Introduction to DEPT

LECTURE 1

Introduction

- Digital Electronics
- Pulse Techniques

Digital Electronics

Digital electronics is a field of electronics involving the study of digital signals and the engineering of devices that use or produce them. Digital electronics is the foundation of modern computers and digital communications.

Pulse Techniques

A pulse is a burst of current, voltage, or electromagnetic-field(a physical field produced by electrically charged objects) energy.

In digital systems, pulses comprise brief bursts of DC (direct current) voltage, with each burst having an abrupt beginning (or rise) and an abrupt ending (or decay).

Pulse techniques consist of generation of different types of electrical , electrical pulse shaping and pulse transformation.

Course Overview

Digital electronics

- ❖ Introduction to digital Logic Families e.g. DTL, TTL, ECL, CMOS.
- ❖ Design of these digital logic gates using electronics devices.
- ❖ Analyze the performance of these logic gates and compare them .

Pulse techniques

- ▪ Design of Analog to digital as well as digital to analog converters
- ▪ Different types of multi-vibrator e.g. monostable, bi-stable and astable.
- ▪ Generation of different pulse wave e.g. triangular, square, sawtooth.

Textbooks

- Electronic Circuits Analysis and Design by Donald A Neamen, 3rd Edition, McGraw-Hill Education 2008

- Integrated Electronics: Analog and Digital Circuits and Systems by Millman-Halkias, McGraw-Hill Education, 2nd Edition, 2010

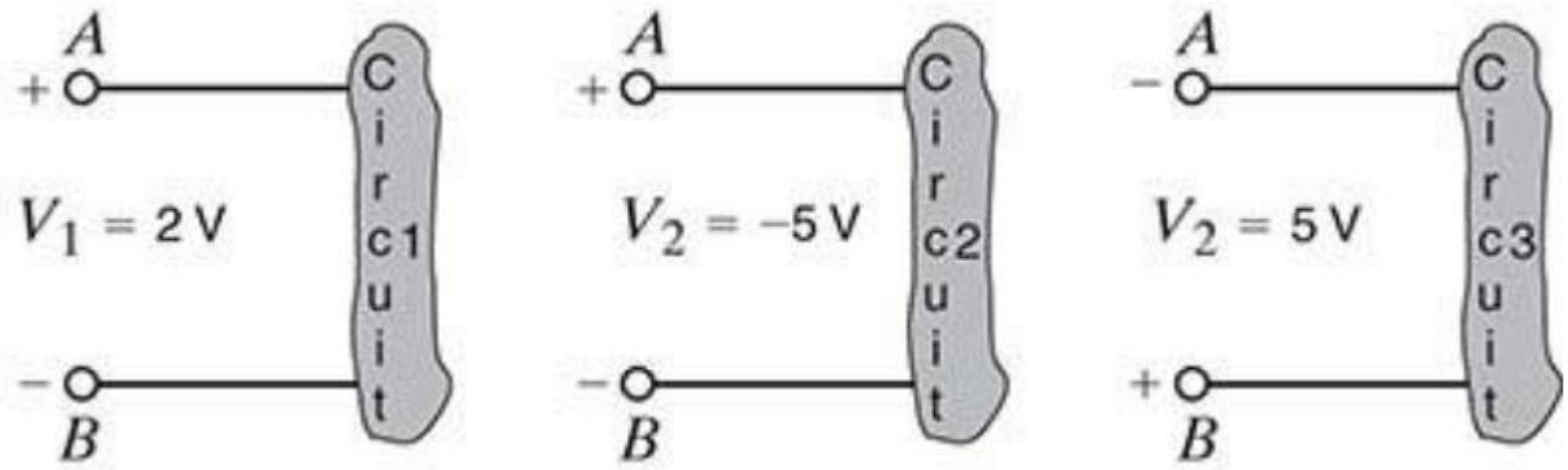
- Operational amplifiers and linear integrated circuits by Coughlin RF, Driscoll FF. . Upper Saddle River, NJ: Prentice Hall,; 2001.

