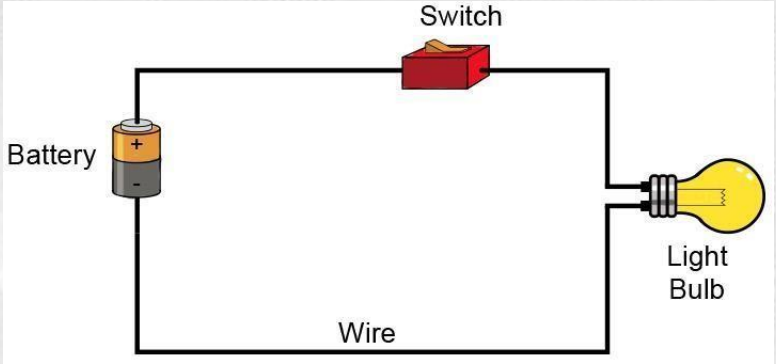
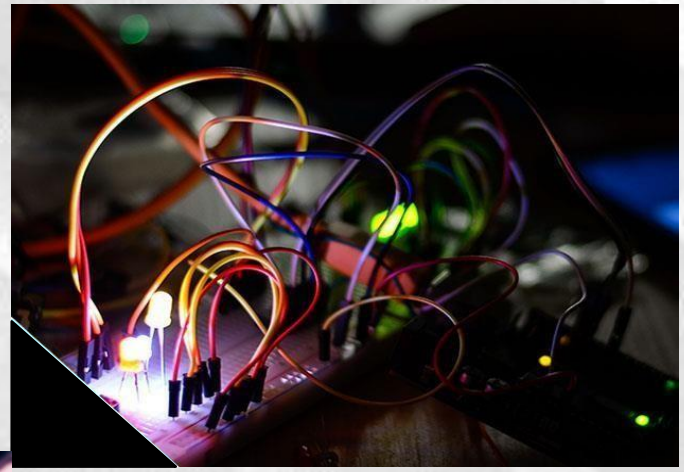
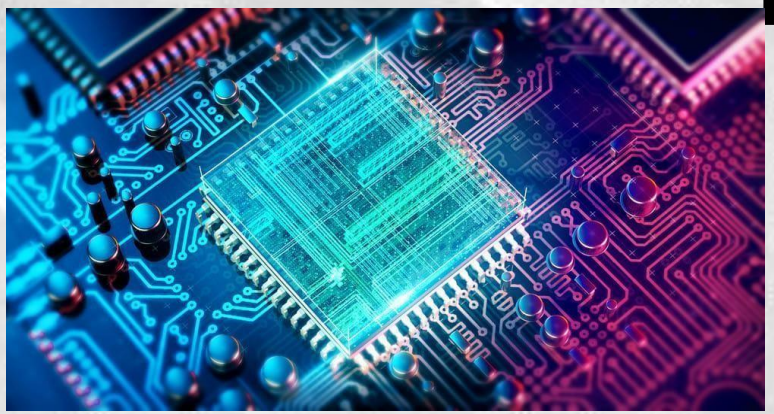
Introduction

Course Title : Basic Electrical Technology



Course Code : EEE 101





About the instructor

MIRZA MAHAMUDUL HASSAN

B.Sc in Civil Engineering
Khulna University of Engineering & Technology (KUET)

Lecturer, Department of Civil Engineering
Daffodil International University (DIU)

E-mail: mirza.ce@diu.edu.bd

Phone No: +8801777247883

Welcome Note

- Why study electric circuits course as a civil engineering student?
  - ***The basic electric circuit theory course is one of the fundamental courses of engineering. Engineering involves all areas of science. As a professional engineer, having interdisciplinary knowledge is very important.***
- Electric circuit theory and electromagnetic theory are the two fundamental theories upon which all branches of electrical engineering are built .
- Branches of electrical engineering - electronics, power, electric machines, control, communications, instrumentation, etc

COURSE SYLLABUS

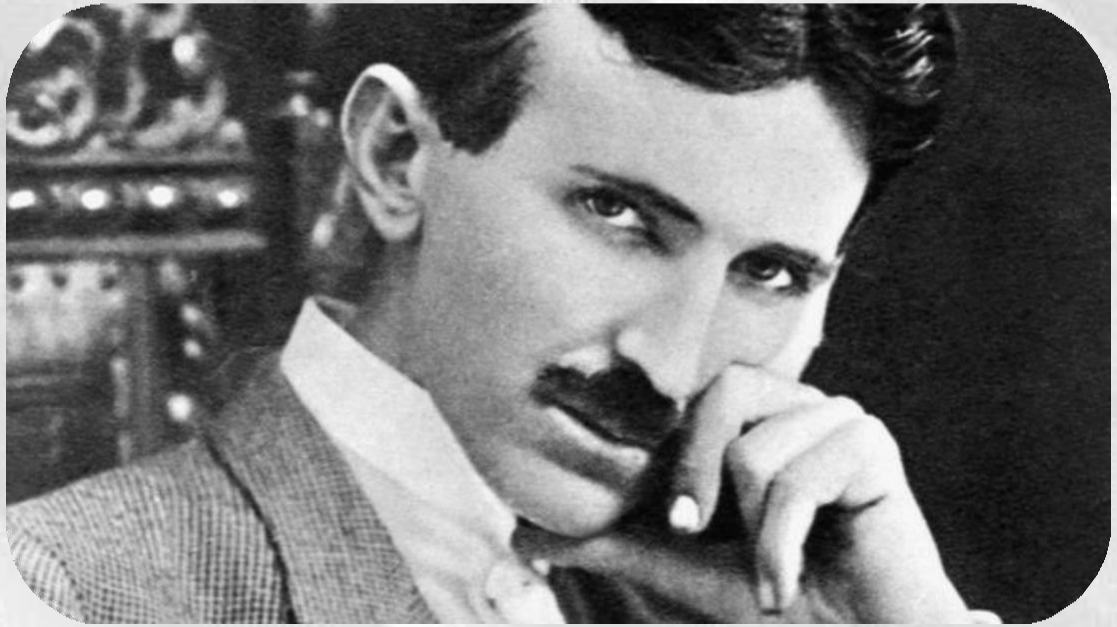
Lecture module 01: Basic Concepts	Introduction to circuit analysis
	Definition about Charge, Current, Voltage, Power, Energy.
	Definition of passive sign convention.
	Problem solving for absorbed and supplied power.
Lecture module 02: Different combinations of resistances	Series resistances and voltage division.
	Parallel resistances and current division.
	Delta to Wye conversion.
	Wye to delta conversion.
Lecture module 03: Basic Laws	Introduction to Ohm's law
	Definition of Nodes, Branches and Loops.
	Introduction to Kirchhoff's voltage law.
	Introduction to Kirchhoff's current law.

