- current -- amperes (A), A=C/s
- voltage -- volts (V)
- resistance -- ohms (Ω), Ω=V/A
- capacitance -- farads (F), F = C/V
Note: farads are huge units -- usually use μF (microfarads)
Circuit Elements

- voltage source (e.g. battery) -- water pump with specified pressure. Units: volts (V)

AC to DC

- AC = alternating current (wall plug-in)
- DC = direct current (battery)

Circuit Elements

- resistor -- pipe with small cross-sectional area that impedes water flow. Units: ohms (Ω)

Circuit Elements

- capacitor -- balloon or membrane across a pipe that can stretch with water pressure. Units: farads (F)

Circuit Elements

- diode -- valve that only allows water to flow one direction. (No units)

Ohm’s Law

- The current $I$ flowing through a resistor is proportional to the voltage $V$ across it and inversely proportional to the resistance $R$:

$$\frac{V}{R} = I$$

or

$$V = IR$$
Ohm’s Law - Example

Always:
- Label current directions
- Put +/- signs on voltages

I = 5/100 = 0.05A

Passive sign convention: place the positive voltage reference at the same terminal that the current enters

Connection Types

- Series
- Parallel

Series Connection

- Current is the same through all elements.

Series Connection

- Resistor add in series. These are equivalent.

Ex: R1=50Ω, R2=100 Ω ⇒ R=150 Ω

Multiple Voltage Sources

- Multiple voltage sources in series add.
- These circuits are equivalent.

Wait – I thought they ADDED!

- 10 + 4 = 6?
- Have to look at the polarity
Parallel Connection

- The voltage is the same in all elements.

\[ V_1 = V_2 \]

\[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R = \frac{R_1 \cdot R_2}{R_1 + R_2} \]

Ex: \( R_1 = 50 \Omega, R_2 = 100 \Omega \Rightarrow R = \frac{50 \cdot 100}{150} = 33.33 \Omega \)

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Series vs. Parallel

- Are the lights in your house/apartment wired in series or parallel?

\[ V_1 = \frac{R_1}{R_1 + R_2} \cdot V \]

Answer: Parallel!

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Voltage Division

- If \( R_1 \) represents the wire resistance and \( R_2 \) represents the motor and motor circuit resistance, we want \( R_1 \) to be as small as possible. This will deliver the maximum voltage to the motor.

\[ V_2 = \frac{R_2}{R_1 + R_2} V_1 \]

A voltage-division problem will be on next Tuesday’s quiz!!!

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Voltage Division - Example

\[ V_2 = \frac{R_2}{R_1 + R_2} V_1 \]

\[ V_2 = \frac{20}{10 + 20} \times 15 = 10V \]

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Breadboards

- Used for rapid prototyping
  - Easier & faster than soldering
  - Allow for easy alterations
- Generally for temporary use
- Components just plug in
How a Breadboard Works

- Connect components by plugging them in
- Components are connected by copper wires underneath holes

Connecting Resistors in Series

Connecting Resistors in Parallel