Review of Circuit and Electronics

- Basic terminologies related to electronic circuit
- Basic circuit law and techniques
- Basic model of electronic devices e.g. diode, BJT and CMOS
- Basic DC analysis techniques of these electronics devices

Terminologies

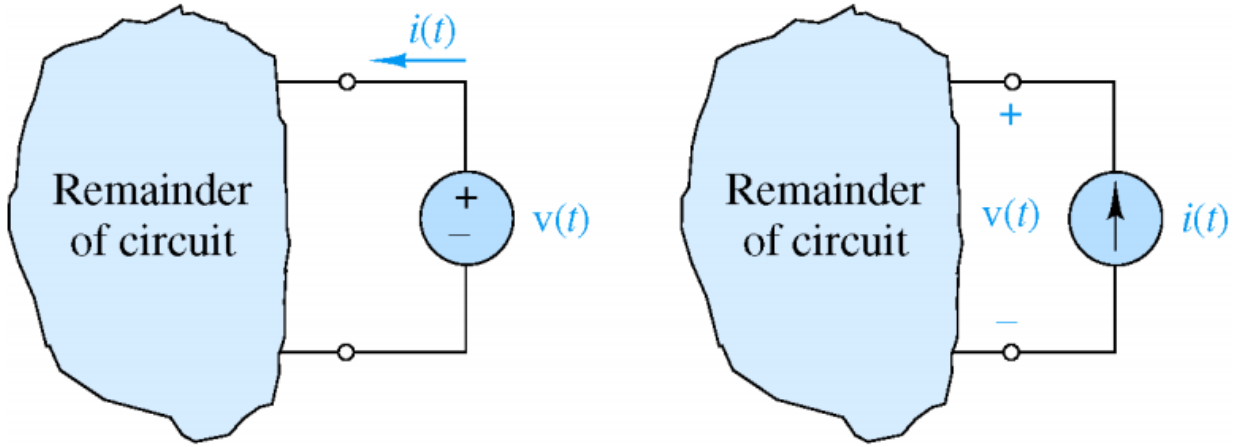
Voltage between two points in a circuit is the difference in energy level of a **unit charge** located at each of the two points.



Terminologies

Current is the net flow of charge across any cross section of a **conductor** or a **semi-conductor**, measured in Amperes in SI unit.

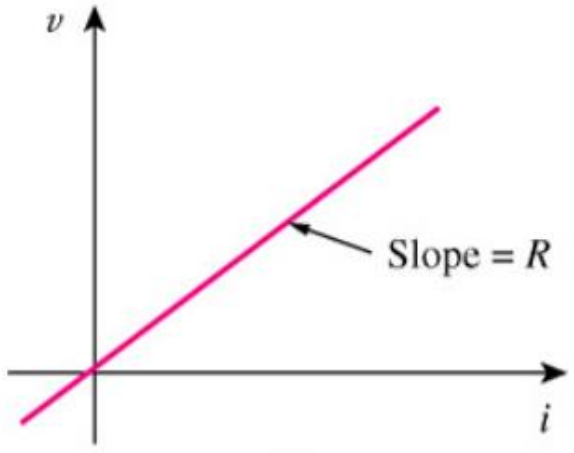
An (ideal) **independent source** is an **active element** that provides a specified voltage or current that is independent of other circuit elements.

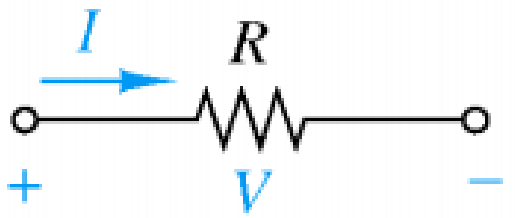


Ohm's Law

The voltage v across a conductor is directly proportional to the current i flowing through the conductor. The proportionality constant is the resistance R of the conductor.