COURSE SYLLABUS

Lecture module 04: Nodal Analysis	Nodal analysis.
	Nodal analysis with voltage source.
	Problem solving using nodal analysis.
Lecture module 05: Mesh analysis	Mesh analysis.
	Mesh analysis with current source.
	Problem solving using mesh analysis.
Lecture module 06: Circuit Theorems part 1	Linearity property.
	Superposition.
	Source transformation.
Lecture module 07: Circuit Theorems part 2	Thevenin's theorem.
	Norton's theorem.
	Maximum power transfer theorem.

Contributers to EEE

Nicola Tesla (1856-1943)



- Father of AC current .
- Inventor of induction motor.
- Around 111 patents.
- Is considered the most genious scientists / Engineers of all time.
- The electric car Tesla is named after him .

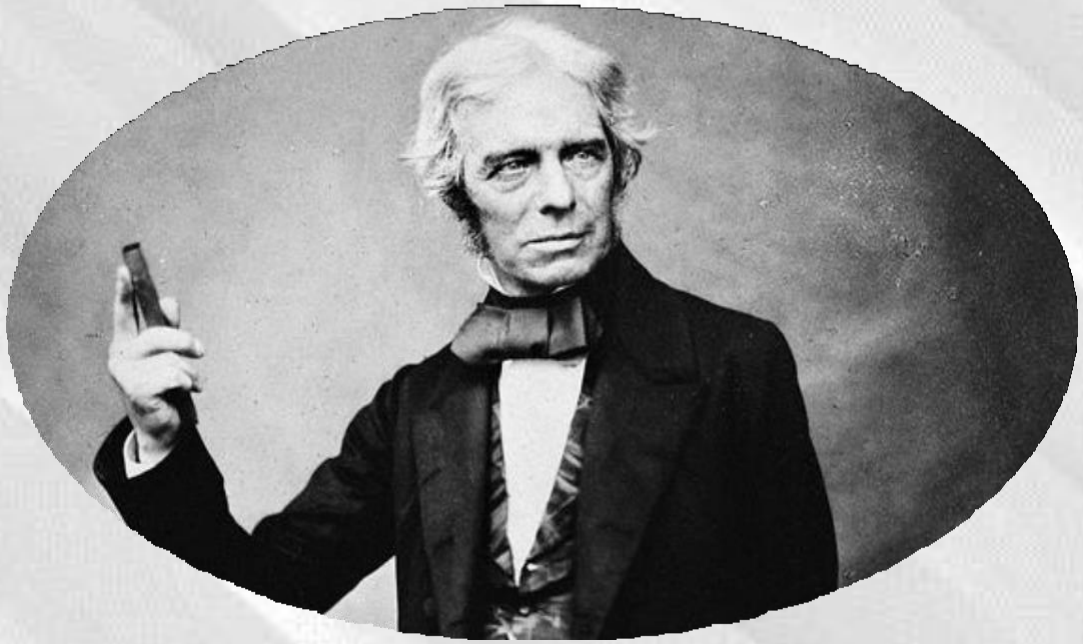
Contributers to EEE

Thomas Alva Edison (1847-1931)

- Father of DC current .
- Inventor of light bulb.
- Inventor of Phonograph.
- More than 2000 patents.

Contributers to EEE

Michael Faraday(1791-1867)



- Father Electro chemistry.
- Faraday’s Law of induction.

