Circuit Topology & Kirchhoff's Laws

EGR 220, Chapter 2

Jan 30, 2020

Class Concepts

- Understanding circuit topology
  - Identifying nodes, branches & loops in circuits
- Open & Short circuits
  - Implied resistance for the branch
  - V across & I through for the branch
- Kirchhoff → Conservation laws
  - Current law, KCL (conservation of charge)
  - Voltage law, KVL (conservation of energy)

Recap: Electricity Concepts

- Define in words and with an equation/expression
- Current
  - Symbol and unit:
  -
- Resistance
  - Symbol and unit:
  -

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- Resistance
  - Symbol and unit:
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- Voltage
  - Symbol and unit:
  -
- Power
  - Symbol and unit:
  - How is power related to energy?

Defining a Circuit

- What elements can be in a circuit?
  - Energy source – independent and dependent
  - Energy dissipating element
  - Energy storage elements
  - A "load"
- Give examples of each element

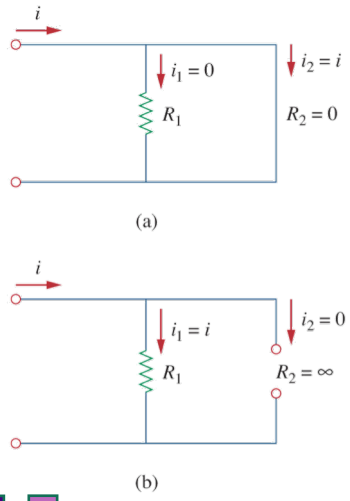
New Concepts: Open & Short Circuits

Tasks:

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

Open & Short Circuits

Find V & I for resistors R_1 & R_2



* 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?

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

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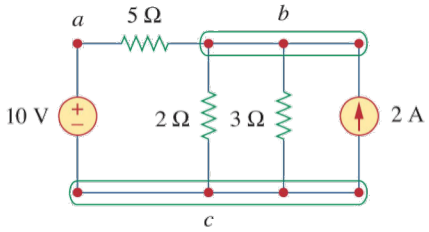
Discuss: Nodes & Branches

- 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.



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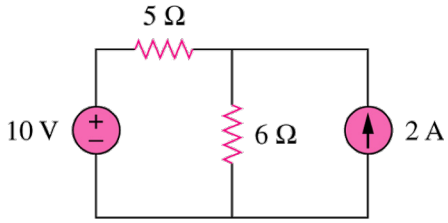
Identify nodes, branches & loops

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



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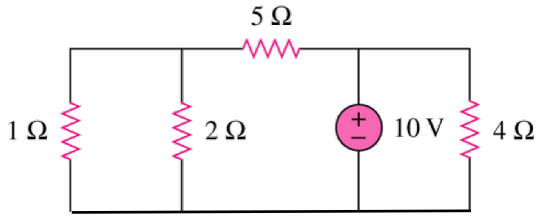
Identify nodes, branches & loops; series and || elements



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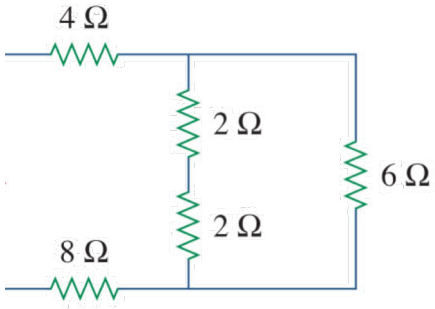
Nodes, Branches, Loops, Series & Parallel



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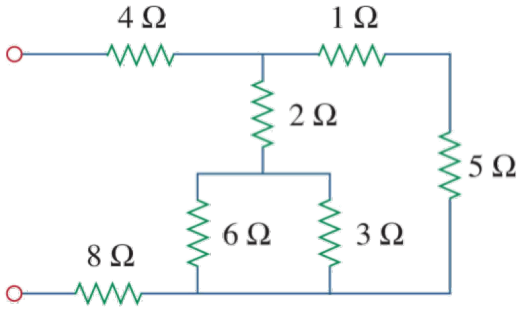
Nodes, Branches, Loops, Series and Parallel



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Kirchhoff's Current and Voltage Laws:
KVL & KCL

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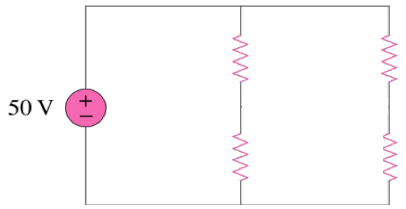
Kirchhoff's Current Law, KCL