$$\boldsymbol{V(t) \propto I(t) \Rightarrow V(t) = RI(t)}$$

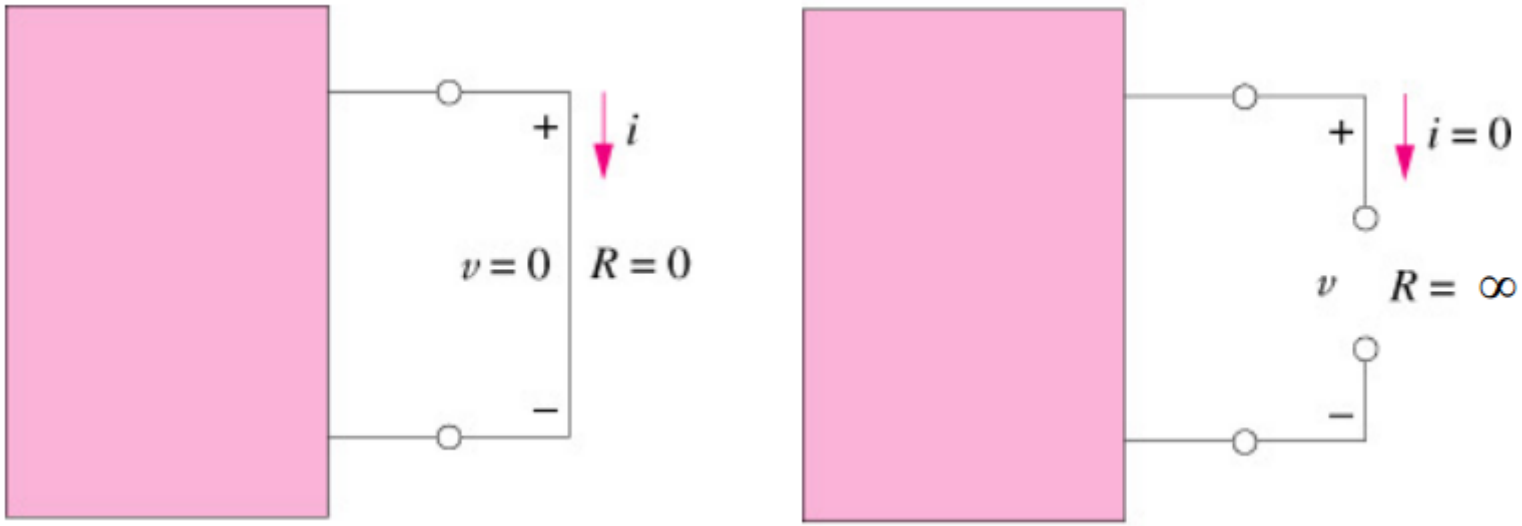




Terminology

A conductor designed to have a specific resistance is called a **resistor**.

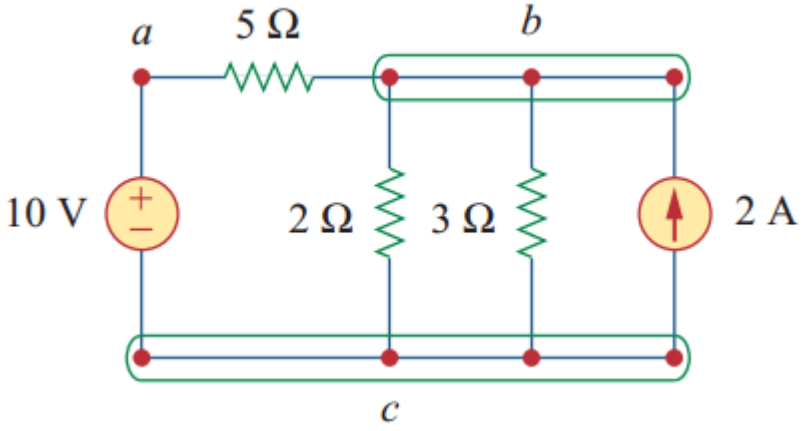
A device with zero resistance is called **short circuit** and a device with infinite resistance is called **open circuit**.



Terminology

A **branch** represents a single element with two terminals such as a voltage source or a resistor.

A **node** is the point of connection between the terminals of two or more circuit elements.

