

ECE 2200/10 Introduction to Electrical Engineering for non-majors

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12/30/11
8/24/15,
8/21/23

2200 = 1/2 semester (Mining, Mat. Sci.)

ECE 2200 Without the Physics is hard, Plan on it!

2200, Decide today when you want to take the **final**:
Final is **after** official end of class unless you ask for different accommodation today.

2210 = Full semester (Mechanical, Chemical, etc.)

2210 Final in finals week, see U of U schedule

BOTH

Regularly check the calendar on for this class on Canvas. Watch your Canvas announcements.
Be prepared to download and possibly print weekly packets, which include notes and homeworks.

Homeworks are due by 11:59 pm of the due date on Canvas. Make sure you have a way to scan paper or do your work on a tablet so that you will can submit a .pdf file. If the homework assignment .pdf provides room for you to work out the problem, please do your work on the provided .pdf files. This makes graders job easier.

WARNING: HWs are often due on non-class days.

Most labs start next week. Need a lab notebook and a U-card with \$16 for labs.

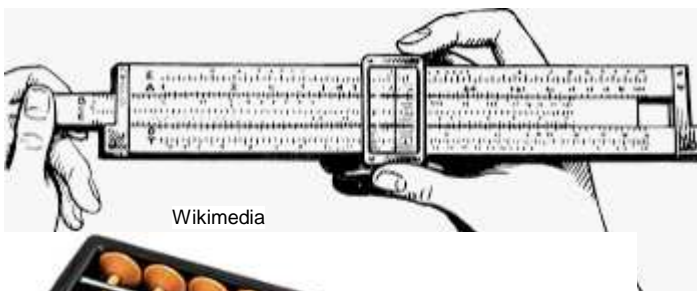
How to survive

1. Easiest way to get through school is to actually learn and retain what you are asked to learn.
Even if you're too busy, don't lose your good study practices. What you "just get by" on today will cost you later.
Don't fall for the "I'll never need to know this" trap. Sure, much of what you learn you may not use, but you will need some of it, some day, either in the current class, future classes, or maybe sometime in your career. Don't waste time second-guessing the curriculum, It'll still be easier to just do your best to learn and retain what is covered.
2. Don't fall for the "traps".
Homework answers, Problem session solutions, Posted solutions, Lecture notes.
3. KEEP UP! Use calendar.
4. Make "permanent notes" after you've finished a subject or section and feel that you know it.

WHY? Why do you need some knowledge of electrical circuits?

1. Information processing. If you want to make anything interesting, your system or device will deal with information. Information like location, velocity, temperature, ph, flow rate, etc., etc. must be processed and acted on. Information can be read, processed, recorded and used to create results electrically much faster, cheaper and more accurately than any mechanical way. Some examples:

Mechanical



Electrical



VS

Mechanical



Creativefabrica

< 3 bytes

Electrical



Amazon

$2^{32} = 4294967296$ bytes plus a 1.2 GHz processor
= about 9 orders-of-magnitude more "memory"

VS

Data Density



Kodak

2 - 3 GB



Amazon

VS

= about 2 orders-of-magnitude more
= about 100 raw images, or 35,000 jpegs

Or, just get one of these:



NBC

And there's a little matter of **speed**. Electrical systems perform 3 to 5 orders-of-magnitude faster.

2. Power and energy manipulation. In the 1800's steam engines dramatically changed people's lives. Later, internal combustion engines had a similarly dramatic effect, especially in transportation. For all other power needs, electricity took over, and it may soon displace internal combustion engines in vehicles. The upshot of this is that if you want to work in any field that supplies or uses energy, you'd better learn something about electricity.



Punch Newspapers

Thermal power plants can achieve above 60% efficiency. Wind and water turbines can do even better.



The Conversation

Power distribution systems can be 95% efficient

$$60\% \cdot 95\% \cdot 90\% = 51\%$$



Tesla

Electric vehicles can be almost 90% efficient and typically harvest mechanical energy when decelerating.

3. The study of basic circuits helps prepare you for the study of far more complex subjects later.

- Fluid Dynamics
- Heat Transfer
- Robotics

Internal combustion engines max out at about 25% efficiency and they never put gas back in your tank when you hit the brakes.



Autotrader

Lecture So, Let's get started...

Basic electrical quantities

Letter used

Units

Fluid Analogy

Charge, actually moves

Q

Coulomb (C)

m^3

Current, like fluid flow

$$I = \frac{Q}{\text{sec}}$$

Amp (A, mA, μ A,...)

