EECS2200 Electric Circuits

Chapter 1

Introduction

EECS 2200 Electric Circuits

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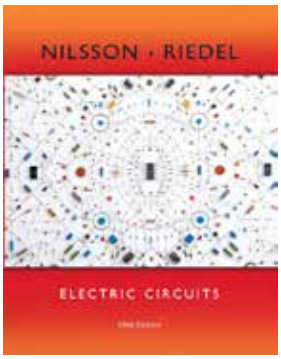
- Course Web
  https://wiki.eecs.yorku.ca/course_archive/2015-16/F/2200 /
  - Schedule:
    - Lectures: Tue. & Thur 11:30am – 1:00pm
    - Labs@WSC 108
      Lab-01, 03 Wed. 1:30-4:30pm
      Lab-02, 04 Fri. 4:30-7:30pm
- Office hours: TR 2:00-4:00pm@LAS1012C

EECS 2200 Electric Circuits

- Text book

Electric Circuits, 10th Edition
By: James W. Nilsson and
Susan Riedel
Pearson Education
ISBN-10: 0133760030
ISBN-13: 9780133760033
Available at York Bookstore



Assessment

- Quiz: 20% (3 quizzes in class)
- Lab: 15%
  - 5 lab sessions
  - Starts on Sept. 23/25 (week 3)
  - Lab groups 1 and 2 on odd weeks, and Lab groups 3 and 4 on even weeks
- Midterm 30%
- Final 35%

LAB

- Will be done in group of 2
- Every other week for each group
- Each lab contains two parts
  - Prelab part should be done before the lab and submitted at the beginning of every lab
  - Hands-on part should be done during 3 hours of lab session. Report should be submitted at the beginning of next lab.
- Maintain a laboratory book or journal for all lab sessions. It must be signed by the TA before you leave the lab.

Topics covered

- Introduction and simple resistive circuits
- Techniques for circuit analysis
- Inductance, capacitance and mutual inductance
- First order circuits RC and RL
- Second order circuits RLC
- AC circuits (analysis and power calculation)
- Balanced 3-phase circuits
- Introduction to Laplace transform

Acknowledgement

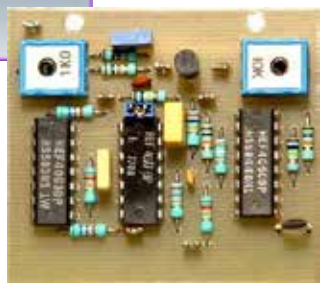
- The presentation slides of all chapters are based on Prof. Mokhtar Aboelaze's EECS2200 course materials in Fall 2014-2015 and text book's teaching resources, i.e. "Electric Circuits" 10th Edition by James W. Nilsson and Susan A. Riedel.

EECS2200 Electric Circuits

Introduction

What is an electric circuit?

A mathematical model that approximates the behavior of an actual electrical system



Objectives of Chapter 1

- Understanding and be able to use the International System of Units (SI) and standardized prefixes to signify for powers of 10
- Know and able to use the definition of volts and currents
- Be able to use the passive sign convention to calculate the power for an ideal basic circuit element given its voltage and current

International System of Units

TABLE 1.1 The International System of Units (SI)

Quantity	Basic Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	degree kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Derived Units in SI

TABLE 1.2 Derived Units in SI

Quantity	Unit Name (Symbol)	Formula
Frequency	hertz (Hz)	s^{-1}
Force	newton (N)	$kg \cdot m/s^2$
Energy or work	joule (J)	$N \cdot m$
Power	watt (W)	J/s
Electric charge	coulomb (C)	$A \cdot s$
Electric potential	volt (V)	J/C
Electric resistance	ohm (Ω)	V/A
Electric conductance	siemens (S)	A/V
Electric capacitance	farad (F)	C/V
Magnetic flux	weber (Wb)	$V \cdot s$
Inductance	henry (H)	Wb/A

Standardized Prefixes

TABLE 1.3 Standardized Prefixes to Signify Powers of 10

Prefix	Symbol	Power
atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}
deka	da	10
hecto	h	10^{2}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
tera	T	10^{12}

Memorize the boxed prefixes – we use them ALL THE TIME!!

