# HKN ECE 110 Review Session
# Exam 1

COREY SNYDER

# What is charge? Current? Voltage? Resistance?

- Electrons carry charge and thus convey electrical energy
  - Units: Coulombs [C]
- Current is the flow of charge
  - Units: Coulombs/second = Amps [A] (Amperes)
- Voltage is the work done per unit charge. Think of this as the force or pressure on the electrons
  - Units: Joules/ Coulomb = Volts [V]
- Resistance is the opposition to the flow of charge
  - Units: Ohms [$\Omega$]

# Energy vs. Power

- Energy is the ability to do work
  - Units: Joules [J]
- Energy can take on many forms
  - Potential Energy – Chemical, Electrical, Mechanical
  - Kinetic Energy
- Energy is always conserved!
- Power is the rate at which energy is transferred
  - Units: Joules/second = Watts [W]

# Capacitors

- A capacitor is a device that stores charge
  - Units: Coulombs/Volt = Farads [F]
  - This charge is said to be “coupled”

- $E_{capacitor} = \frac{1}{2}CV^2$

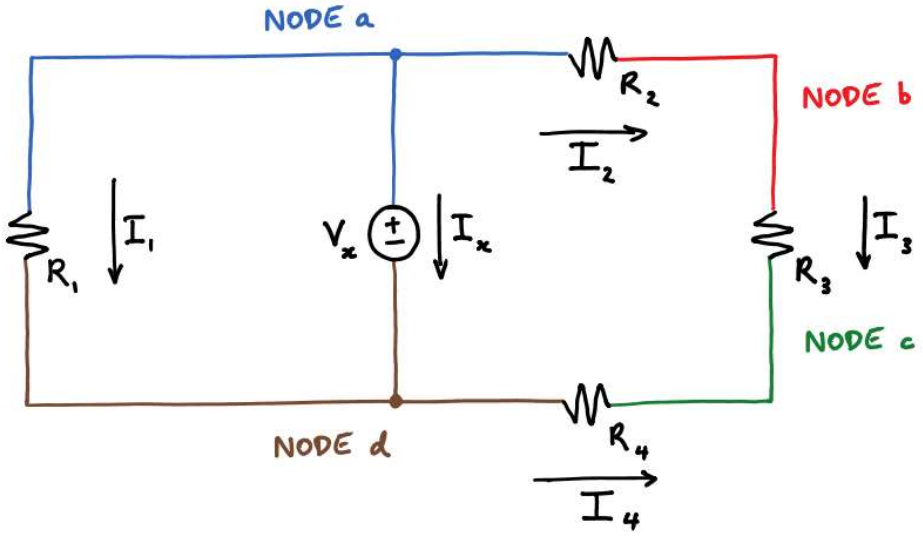
- $C = \frac{Q}{V}$

# Ohm's Law, Resistance, and Power

- Ohm's Law describes the relationship between the voltage *across* and current *through* a resistive element
  - Ohm's law only applies for linear components, i.e. resistors
  - More on linear components with Thevenin/Norton Equivalents (and in ECE 210!)
- V = IR
- Resistance of an element can found by: $R = \frac{\rho l}{A}$
- Power dissipated by an element can be found by: $P = IV, \mathrm{P} = I^2R, P = \frac{V^2}{R}$
  - You can go between the three forms using Ohm's Law!

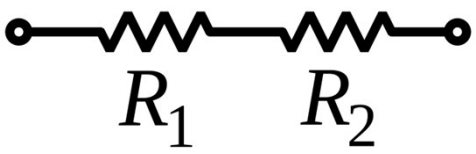
# Nodes, KVL, and KCL

- A node is any part of a circuit that is at an *equipotential*
  - Wires are equipotentials
- Kirchhoff's Voltage Law
  - Conservation of Energy
  - Performed on a loop
- $\sum V_{rises} = \sum V_{drops}$
- Kirchhoff's Current Law
  - Conservation of Charge
  - Performed at a node
  - Bubble method
- $\sum I_{in} = \sum I_{out}$