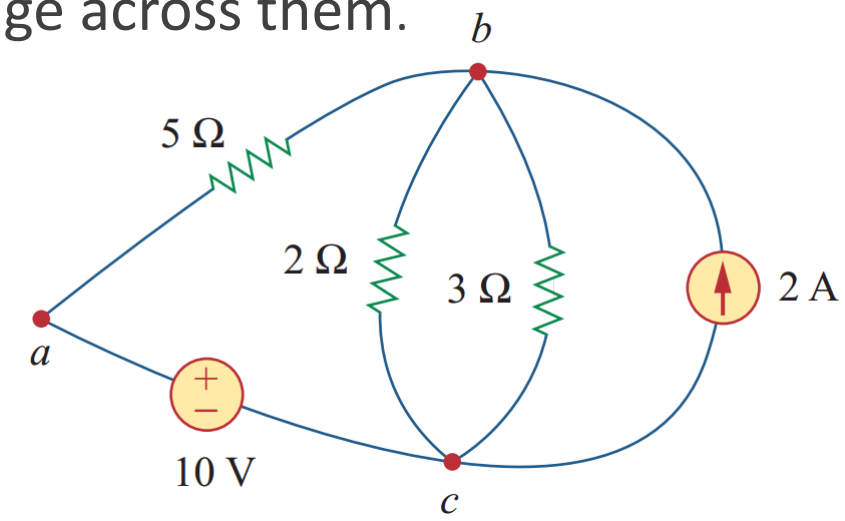


Terminology

A **loop** is any closed path in a circuit.

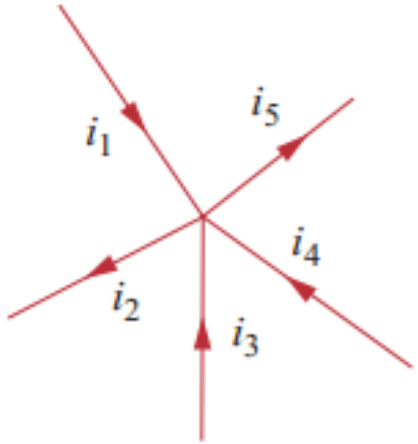
Two or more elements are in **series** if they exclusively share a single node and consequently carry the same current.

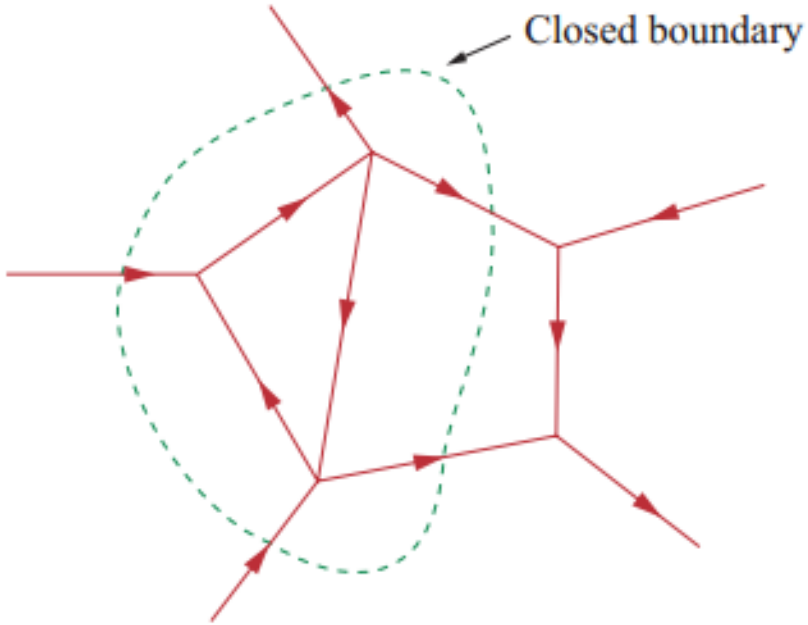
Two or more elements are in **parallel** if they are connected to the same two nodes and consequently have the same voltage across them.



Kirchhoff's Current Law (KCL)