EECS2200 Electric Circuits

Circuit Variables

Current, voltage, power

Current

- The electric charge exists in discrete quantities that are multiple of electron charge 1.6022×10^{-19}C
- Current is the rate of charge flow

$$i = \frac{dq}{dt}$$

- i is current in amperes (A)
- q is charge in coulombs (C)
- t is time in seconds (s)

André-Marie Ampère
(1775-1836)

Activity 1

(a) Assume that 10 millions electrons are moving from left to right in a wire every microsecond, what is the value of the current flowing in the wire?

(b) What about direction?

Voltage

- Voltage is the energy per unit charge created when "+" and "-" charges are separated

$$v = \frac{dw}{dq}$$

Alessandro Volta
(1745-1827)

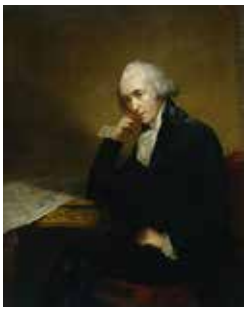
- v is voltage in volts (V)
- w is energy in joules (J)
- q is charge in coulombs (C)

Power

- The time rate of change of energy

$$P = \frac{dw}{dt} = \frac{dw}{dq} \times \frac{dq}{dt}$$

$$P = v \times i$$



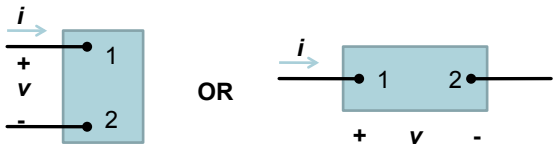
James Watt

(1736-1819)

- *p* is power in watts (W)
- *w* is energy in joules (J)
- *t* is time in seconds (s)

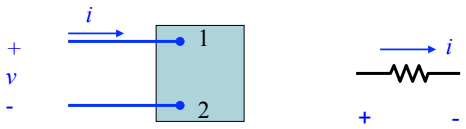
Ideal Basic Circuit Element

- Ideal – the element can be described solely in terms of the relationship between its voltage and its current.
- Basic – the element cannot be sub-divided into simpler elements.
- Circuit Element – the element has two terminals used to connect it to other elements and form a circuit.



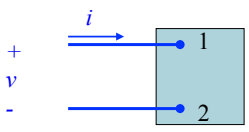
Reference Polarity

- Assignment of reference polarity is arbitrary
- Once you choose a reference, stick to it.
- In this course, we use **passive sign convention.**
  - The reference direction of a current in an element is the direction of the reference voltage drop across the element



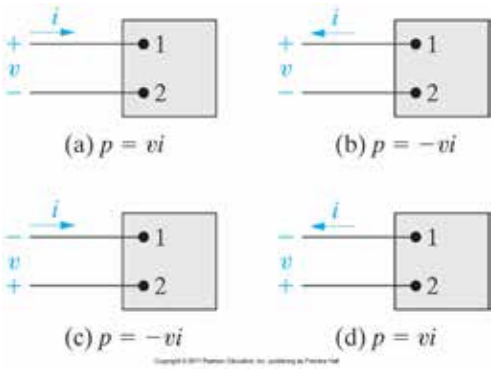
Reference Polarity

- Positive voltage drop from 1 to 2
- Positive charge flow from 1 to 2
- Voltage rise from 2 to 1
- For example $v_{12} = v_1 - v_2 = 5\ V$
- Positive charge are moving from 1 to 2

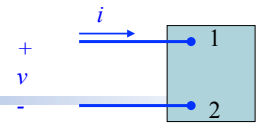


More on Power

- If a positive charge moves through a drop in voltage, it loses energy
- If a positive charge moves through a rise in voltage, it gains energy.
- Power is positive in a circuit element, it means power is being delivered to the element



Activity 2



Assume the current and voltage are gives as

$$i(t) = \begin{cases} 0 & t < 0 \\ 20e^{-5000t} & t \geq 0 \end{cases} \qquad v(t) = \begin{cases} 0 & t < 0 \\ 10e^{-5000t}\,KV & t \geq 0 \end{cases}$$

(a) Find the total charge entering the element

(b) Max. value of the current entering the element

(c) Power supplied to the element at 1ms

(d) Total energy delivered to the circuit

Activity 3

Voltage and current at the terminals of a circuit block are shown.

(1) Sketch the power versus t plot for 0 to 80ms.

(b) Calculate the energy delivered to the circuit element at t=10, 30 and 80ms.