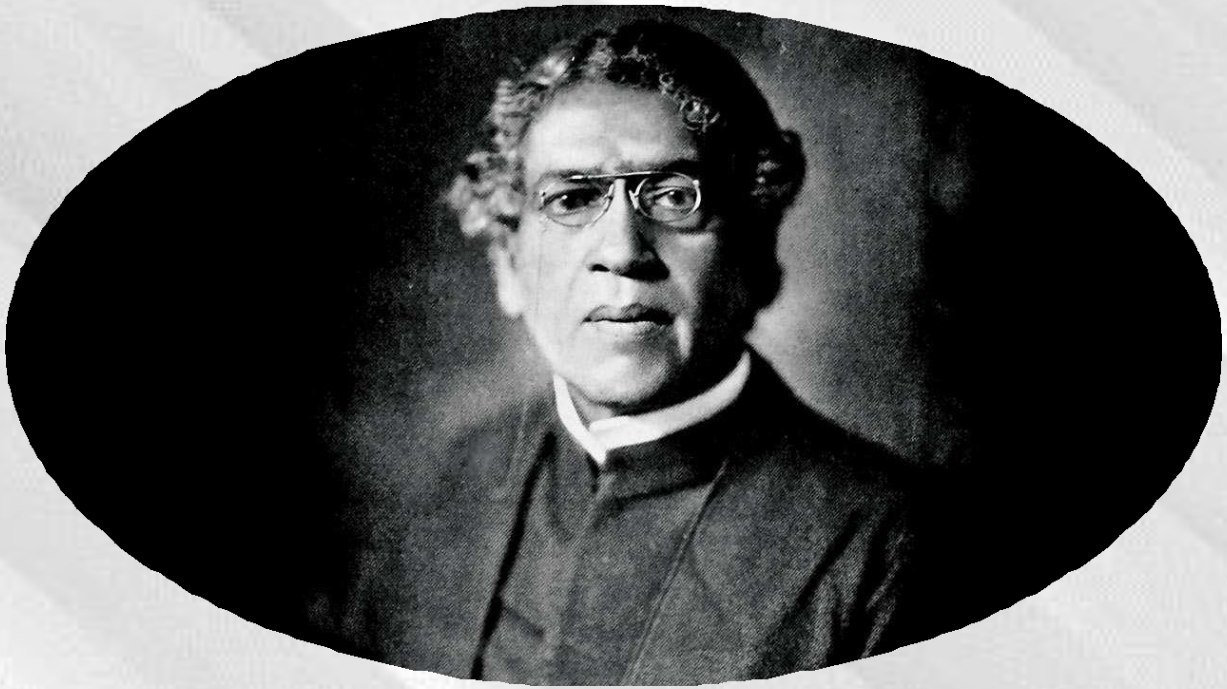
Contributers to EEE

Jack Kilby(1923-2005)

- Inventor of Integrated Circuit (IC).
- Won Nobel prize in 2000

Contributers to EEE

Jagadish Chandra Bose(1856-1943)



