ANNOUNCEMENT

*Exam 1: Monday February 20, 2012, 8 PM - 10 PM
*Location: Elliot Hall of Music
*Covers all readings, lectures, homework from Chapters 21 through 24.
*The exam will be multiple choice (15-17 questions).

Be sure to bring your student ID card and your own one-page (two-side) crib sheet.

NOTE THAT FEW EQUATIONS WILL BE GIVEN – YOU ARE REMINDED THAT IT IS YOUR RESPONSIBILITY TO CREATE WHATEVER TWO-SIDED CRIB SHEET YOU WANT TO BRING TO THIS EXAM.

The equation sheet that will be given with the exam is posted on the course homepage. Click on the link on the left labeled “EquationSheet”

Kirchhoff’s First Rule (“Loop Rule” or “Kirchhoff’s Voltage Law”)

The algebraic sum of the changes in potential encountered in a complete traversal of any loop of circuit must be zero.

Rules

Voltage Gains enter with a + sign.
Voltage Drops enter with a - sign.

Note: & always points from negative to positive

Loop Example
Internal Resistance of an emf Device

Resistors in Series

Another (intuitive) way

Consider two cylindrical resistors with lengths $L_1$ and $L_2$

$$R_1 = \rho \frac{L_1}{A}$$

$$R_2 = \rho \frac{L_2}{A}$$

Put them together, end to end to make a longer one...

$$R_{eq} = \rho \frac{L_1 + L_2}{A} = R_1 + R_2$$

$$R = R_1 + R_2$$

Kirchhoff’s Second Rule (Junction Rule or “Kirchhoff’s Current Law”)

The sum of the current entering any junction must be equal to the sum of the currents leaving that junction.

* When a potential difference, $V$, is applied across resistances in series, the resistances have identical current.

* Resistances in series can be replaced with an equivalent resistance, $R_{eq}$, that has the same current $I$ and the same total potential difference $V$ as the actual resistances.
How to use Kirchhoff’s Law:

Analyze the circuit & identify all circuit nodes:

Identify all independent loops & use Kirchhoff’s Voltage Law:

\[ \varepsilon_1 + R_3 - R_2 \]

Resistors in Parallel

*In parallel, the resistances all have the same potential differences.
* Resistances in parallel can be replaced with an equivalent resistance, \( R_{\text{eq}} \), that has the same potential difference, \( V \), and the same total current, \( I \), as the actual resistances.

Another (intuitive) way

Consider two cylindrical resistors with cross-sectional areas \( A_1 \) and \( A_2 \):

\[ R_1 = \rho \frac{L_1}{A_1} \]
\[ R_2 = \rho \frac{L_2}{A} \]

Put them together, side by side … to make one “fatter” one:

\[ R_{\text{eq}} = \frac{\rho L}{(A_1 + A_2)} \]

\[ \frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} \]

Summary of Resistor & Capacitor Combinations

Resistors

Series \( R_{\text{eq}} = \sum_{i=1}^{n} R_i \)

Parallel \( \frac{1}{R_{\text{eq}}} = \sum_{i=1}^{n} \frac{1}{R_i} \)

Capacitors

Series \( \frac{1}{C_{\text{eq}}} = \sum_{i=1}^{n} \frac{1}{C_i} \)

Parallel \( C_{\text{eq}} = \sum_{i=1}^{n} C_i \) for \( n = 2 \)

\( R_{\text{eq}} = \frac{R_1 R_2}{R_1 + R_2} \) for \( n = 2 \)
Summary of Simple Circuits

- Resistors in series: \( R_{eq} = R_1 + R_2 + R_3 + \ldots \)
  Current thru is same; Voltage drop across is \( IR \)
- Resistors in parallel: \( \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \)
  Voltage drop across is same; Current thru is \( V/R \)

Problem Solving Tips

- When you are given a circuit, you must first carefully analyze circuit topology.
  - find the nodes and distinct branches and pick Linearly Independent subsets of each.
  - assign branch currents
- Use Kirchhoff’s First Rule for all independent loops in the circuit.
- Use Kirchhoff’s Second Rule for all independent nodes in circuit.

Example 25-16

Cramer’s Rule

If \( a_1x + b_1y = c_1 \)
\( a_2x + b_2y = c_2 \)
then
\[
\begin{vmatrix}
  c_1 & b_1 \\
  c_2 & b_2 \\
\end{vmatrix} = \frac{c_1b_2 - c_2b_1}{a_1b_2 - a_2b_1}
\]

\[
\begin{vmatrix}
  a_1 & c_1 \\
  a_2 & c_2 \\
\end{vmatrix} = \frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1}
\]