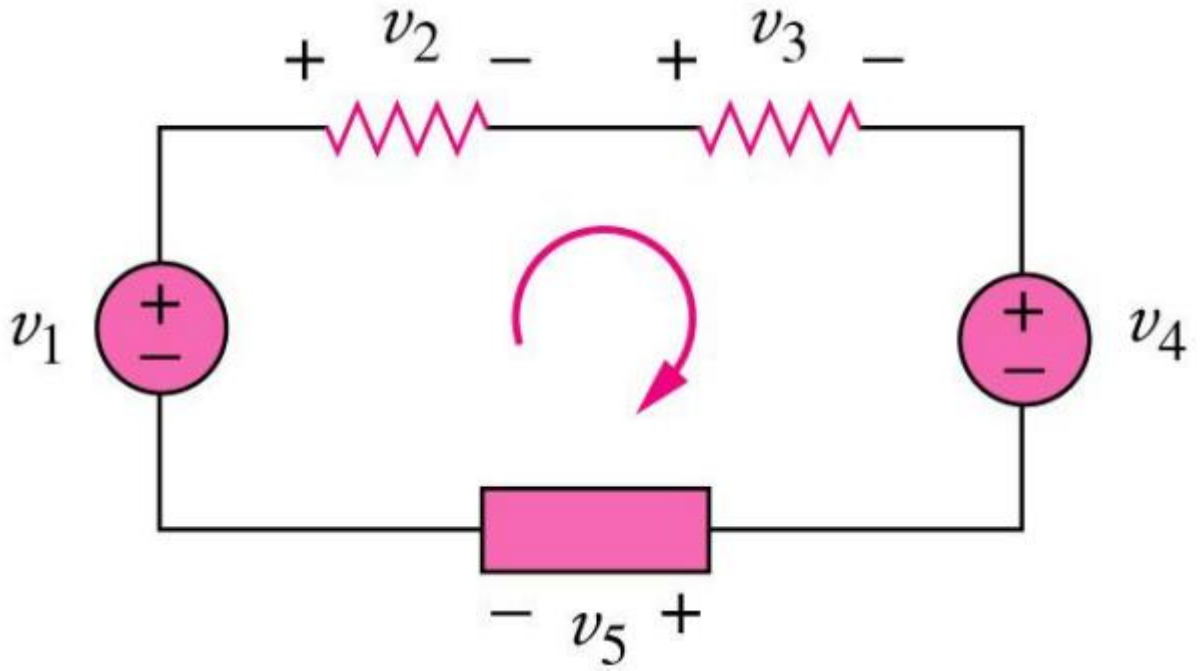
The algebraic sum of the currents leaving a node (or a closed boundary) is zero.





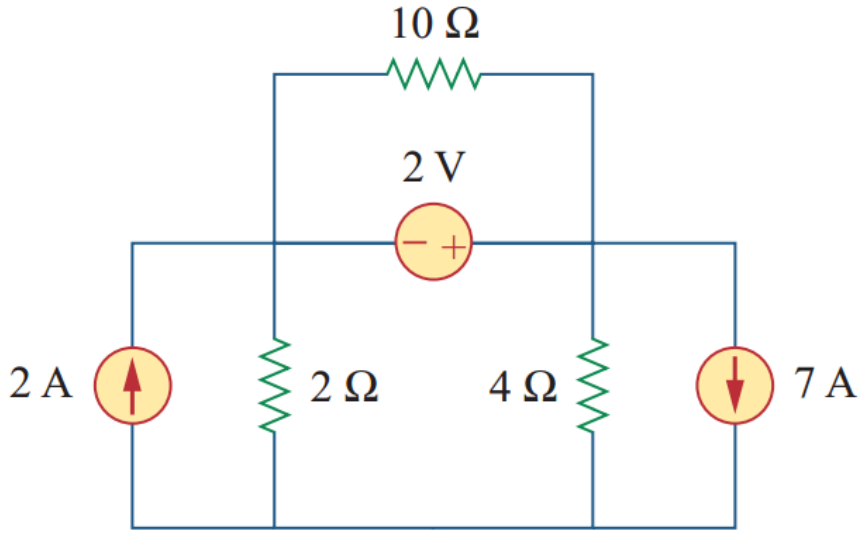
Kirchhoff's Voltage Law (KVL)