- Radio Communication
- Inventor of Crescograph

Contributers to EEE

Gustav Robert Kirchhoff

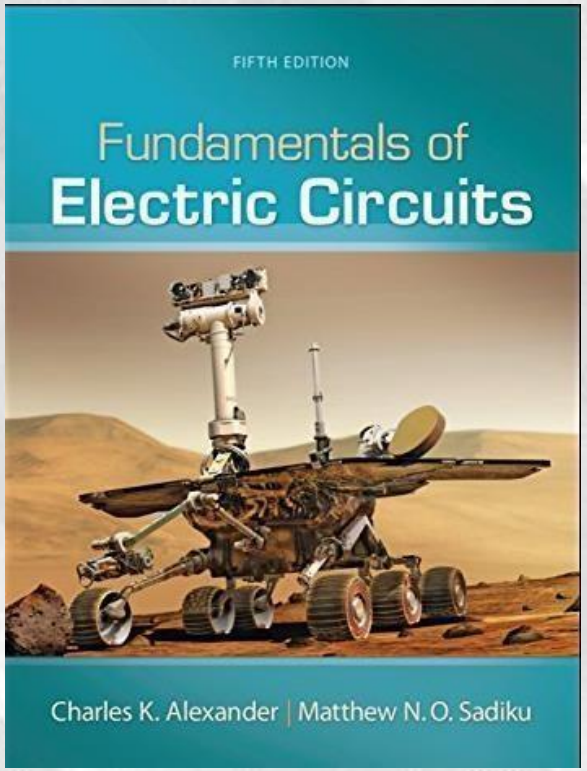
1824-1887

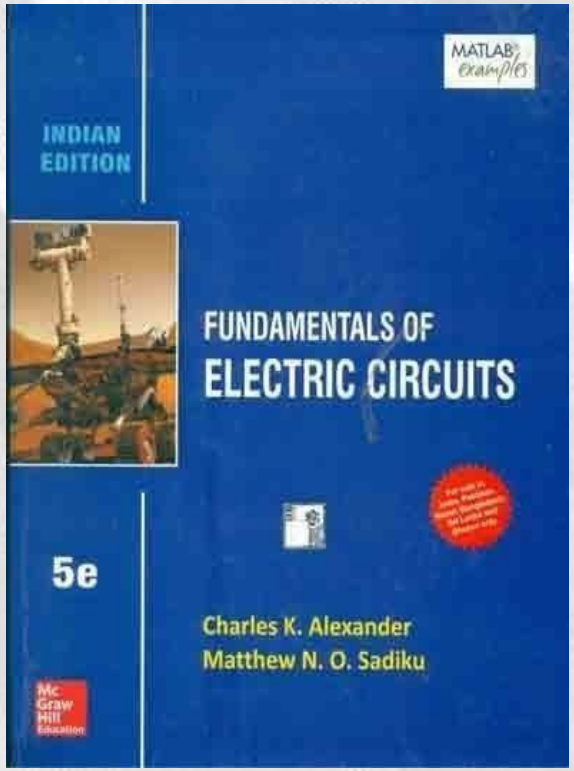
George Simon Ohm

1856-1943

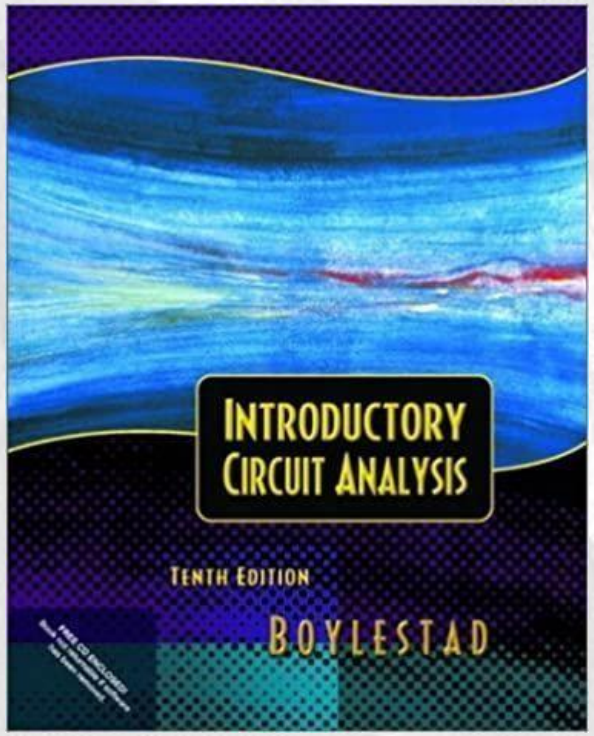
Text Books

Fundamentals of Electric Circuits - Charles K. Alexander & Matthew N. O. Sadiku





Introductory Circuit Analysis - Boylestad



Basic Concepts

LEARNING OBJECTIVES:

- To explain the basic definitions.
- To explain the passive sign convention.
- To calculate absorbed and supplied power of electrical elements.

LECTURE CONTENTS:

- Introduction to circuit analysis
- Definition about Charge, Current, Voltage, Power, Energy.
- Definition of passive sign convention.
- Problem solving for absorbed and supplied power.

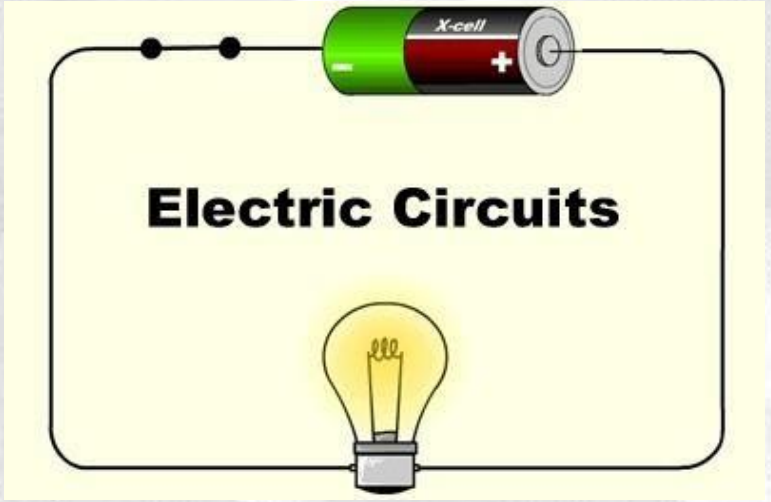
LEARNING OUTCOMES:

- Know basic definitions regarding electrical circuits.
- Solve absorbed and supplied power for the electrical elements of a circuit.

Introduction to Electric Circuits

Definition

An electric circuit is an interconnection of electrical elements. Each component ofthe circuit is known as an element



Function

To transfer energy from one point to another.

Basic parameter

Charge , Current , Voltage , Power , Circuit elements. Energy.

Charge

- Charge is an electrical property of the atomic particles of which matter consists, measured in coulombs (C).
- Exist as negative (electron) and positive (proton) charges. Measured in Coulombs (C).

  1 electron = $-1.602*10^{-19}$C
- **The law of conservation of charge** states that charge can neither be created nor destroyed, only transferred. Thus the algebraic sum of the electric charges in a system does not change.
- The motion of charges creates an electric current. It is conventional to take the current flow as the **movement of positive charges**. That is, opposite to the flow of negative charges

Charles-Augustin de Coulomb

- French Born Military Physicist and Engineer .
- Famous For Coulumb’s law of charge

Current

- Defined as the charge flow rate.
- Measured in Ampere (A). $i = \frac{dq}{dt}$
- Direct current (DC) is the unidirectional flow of electric charge.
- In alternating current (AC), the flow of electric charge periodically reverses direction.

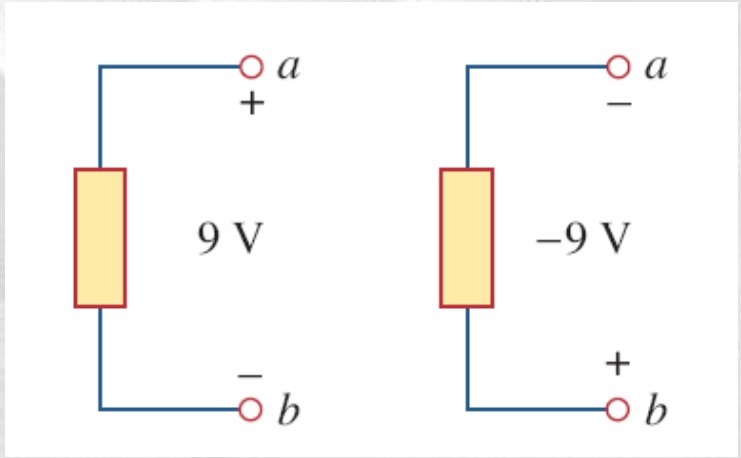
Andre-Marie Ampere (1775–1836), a French mathematician and physicist defined the electric current and developed a way to measure it in the 1820s. The unit of electric current, the ampere, was named after him.

Voltage

- Defined to be the charge rate of doingwork.
- ***Voltage (or potential difference) is the energy required to move aunit charge through an element. It is measured in volts (V).***
- 1 volt = 1 joule/coulomb = 1 newton meter/coulomb

$$v_{ab} \triangleq \frac{dw}{dq}$$

$$v_{ab} = -v_{ba}$$



- Current and voltage are the two basic variables in electric circuits.

Alessandro Antonio Volta (1745–1827), an Italian physicist, invented the electric battery and the capacitor. The unit of voltage or potential difference, the volt, was named in his honor.

