EE215 – FUNDAMENTALS OF ELECTRICAL ENGINEERING

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EE215 - FUNDAMENTALS OF EE

- **Electrical Engineering** deals with systems that produce, transmit, and measure electrical signals
- Five major categories:
  - E & M: Communications systems
  - Electronics: device, semiconductors, & transducers
  - Controls & Robotics systems
  - Energy: Power electronics
  - Signal & Image Processing systems
- They all have one thing in common:
  Electric Circuits!

EE215 – GOALS AND OBJECTIVES

- Goals:
  - Develop the tools to design and analyze (linear) circuits
  - Learn the "alphabet" of circuits including
    - Wires and switches
    - Resistors
    - Capacitors
    - Inductors
    - Independent and dependent voltage and current sources
    - Operational amplifiers

EE215 – GOALS AND OBJECTIVES

- Objectives:
  - Identify linear systems and represent them in schematic form
  - Apply Kirchhoff's and Ohm's Law
  - Simplify circuits
  - Perform node and loop analysis (→ systems of linear equations)
  - Identify and model first and second order electric systems involving capacitors and inductors (→ differential equations)
  - Predict their transient behavior

COURSE ADMINISTRATION (1)

- Instructor: Tai-Chang Chen (tcchen@u)
- Textbook: Nilsson & Riedel, Electric Circuits 9th ed.
  - class will follow textbook closely
  - beware of typo's
- Recitation sessions:
  - Review of class material, work out more elaborate examples, build and present lab circuits, discuss material with other students

COURSE ADMINISTRATION (2)

- Grades:
  - Homeworks (20%): top 6 of 7
    - Homeworks are individual work
    - Not all problems may be graded
    - Homeworks are due at the beginning of class Fridays
  - Labs (20%): 5 demos + reports
  - Exams (60%)
    - One midterm @ 30%, one final @ 30%
    - Tentative midterm date: 05/07
    - Final Exam: 06/11

ANNOUNCEMENTS

- NO recitation sessions this week.
- 1st homework posted today.
- 1st Lab posted today, due on the 3rd week.
- Materials covered this week: chapter 1; 2.1-2.3

WEEK 1
CIRCUIT BASICS

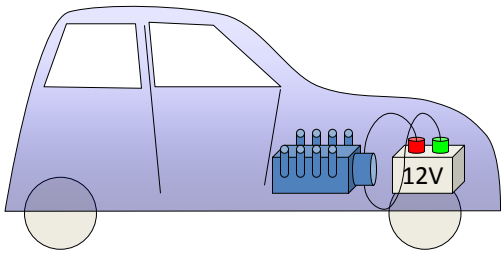
March 31, 2010

QUESTIONS TO ANSWER

- Electric Circuits
  - What is an electric circuit?
  - How to build an electric circuit?
- Current, Voltage, and Power
  - What are those parameters?
  - What is Ohm's law?
- Power calculation (passive sign convention)
  - What is the developed or dissipated power?

ELECTRIC CIRCUITS

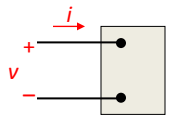
- Example: car battery



"actual electrical system"

BASIC CIRCUIT ELEMENTS

- Ideal basic circuit elements:
- General representation:



IDEAL BASIC CIRCUIT ELEMENTS

- Ideal voltage source
- Ideal current source
- Resistor
- List of circuit elements to be continued…

CURRENT AND VOLTAGE SOURCES

- Example: which circuits are permissible, and which violate the constraints imposed by ideal sources?

(a)

(b)

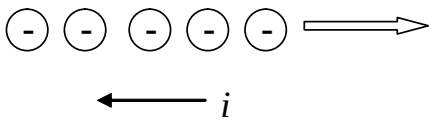
(c)

(d)

CURRENT (1)

- Electrical current

CURRENT (2)



(The reason for this is that Ben Franklin had to pick a direction for current flow. He had no idea what actually moved. He guessed wrong.)

Don't worry too much about what physically moves until you are inside the guts of semiconductors in advanced EE courses. Just think of current as the flow of positive charge.

CURRENT (3)

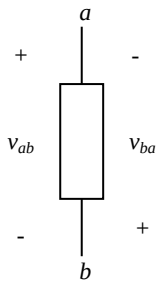
- Charge, q,
- Current, i,

VOLTAGE (1)

- Like pressure making water flow, creating a current, voltage
-
- Voltage has symbol *v* and units of volts (V), named after an Italian physicist. (Volta of frog leg fame.)
- Pressure is measured between two points, a high pressure point and a low pressure point. (Even when you measure the pressure in a tire, you are measuring the pressure between the tire and the atmosphere.)

VOLTAGE (2)

- Similarly, voltage is measured between two points,



POWER (1)

- Another definition of voltage,

POWER (2)

- where *W* is work.

- A lot of the general public get power and energy mixed up. Power, *p*, is

POWER (3)

- Let's do a trick and apply the Chain Rule.

Now note that we know what each of the derivatives in the chain is: voltage and current! So

CAR BATTERY EXAMPLE (AGAIN)

- What is **Ohm's Law** ?

RESISTORS AND OHM'S LAW

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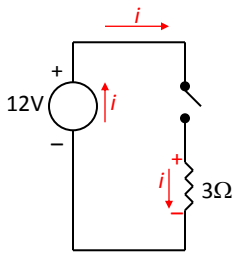
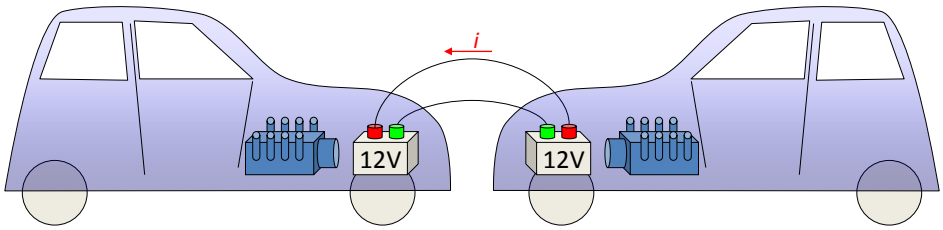
CAR BATTERY EXAMPLE (AGAIN)

- What is the **developed** or **dissipated** power ?



CAR BATTERY EXAMPLE (AGAIN)



MORE IDEAL BASIC CIRCUIT ELEMENTS

- Ideal dependent sources
- Ideal dependent voltage-controlled voltage source (VCVS)
- Ideal dependent voltage-controlled current source (VCCS)

MORE IDEAL BASIC CIRCUIT ELEMENTS

- Ideal dependent current-controlled voltage source (CCVS)
- Ideal dependent current-controlled current source (CCCS)
- Capacitor (to be discussed later)
- Inductor (to be discussed later)

MORE EXAMPLES: CURRENT AND VOLTAGE SOURCES

(a)

(b)

(c)

(d)

POWER DISSIPATION IN RESISTORS

- Recall that power is
- Therefore
- Example (a):

MORE EXAMPLES

(b)

(c)

(d)

PASSIVE SIGN CONVENTION

- It is useful to establish an agreement about voltage drop, direction of current, and sign of voltage / current.

EXAMPLES

(a)

(b)

(c)

A MORE INTERESTING EXAMPLE

- What does this circuit do?