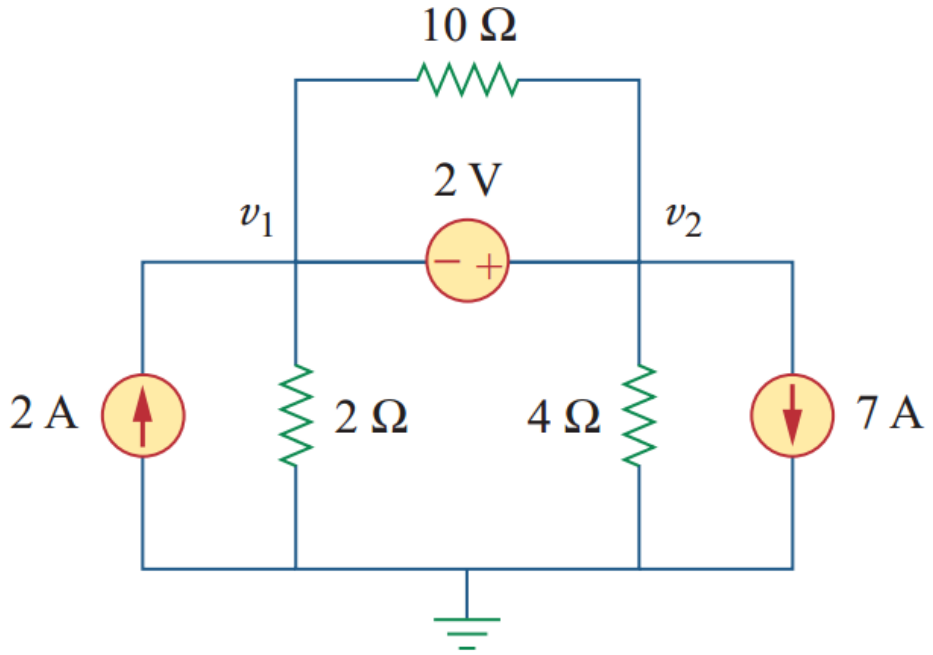
The algebraic sum of the voltage drops around any closed path (or loop) is zero at any instance of time.



Nodal Analysis

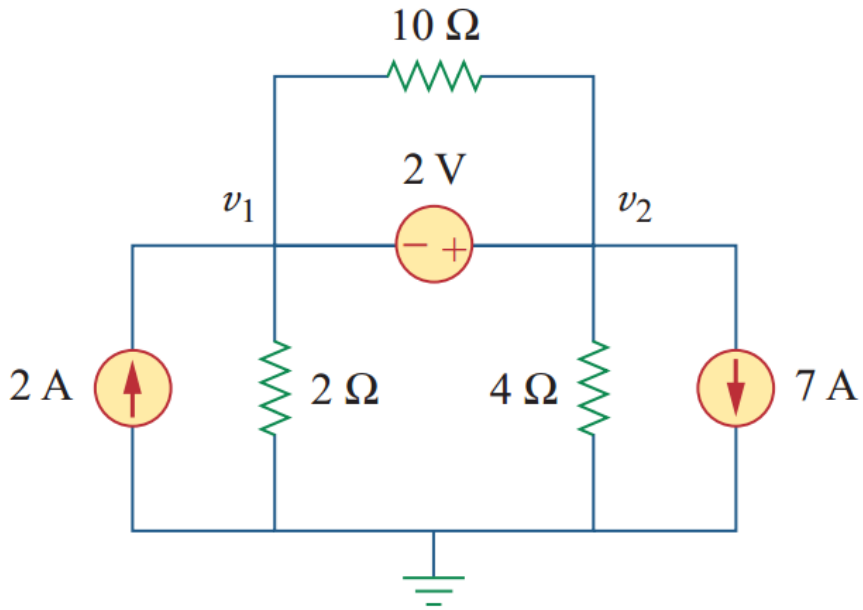
Step 1: Select a node as the **reference node**. Assign voltages $v_1, v_2, \ldots \ldots, v_{n-1}$ to the remaining $n - 1$ nodes. The voltages are referenced with respect to the reference node.