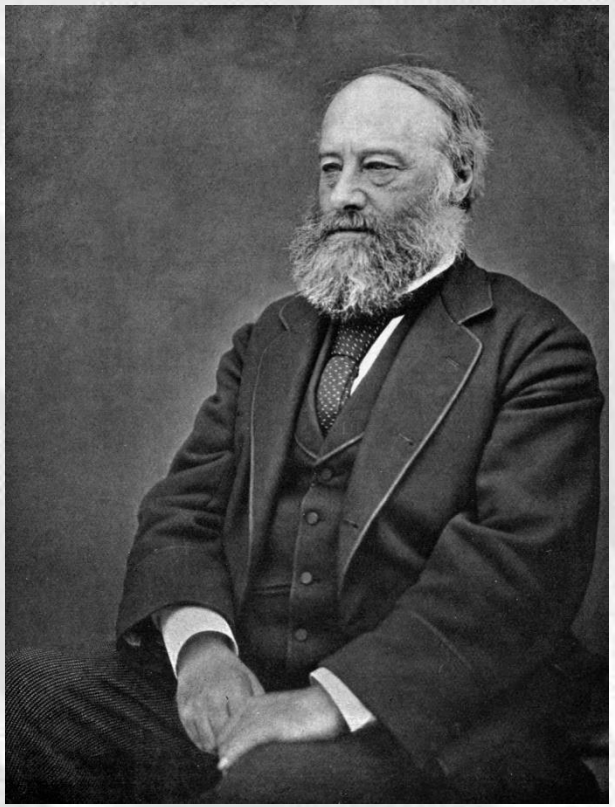
Energy

- Defined as the **capacity to do work**.
- Measured in joules (J).
- 1 Wh = 3600 Joule

$$w = \int_{t_0}^{t} p\,dt = \int_{t_0}^{t} vi\,dt$$

$w = vit$ (J)

- ***Law of conservation of energy states that energy can neither be created nor destroyed - only converted from one form of energy to another.***



James Prescott Joule

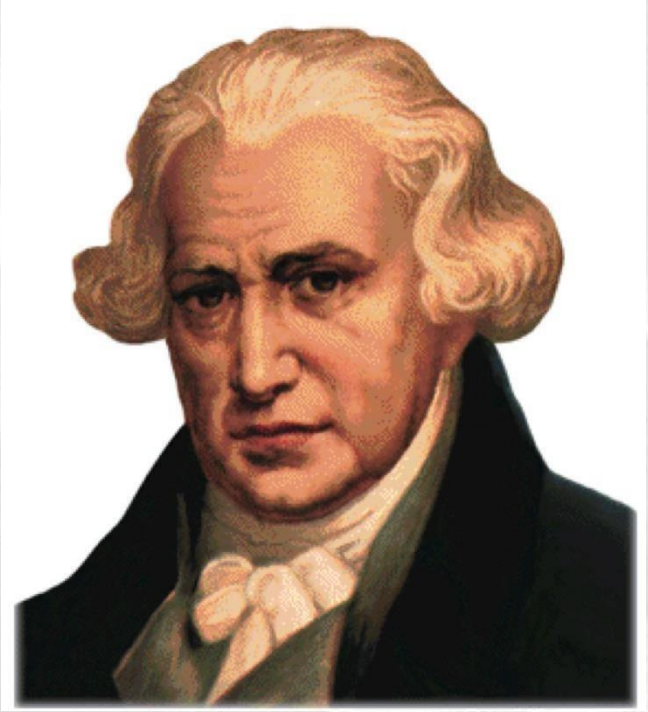
English physicist and mathematician

Power

- Defined to be the time rate of doing work.
- Measured in watts (W)
- Power can be absorbed or supplied by circuit elements.
- **“The law of conservation of energy must be obeyed in any electric circuit."** For this reason, the algebraic sum of power in a circuit, at any instant of time, must be zero.

