FAMU-FSU
College of Engineering

Lecture #2:
Circuit Fundamentals

EEL 3003
Introduction to Electrical Engineering
Summer Semseter, 2013

Instructor: Dr. Michael Frank

Administrative Announcements

- Today's Handouts:
  - Attendance sheet – please sign, & correct your data.
  - Finalize your registration status by tomorrow!
- Outline of Today's Lecture:
  1. Review practice problems I posted yesterday.
  2. Overview of Chapter 2 –
     - Fundamentals of Electric Circuits
  3. Begin in-depth coverage of chapter 2.
- Today's Homework Assignment:
  - Read Ch. 2 of Textbook (Rizzoni 5th ed.)
  - Practice exercises:
    - Attempt the following homework problems (randomly selected):
      - 2.8, 2.19, 2.26*, 2.36, 2.37, 2.51*, 2.57, 2.64*, 2.73, 2.77
        - Starred problems have solutions in the back of the book.
    - You may also want to attempt additional problems that have solutions printed in the back of the book.
  - The related quiz will be next Thursday (May 23rd).

Overview of Chapter 2 (Fundamentals of Electric Circuits)

§2.1 – Definitions

§2.2 – Charge, current, & Kirchhoff's Current Law

§2.3 – Voltage & Kirchhoff's Voltage Law

§2.4 – Electric Power and Sign Convention

§2.5 – Circuit Elements and their *i-v* Characteristics

§2.6 – Resistance and Ohm's Law

§2.7 – Practical Voltage & Current Sources

§2.8 – Measuring Devices

Section §2.1 – Definitions

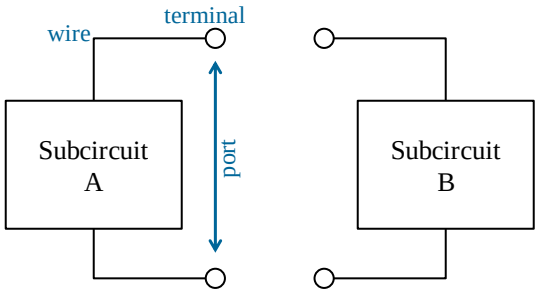
- Circuit topology terms:
  - Wire
  - Terminal
  - Port
  - Source
  - Load
  - Branch
  - Junction
  - Node
    - Supernode
  - Loop
    - Simple loops, figure-8's
  - Mesh

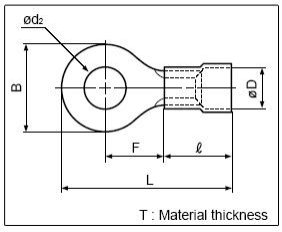
- Ideal Sources:
  - Ideal Voltage Sources
  - Ideal Current Sources
- Dependent (Controlled) Sources:
  - VCVS, CCVS, VCCS, CCCS

Terminals and Ports

- Interconnections between electrical subcircuits can be described in terms of *wires*, *terminals* and *ports*.

(click slide to animate)

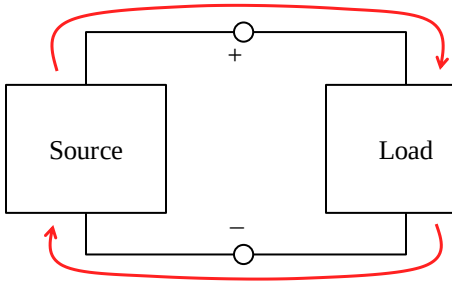




Ring tongue terminal products

Sources vs. Loads

- A given subcircuit could be acting as either a *source* or a *load* depending on whether it is supplying (positive) power to other components, or consuming power delivered to it by other components.
  - Source: Positive current flows *out* of its high-voltage terminal
  - Load: Positive current flows *into* its high-voltage terminal

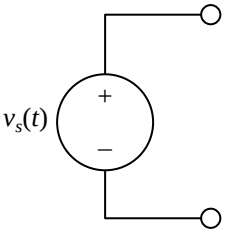


(e.g., a battery)

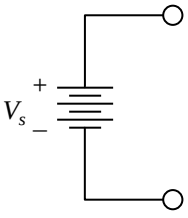
(e.g., a motor)

