Midterm 1 Review

10-12-11
Topics on Midterm 1

◆ Focus on Chapters 1, 2 & 3 of Alexander & Sakiku Textbook
  ◆ Basic Concepts (Ch. 1)
    ◆ Charge, current, voltage, power & energy
  ◆ Basic Laws (Ch. 2)
    ◆ Ohm’s Law
    ◆ Kirchoff’s Laws (KCL & KVL)
    ◆ Voltage Division & Current Division
  ◆ Node Analysis (Ch. 3)
  ◆ Mesh Analysis (Ch. 3)
THINGS YOU MUST KNOW

• Chapter 1 Basic Concepts
  
  1. Definitions of Charge, current, voltage, power & energy
  2. How to calculate power and energy
  3. Definitions of circuit elements

• Chapter 2 Basic Laws
  
  1. Ohm’s law
  2. Definition of elements, nodes, branches and loops
  3. KCL and KVL
  4. How to deal with series resistors and voltage division
  5. How to deal with parallel resistors and current division

• Chapter 3 Methods of Circuit Analysis
  
  1. Node analysis and how to apply to circuits
  2. Mesh analysis and how to apply to circuits
  3. Dealing with dependent sources
  4. Applying supernodes and supermeshes
STUDY PRIORITIES

• ✷. Study the chapters in your textbook
• ✷. Study your class notes
• 2. Understand the homework problems, especially the ones you missed
• 3. Practice with the examples and practice problems in your textbook
• 4. Study the topics above in other books, e.g. Shaum’s Outline
Current (i, Amperes) is the rate of charge (q, Coulombs) flow \( i = \frac{dq}{dt} \)

Voltage is the difference in potential energy (w, Joules) required to move 1 C of charge through a circuit element
\[ v = \frac{dw}{dq} \]

Power is the energy supplied or absorbed per unit time (also the product of voltage and current)
\[ p = \frac{dw}{dt} = vi \]

The energy transferred by a flow of power is the integral of the power over time
\[ w = \int_{t=t_1}^{t=t_2} p(t) dt \]
Ch. 2 Basic Laws

Ohm’s Law \( v = iR \)

Conductance \( G = 1/R \Rightarrow i = Gv \)

KCL: Sum of currents into a node = sum of currents out of the node

KVL: Sum of the voltage drops and rises around a closed circuit = 0

Resistors in series \( R_{eq} = R_1 + R_2 + R_3 + \ldots \)

Resistors in parallel \( \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \) or for 2 resistors \( R_{eq} = \frac{R_1R_2}{R_1 + R_2} \)
Voltage and Current Division

Voltage divides across series resistors in proportion to the resistances compared to the total resistance, e.g. for two resistors in series

\[ v_1(\text{across } R_1) = \frac{R_1}{R_1 + R_2} v \]

Current divides across parallel resistors in proportion to the conductance compared to the total conductance, e.g. for two resistors in parallel

\[ i_1(\text{across } R_1) = \frac{R_2}{R_1 + R_2} i \]
Node and Mesh Analysis

**Node Analysis**
1. Simplify the circuit, combining elements where possible
2. Apply KCL at the non-reference nodes
3. Express currents in terms of voltages, using Ohm’s Law and sources
4. Solve simultaneous equations for node voltages

A **supernode** combines two non-reference nodes connected by a voltage source

Nodal analysis tends to work better on circuits:

- that contain many parallel-connected elements, current sources and/or supernodes
  - where node voltages are sought
  - that contain op amps
  - non-planar circuits

**Mesh Analysis**
1. Simplify the circuit, combining elements where possible
2. Apply KVL around the meshes (loops with no interior circuit in a planar circuit)
3. Express the voltages in terms of the mesh currents
4. Solve the simultaneous equations for the mesh currents

A **supermesh** combines two meshes with a current source in common

Use node or mesh analysis to get the fewest equations to solve.

Mesh analysis tends to work better on circuits:

- that contain many series-connected elements, voltage sources and/or supermeshes
  - where branch or mesh currents are sought
  - that contain transistors
Node Voltage Analysis

\[ v_1 = v_s \]

\[ \frac{v_2 - v_1}{R_2} + \frac{v_2}{R_4} + \frac{v_2 - v_3}{R_3} = 0 \]

\[ \frac{v_3 - v_1}{R_1} + \frac{v_3}{R_5} + \frac{v_3 - v_2}{R_3} = 0 \]
Mesh 1

\[ R_2 (i_1 - i_3) + R_3 (i_1 - i_2) - v_A = 0 \]

Mesh 2

\[ R_3 (i_2 - i_1) + R_4 i_2 + v_B = 0 \]

Mesh 3

\[ R_2 (i_3 - i_1) + R_1 i_3 - v_B = 0 \]