

## Kirchhoff's Laws

EGR 220, Chapter 2  
January 28, 2016

## Class Concepts

- Kirchhoff → Conservation laws
  - Current law, KCL
  - Voltage law, KVL
- Understanding circuit topology
  - Identifying nodes, branches & loops in circuits

2

## Defining a Circuit

- What elements are in every circuit?
  - Energy source – independent and dependent
  - Energy dissipating element
  - Energy storage elements
  - The “load”

4

## New Concepts: Open & Short Circuits

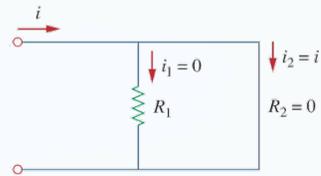
### Tasks:

- Draw an example of each type of connection
- Relate each to Ohm's Law ( $V = IR$ )
- What are  $V$  and  $I$  in each example?
  - (0? <0? >0?  $\infty$ ?)

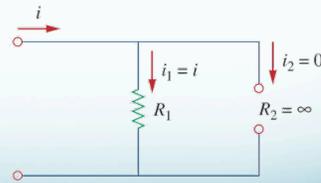
6

## Open & Short Circuits

Find  
V & I for  
resistors  
 $R_1$  &  $R_2$



(a)



(b)

7

## \* Open & Short Circuits \*

- If there is no current, can there be a voltage drop?
  - Examples?
- If there is no voltage drop, can there be current?
  - Examples?
- Power Sources
  - What is the difference between a current source and a voltage source?

8

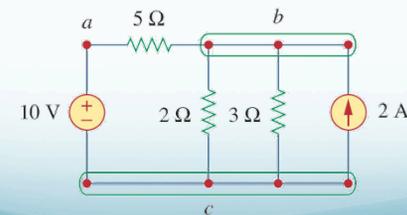
## New Concepts & Laws

- Node, Branch & Loop
- Series resistors
  - Series elements; series branches
  - Shared: nodes? current? voltage?
- Parallel resistors
  - Parallel elements; parallel branches
  - Shared: nodes? current? voltage?
- KVL: Kirchhoff's voltage law
- KCL: Kirchhoff's current law

9

## Discuss: Nodes & Branches

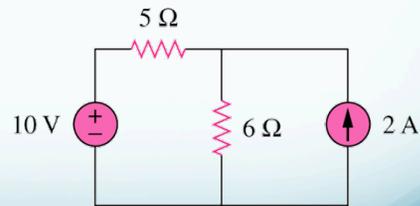
- A branch represents a single element such as a voltage source or a resistor.
- A node is the point of connection between two or more branches.



10

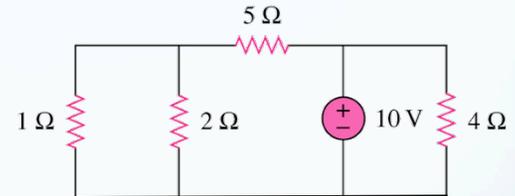
### Identify nodes, branches & loops

- How many of each and where are they?
- Which elements are in parallel and which in series?



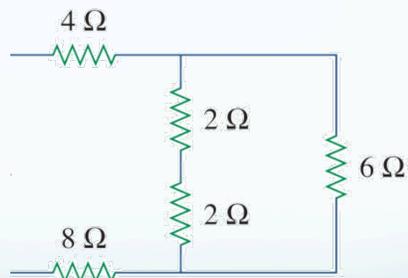
11

### Identify nodes, branches & loops; series and || elements



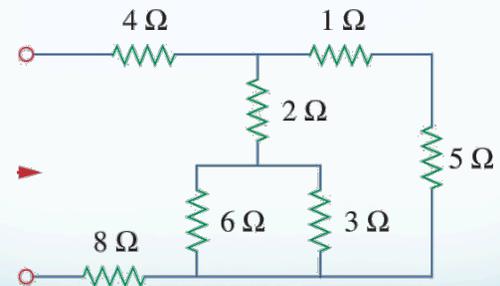
12

### Nodes, Branches, Loops, Series and Parallel



13

### Nodes, Branches, Loops, Series and Parallel



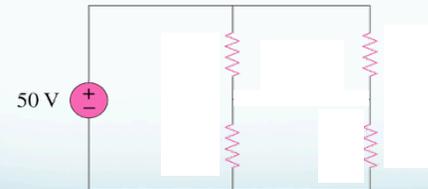
14

## Kirchhoff's Current and Voltage Laws: KVL & KCL

15

## Kirchhoff's Current Law, KCL

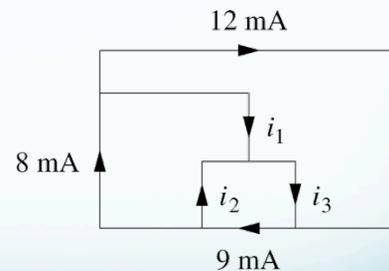
- Principle of conservation of \_\_\_\_\_?
- The sum of ...



16

## Kirchhoff's Current Law

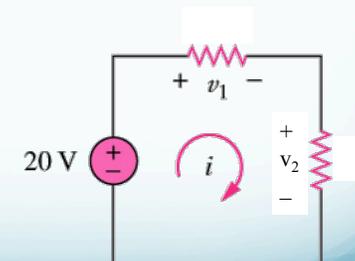
- Find  $i_1$ ,  $i_2$  and  $i_3$ 
  - Label nodes
  - Write KCL eqn's
  - Solve
    - we will use Ohm's law also, when there are resistors in the circuit diagram



17

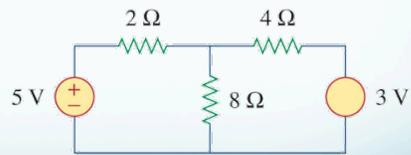
## Kirchhoff's Voltage Law, KVL

- The sum of ...
- Combine Ohm's law with KVL to solve for which quantity?



## Kirchhoff's Voltage Law

- Apply KVL
  - Label voltages
  - Write KVL eqn's
  - We will solve later with mesh analysis



19

## New Terminology

- Node
- Branch
- Loop
- Series
- Parallel

20

## New Analysis Tools

- Ohm's law
- KVL: Kirchhoff's voltage law
- KCL: Kirchhoff's current law
- Current divider
- Voltage divider
- Equivalent resistance

21

## Summary

- New Concepts
  - Ohm's law
  - Kirchhoff's current and voltage laws
  - Series and parallel combinations
  - Open and short circuits
  - Nodes, branches and loops
- Labs
  - Pre-lab due *before* lab, individually
  - Lab memo completed with partner