Ideal Voltage Sources

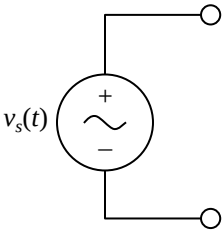
- Some variants:



General time-dependent voltage source



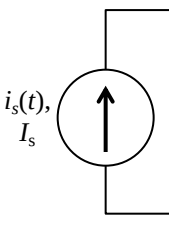
DC voltage source (an ideal battery)



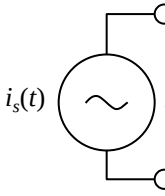
Sinusoidal AC voltage source

Ideal Current Sources

- Generally more difficult to approximate in practice than ideal voltage sources.
  - However, many different methods for constructing approximate current sources are known.



General current source



Sinusoidal AC current source

Dependent (Controlled) Sources

- Four basic types:
  - VCVS – Voltage Controlled Voltage Source
  - CCVS - Current Controlled Voltage Source
  - VCCS – Voltage Controlled Current Source
  - CCCS – Current Controlled Current Source

Some More Network Terminology

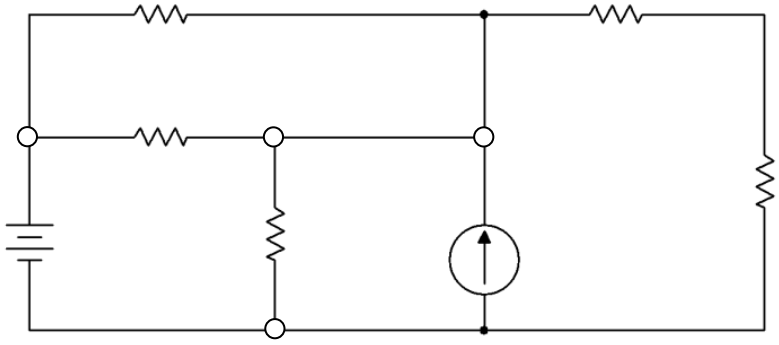
- Component (a.k.a. device)
  - A minimal element of a circuit diagram, other than an ideal wire
  - Needs 2 or more terminals to be useful in a circuit
- Wire
  - a direct connection between two points (device terminals or junctions)
  - Treated as an ideal conductor
- Junction (a.k.a. join, solder dot)
  - A point of connection between 2 or more wires
  - Treated as an ideal conductor
  - A junction and all wires incident on it are part of the same node
- Node
  - A maximal connected set of wires and junctions.
  - A maximal ideally-conductive region, which may have any number of circuit branches incident on it.
- Circuit
  - A maximal connected set of wires, devices & joins
- Subcircuit
  - A connected subset of a circuit.
- Terminal
  - A designated entry/exit point of a device or subcircuit, on a wire crossing its boundary
  - May be considered a type of junction (when connected)

Even more terminology…

- Supernode
  - Any subcircuit with two or more terminals
- Branch
  - Most generally: Any supernode with exactly 2 terminals
  - Often comprises a maximal linear chain of devices
  - Branches may, however, contain loops inside them
- Minimal branch
  - A single 2-terminal device
- Loop
  - A cycle (cyclical sequence) of connected branches & nodes
- Simple Loop
  - Includes no node more than once.
- "Figure Eight"
  - A (non-simple) loop that includes 1 node exactly twice.
- Mesh
  - A loop that has no smaller loops inside it.
  - No "short cut" across the loop.

Terminology Example

- Exercise (in-class or at-home):
  - Identify & count all of the following items in this circuit:
    - Components, wires, indicated terminals, junctions, subcircuits, nodes, supernodes, branches, meshes, simple loops, figure-8's



(from fig. 2.8)

Counting the Loops

- The caption on figure 2.8 says that this circuit has 15 loops, but really, to be more precise:
  - It has only 10 simple loops.
  - It also has 5 figure eights.
    - Highlighted in yellow on next slide
  - It also includes several additional loops (not shown on next slide) in which more than one node is included more than once
    - If you're bored, see if you can count all of those…