$$\sum P_{supplied} + \sum P_{absorbed} = 0$$

$$p = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = vi$$

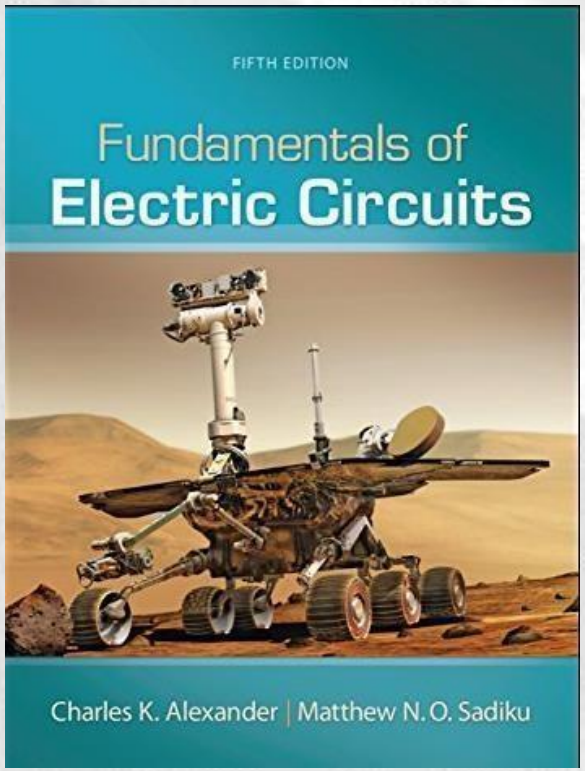


James Watt
Scottish mathematician and engineer

Self Study

- Example 1.1-1.6.
- Practice Problem 1.1-1.6

Fundamentals of Electric Circuits - Charles K. Alexander & Matthew N. O. Sadiku



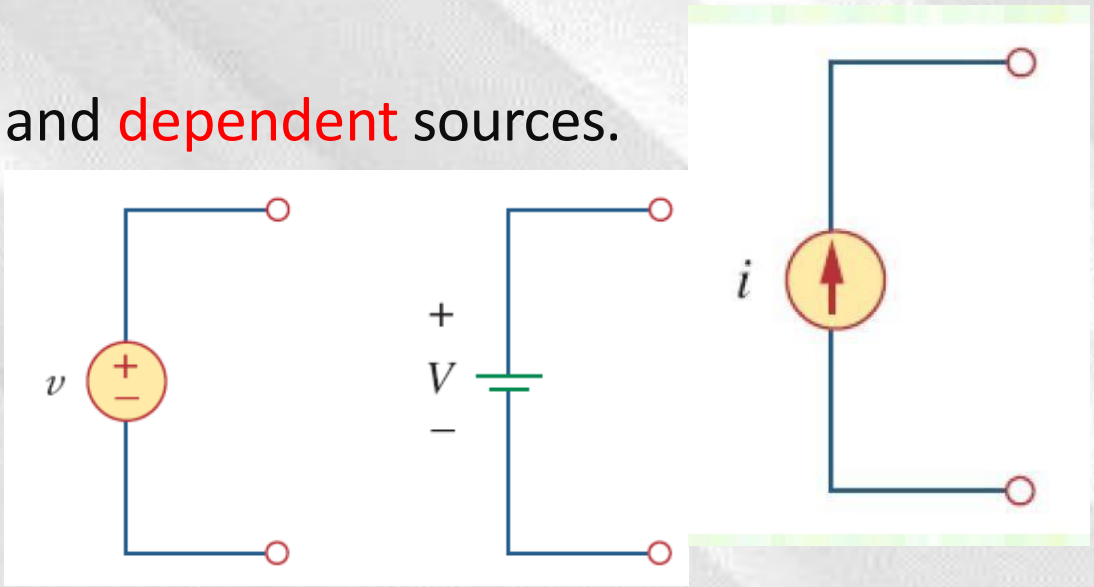
Circuit Elements

- An element is the basic building block of a circuit.
- There are two types of elements found in electric circuits: passive elements and active elements. An active element is capable of generating energy while a passive element is not.

Circuit Elements

There are two kinds of sources: independent and dependent sources.

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



Circuit Elements

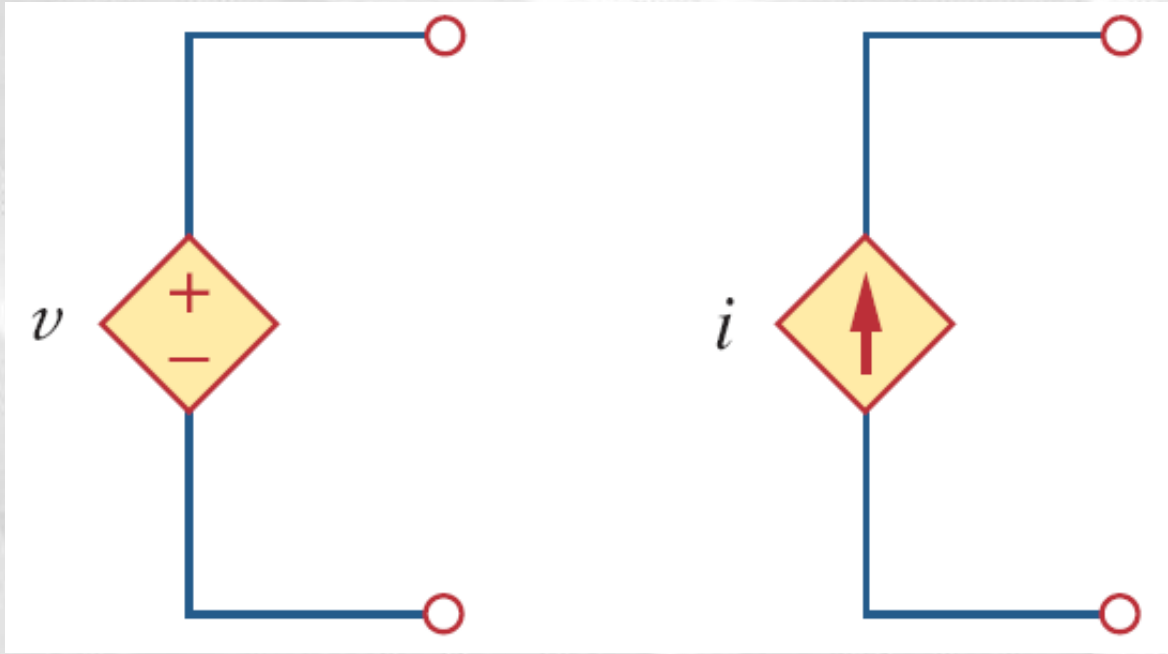
The control of the dependent source is achieved by a voltage or current of some other element in the circuit, and the source can be voltage or current, it follows that there are four possible types of dependent sources, namely:

1. A voltage-controlled voltage source (VCVS).

2. A current-controlled voltage source (CCVS).

3. A voltage-controlled current source (VCCS).

4. A current-controlled current source (CCCS).



Sign Convention

Current direction and voltage polarity play a major role in determining the sign of power.

Passive sign convention is satisfied when the current enters through the positive terminal of an element so p=vi. If the current enters through the negative terminal, p=-vi.