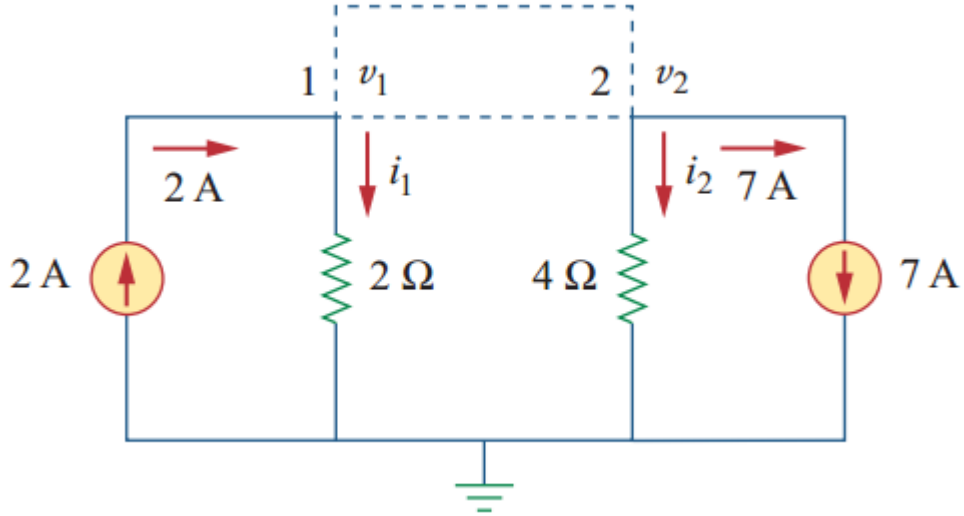




Nodal Analysis

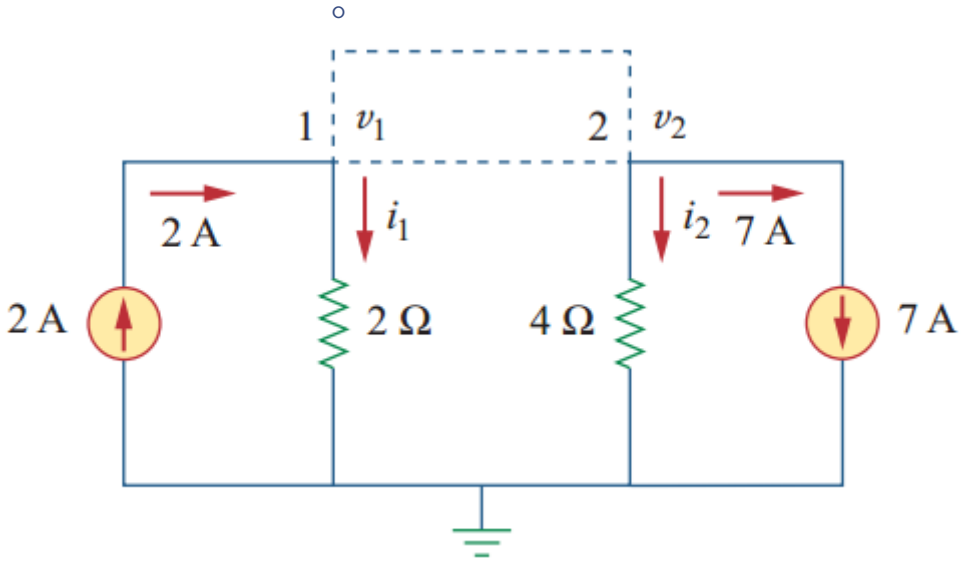
Step 2: Apply KCL to each of the nonreference nodes. Use Ohm's law to express the branch currents in terms of node voltages.





Nodal Analysis

Step 3: Solve the resulting **simultaneous equations** to obtain the unknown node voltages.



$$i_1 + i_2 - 2 + 7 = 0$$

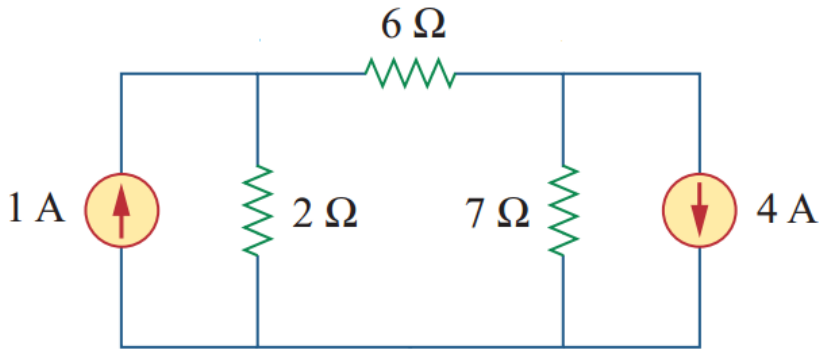
$$i_1 = \frac{v_1 - 0}{2},\ i_2 = \frac{v_2 - 0}{4}$$

$$v_2 - v_1 = 2\ V$$

$$\frac{v_1 - 0}{2} + \frac{v_2 - 0}{4} + 5 = 0$$

$$\frac{v_1 - 0}{2} + \frac{v_1 + 2}{4} + 5 = 0 \Rightarrow \begin{cases} v_1 = -\frac{22}{3} \\ v_2 = -\frac{16}{3} \end{cases}$$

Example



$v_1 = -2V, v_2 = -14\ V$

Summary

1. Introduction and overview of the course
2. Basic review of circuit analysis