$\frac{m^3}{\text{sec}}$

Voltage, like pressure

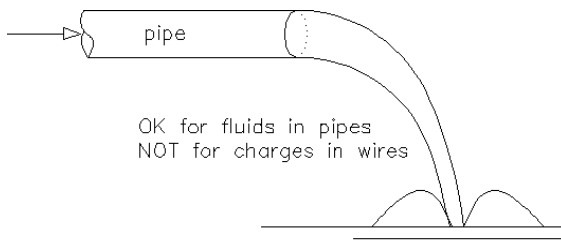
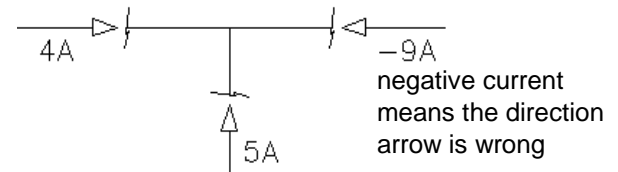
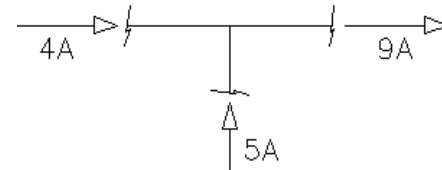
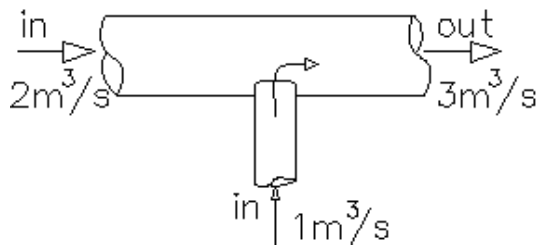
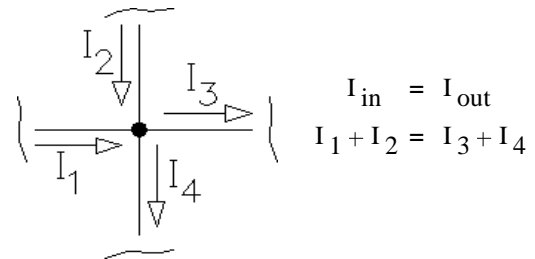
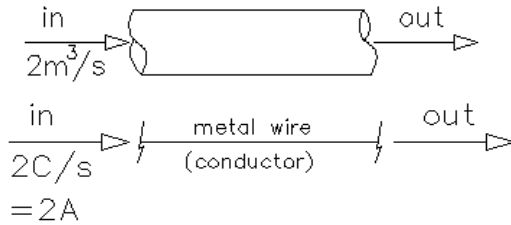
V or E

volt (V, mV, kV,...)

$\text{Pa} = 1 \cdot \frac{N}{m^2}$

KCL, Kirchhoff's Current Law

$I_{\text{in}} = I_{\text{out}}$ of any point, part, or section



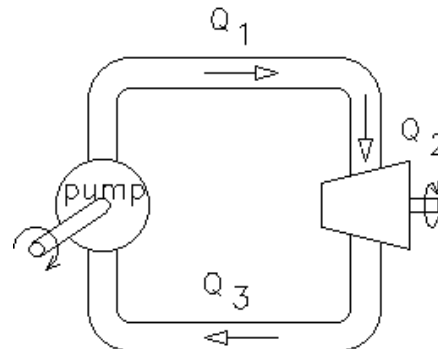
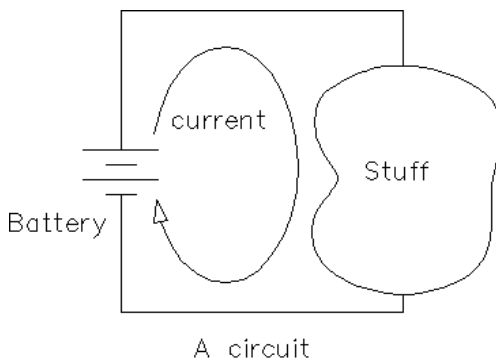
Electrical Conductors VS Nonconductors
Typically materials we would recognize as metals VS Typically "nonmetals"

Required Simplifications (Almost true)

Electrical: Charges do not collect or "bunch up" anywhere. (No "static" electricity effects)

Fluids: Retain the same volume regardless of pressure. (Incompressible)

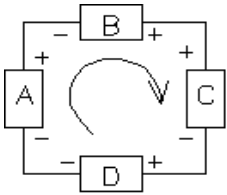
Battery also obeys KCL
No accumulation of charge anywhere, so it must circulate around.
Leads to the concept of a "Circuit"



Voltage is like pressure
KVL, Kirchhoff's Voltage Law

$$V_{\text{gains}} = V_{\text{drops}}$$

around any loop



Massless fluid in our analogy
 No gravity effects No Bernoulli effects

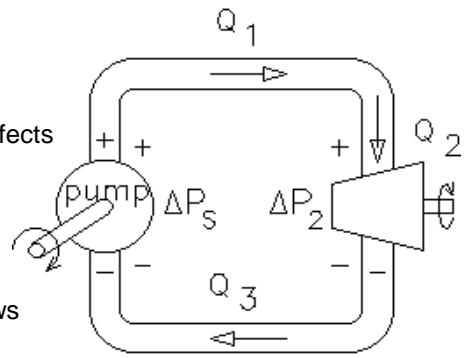
Reasonable because:

Electron mass is $9.11 \cdot 10^{-31} \cdot \text{kg}$

Electron charge is $-1.6 \cdot 10^{-16} \cdot \text{C}$

Negative charge flows
 in negative direction

Fluid Analogy



Required Simplifications (Almost true)

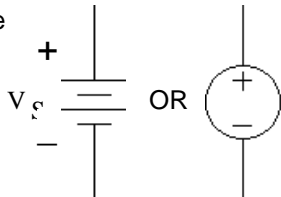
Electrical: All voltages differences are due to sources and current flows. Voltages require no time to "move" throughout the circuit.

Other voltage differences will equalize at nearly the speed of light-- fast enough for us to neglect.

Fluids: All pressure differences are due to pumps and current flows. Pressures require no time to "move" throughout the system. Other pressure differences would equalize at the speed of sound in the fluid, which would be ∞ in an incompressible fluid.

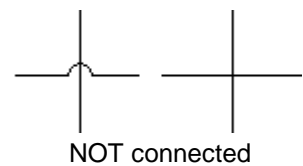
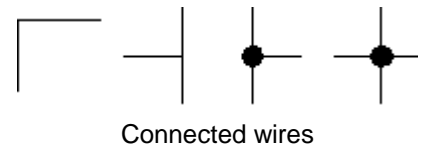
Ideal elements in electrical circuit schematics

Batteries or voltage sources always the same voltage regardless of current.



— Ideal wire, assume no resistance to current flow

— Ideal resistor, assume linear resistance to current flow



Take notes in class