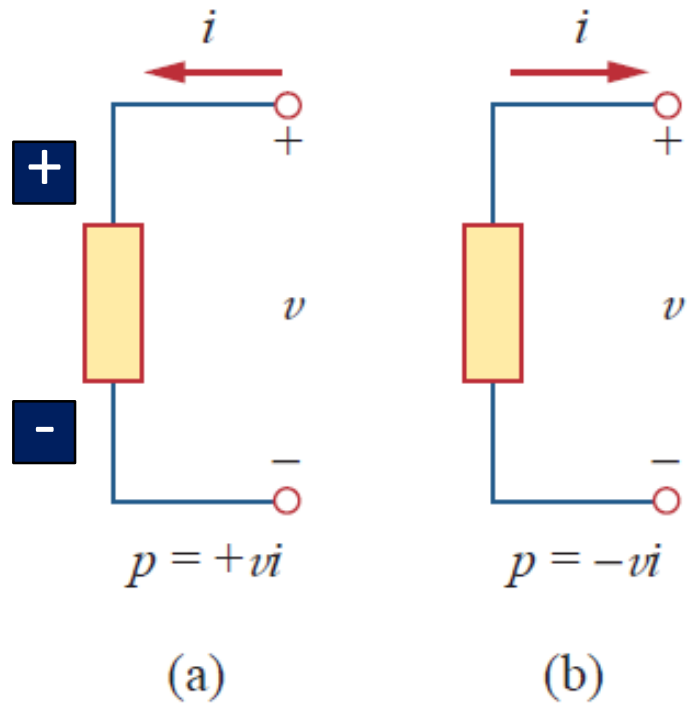


Figure 1.8
Reference polarities for power using the passive sign convention: (a) absorbing power, (b) supplying power.

Sign Convention

Current direction and voltage polarity play a major role in determining the sign of power.

Passive sign convention is satisfied when the current enters through the positive terminal of an element and p=vi. If the current enters through the negative terminal, p=-vi.

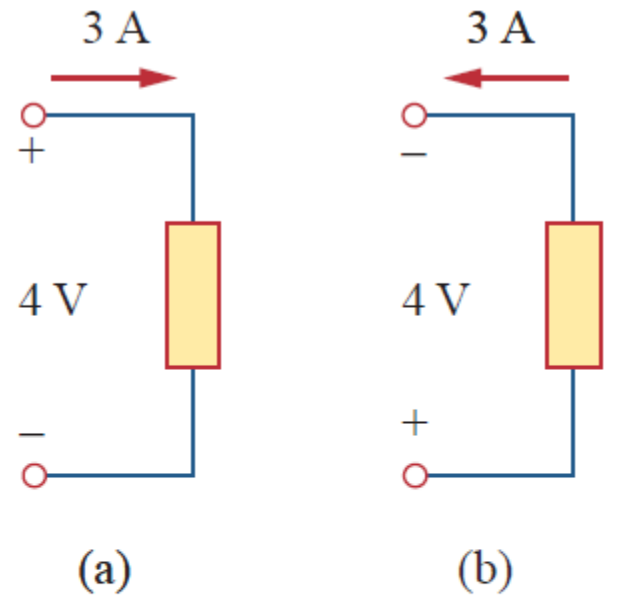
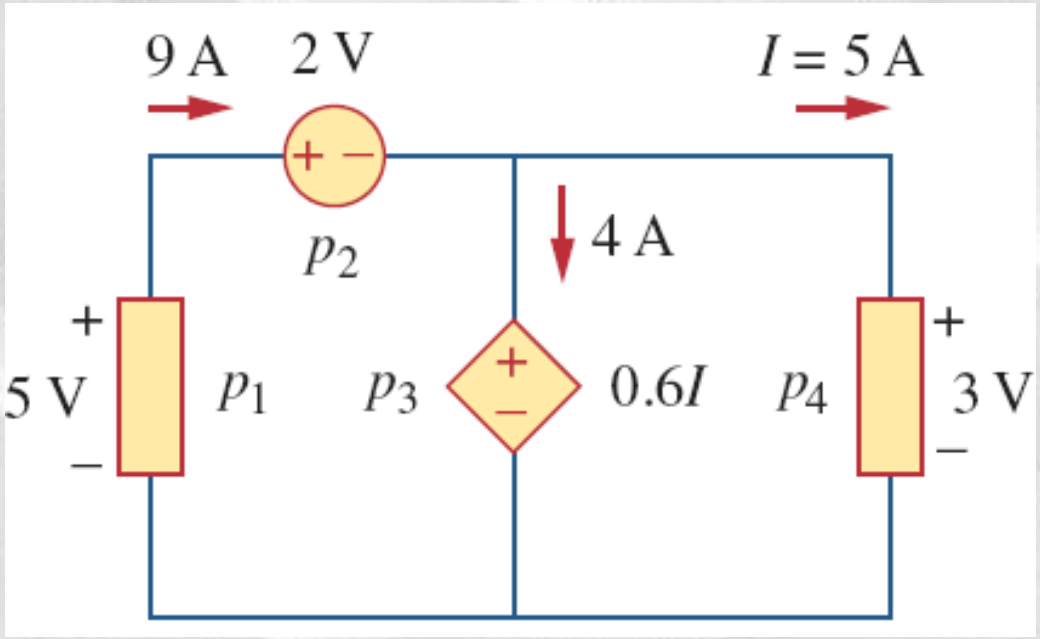


Figure 1.9
Two cases of an element with an absorbing power of 12 W: (a) $p = 4 \times 3 = 12$ W, (b) $p = 4 \times 3 = 12$ W.

MATHEMATICAL PROBLEM

Calculate the power supplied or absorbed by each element .