- Current flowing in = current flowing out.
- Principle of conservation of _____?
- The math expression is:



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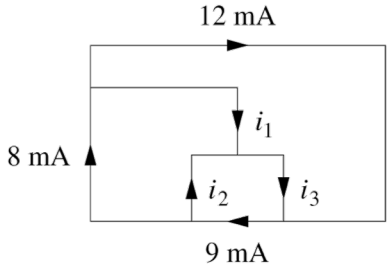
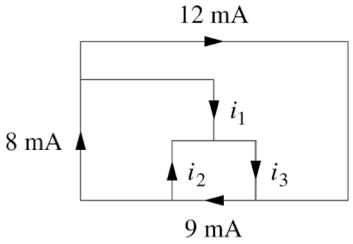
Kirchhoff's Current Law

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

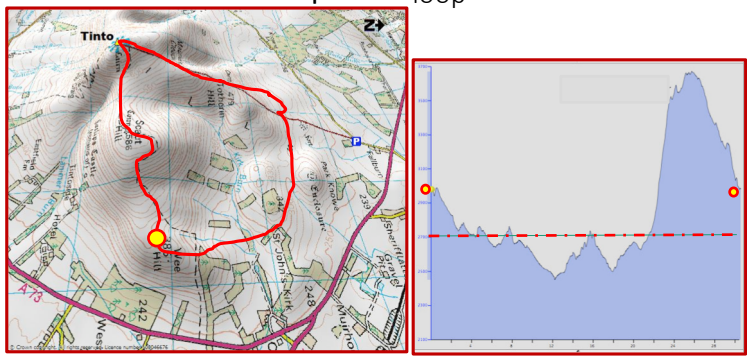


Kirchhoff's Current Law



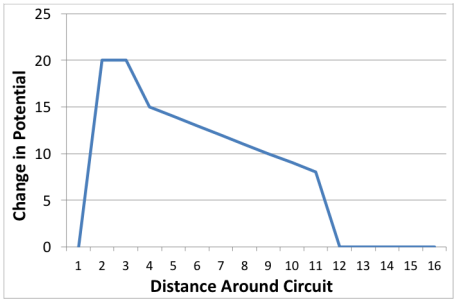
Kirchhoff's Voltage Law, KVL

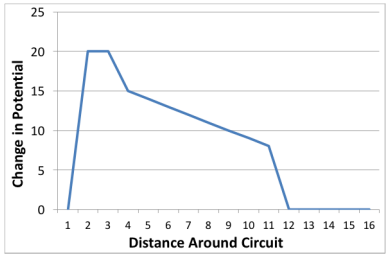
For *EVERY* loop: $\Sigma V_{loop} = 0$



Kirchhoff's Voltage Law, KVL

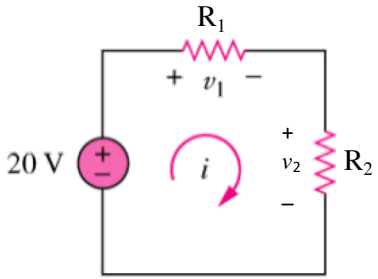
- Draw and label an electrical circuit that is consistent with the graph shown below.





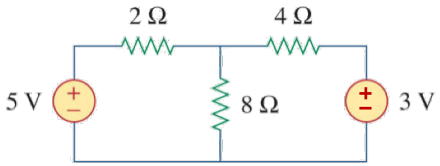
Kirchhoff's Voltage Law, KVL

- The conservation of _____
- Combine Ohm's law with KVL to solve for _____?



Kirchhoff's Voltage Law

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



New Terminology

- Node
- Branch
- Loop
- Series
- Parallel

New Analysis Tools

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

Office & Tutor Hours

- Office Hours
  - Monday: 10:15 – 11:45
  - Tuesday: 1:30 – 2:30
- Master Tutor
  - Sunday – Thursday evenings there will always be 3 or so master tutors in the Playground
  - https://www.smith.edu/qlc/tutoring.html?colEGR=open#PanelEGR
  - Tani Somolu point person for EGR 220

Summary

- New Concepts
  - Kirchhoff's current and voltage laws
  - Series and parallel combinations
  - Open and short circuits
  - Nodes, branches and loops
- Labs
  - Pre-lab due ***before*** lab
    - One per team for 'design your own lab' days
  - Lab memo completed with partner, one memo per team

Questions?