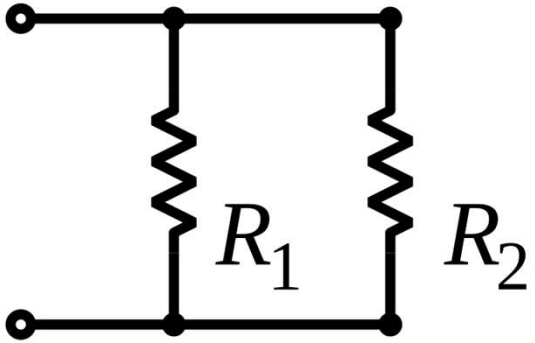


# Series and Parallel Components

- Two components are in series if they share the same current

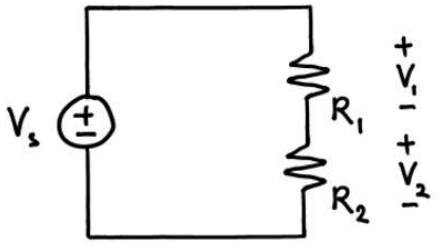



- Two components are in parallel if they share the same two nodes
  - As a consequence, they must share the same voltage



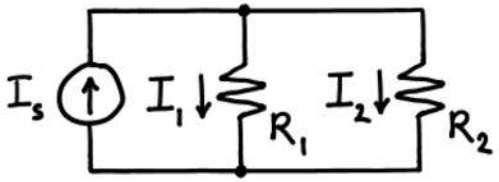
# Voltage Divider and Current Divider

- We can use voltage divider rule (VDR) in order to find the voltage across individual resistors in series




$$V_1 = \frac{R_1}{R_1 + R_2} V_s \qquad V_2 = \frac{R_2}{R_1 + R_2} V_s$$

- We can use current divider rule (CDR) in order to find the current through individual resistors in parallel




$$I_1 = \frac{R_2}{R_1 + R_2} I_s \qquad I_2 = \frac{R_1}{R_1 + R_2} I_s$$

# Root-mean-square Voltage ($V_{rms}$)

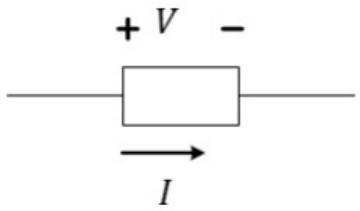
- The exact definition of $V_{rms}$ is:

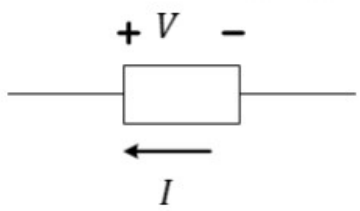
$$V_{rms} = \sqrt{\frac{\left(\int_0^T f^2(t)dt\right)}{T}}$$

- This is the "square root of the average value of the functions squared"
- We will mainly ask you to use the following two formulas:
- $V_{rms}(sinusoid) = \frac{Amplitude}{\sqrt{2}}$
- $V_{rms}(square\ wave) = V_{p-p}\sqrt{\%DC}$
- We use $V_{rms}$ to determine the power delivered to a load from a time-varying source
  - $P_{avg} = \frac{V_{rms}^2}{R}$

# Power and Labeling

- We know that power can be expressed in three ways: $P = IV = I^2R = \frac{V^2}{R}$
- If the value of power is positive, the element is absorbing power
- If the value of power is negative, the element is supplying power
- Standard vs. Non-Standard Labeling
- Standard: $P = IV, V = IR$, Current goes + to -
- Non-Standard: $P = -IV, V = -IR$, Current goes – to +



# I-V Characteristics

- We can characterize circuits where the current is a function of the voltage
- For ECE 110, we typically want to characterize linear circuits, where the I-V Characteristic is of the form
  - $I = mV + b$
- In order to obtain this equation, we want to find two points:
  - $V_{oc}\ and\ I_{sc}$
- $V_{oc}\ is\ the\ x-intercept, I_{sc}\ is\ the\ y-intercept$

# Legit Tips and Tricks to Show Off Your Wits

- Use your note sheet more like a study tool
- Use the practice exam on PrairieLearn
- Do not spend too much time on questions you cannot answer
- Spend your time showing what you know
- Study past exams