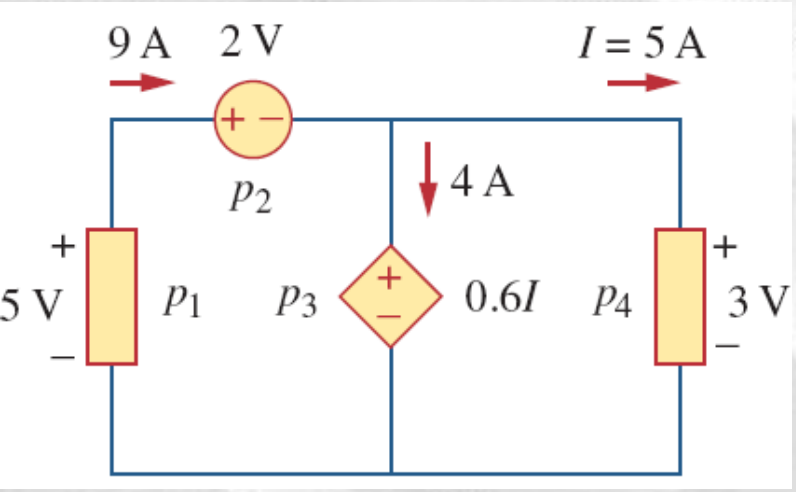


Hint : Use the formula

$P=vi$

MATHEMATICAL SOLUTION

Calculate the power supplied or absorbed by each element.



$P_1 = -vi = -5\ X9\ W = -45W$

$P_2 = vi = 2\ X9\ W = 18W$

$P_3 = vi = 0.6\ X5\ X4\ W = 12W$

$P_4 = vi = 3\ X5\ W = 15W$

Power Supplied

Power Absorbed

Power Absorbed

Power Absorbed

$P_1 + P_2 + P_3 + P_4 = (-45 + 18 + 12 + 15\ )W)\ = 0\ W$

Recall

□ P=

0

$\sum P_{supplied} + \sum P_{absorbed} = 0$

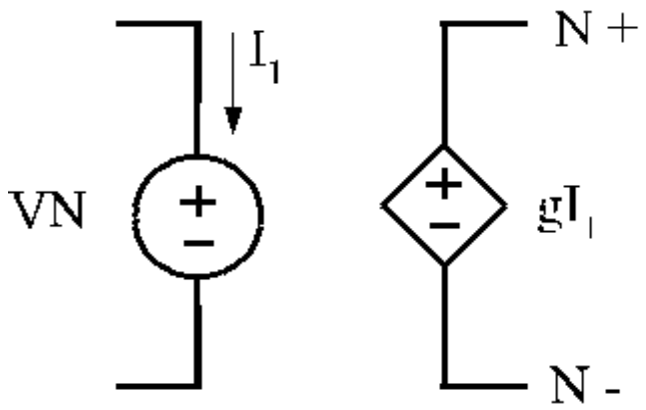


Fig. 6(a)

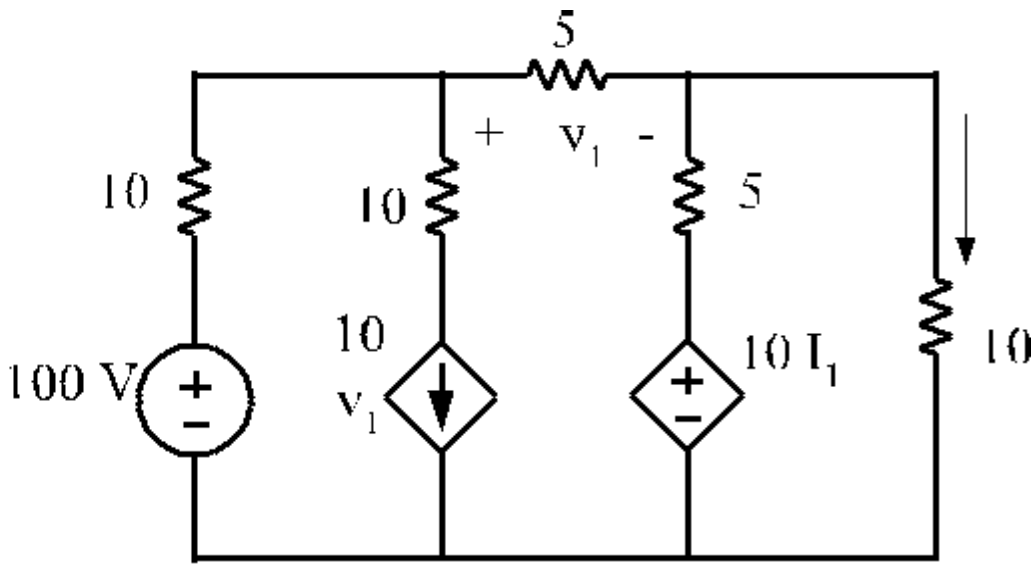


Fig. 6(b)

A homeowner consumes 700 kWh in January. Determine the electricity bill for the month using the following residential rate schedule:

Base monthly charge of $12.00.

First 100 kWh per month at 16 cents/kWh.

Next 200 kWh per month at 10 cents/kWh.

Over 300 kWh per month at 6 cents/kWh.

Solution:

We calculate the electricity bill as follows.

$$\begin{aligned}
\text{Base monthly charge} &= \$12.00 \\
\text{First 100 kWh @ \$0.16/kWh} &= \$16.00 \\
\text{Next 200 kWh @ \$0.10/kWh} &= \$20.00 \\
\text{Remaining 400 kWh @ \$0.06/kWh} &= \$24.00 \\
\text{Total charge} &= \$72.00
\end{aligned}$$

$$\text{Average cost} = \frac{\$72}{100 + 200 + 400} = 10.2 \text{ cents/kWh}$$