PHENIKAA UNIVERSITY

Chapter 1: Basic concepts

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Course outline

1. Course description
2. Objectives
3. Learning outcomes
4. Recommended Books
5. Exams and attendance

Course description

Điện tử học cơ sở cung cấp cho sinh viên các kiến thức cơ bản về các thành phần và mạch điện tử. Sinh viên sẽ nắm được các nguyên lý hoạt động, và ứng dụng của các linh kiện cơ bản như điện trở, tụ điện, cuộn cảm, diode, transistor, điện tử số... Môn học cũng giới thiệu cho sinh viên một số mạch điện thông dụng.

Objectives

G1 Hiểu biết kiến thức cơ bản về các linh kiện điện tử

G2 Khả năng thiết kế và phân tích một số mạch điện tử ứng dụng

G3 Kỹ năng tìm đọc tài liệu và giải quyết vấn đề liên quan bằng tiếng Anh.

Learning outcomes

G1.1 Trình bày được kiến thức cơ bản về các linh kiện điện tử thụ động: điện trở, tụ điện, cuộn cảm

G1.2 Trình bày được kiến thức cơ bản về các linh kiện điện tử tích cực: diode, các transistor BJT, FET

G1.3 Phân tích một số mạch điện tử thông dụng như mạch khuếch đại thuật toán, cơ sở kỹ thuật điện tử số

G2.1Phân tích một số mạch điện cơ bản

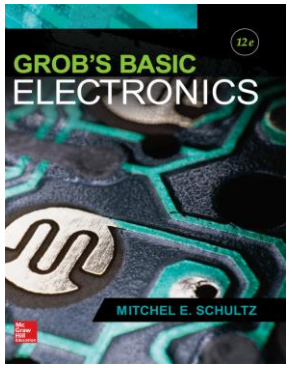
G3.1. Khả năng tìm đọc các tài liệu, trả lời các câu hỏi và bài tập, giải quyết các vấn đề liên quan bằng tiếng Anh

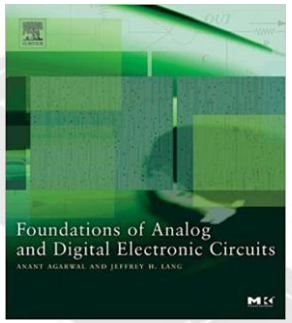
Recommended Books

1. Required Textbook

- Mitchel E. Schultz - **Grob's Basic Electronics**, 12th Edition- McGraw-Hill Education (2015). (For analog Part)

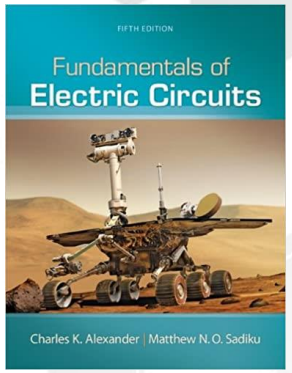
- Agarwal, A. and Lang, J.H., ***Foundations of Analog and Digital Electronic Circuits***, Elsevier (2005)





2. You may also wish to refer to the book

Charles K Alexander, Matthew Sadiku, ***Fundamentals of Electric Circuits*** (5 ed.), McGraw-Hill Education (2013).



3. Handout-Lecture note:

Evaluation strategy

LO (Gx.x)	Activities and Grading		
	CC (10%)	BTVN (30%)	TKTHP (60%)
G1.1		BTVN1	KTHP
G1.2		BTVN2	KTHP
G1.3		BTVN3	KTHP
G2.1			KTHP
	Process grade	Process grade: CC = d*0.5+Quizzes*0.5	
	Course grade	f = CC*0.1+BTVN*0.3+KTHP*0.6	Final exam

Grading will be based on the following:

Random Quiz's 0 (5 marks)

Informed Quiz- (5 marks each)

Mid semester examination (30% Weight)

End semester examination (60% Weight)

Lecture schedule and Evaluation strategy

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Course Meeting Times

- Lectures: 3 sessions/week, 50 minutes/session (weekly on Wednesday 6-8 sections – 1:00 pm to 3:40 pm)

Attendance:

- Since much of the course involves hands-on and interactive lessons, attendance is essential. Active participation in the demonstrations and laboratory exercises is expected. The compulsory attendance no less than 80%.

Homework: Assignments are handed out and are due as listed in the schedule. Late assignments will not be accepted, and count to the process grade

Laboratory: (1 credit) since covid-19 pandemic so the schedule will be notified later

Attendance

Process grade (10%) includes Attendance (5%) and Quizzes (5%)

Attendance could be a check canvas daily

The absent sections	Point levels
Full of attendance	5 points
Absence > 20%	Fail to join final exam

Minimum 80% attendance compulsory (institutional requirement: your attendance is your responsibility!)

Course contents

Chương 1. Giới thiệu chung (3 tiết)

Chương 2. Mạch điện trở (6 tiết)

Chương 3. Tụ điện và cuộn cảm (6 tiết)

Chương 4. Diode và ứng dụng (3 tiết)

Chương 5. Transistor lưỡng cực (BJT) (6 tiết)

Chương 6. Transistor trường (FET) (6 tiết)

Chương 7. Khuếch đại thuật toán (Op-Amp) (6 tiết)

Chương 8. Cơ sở điện tử số (6 tiết)

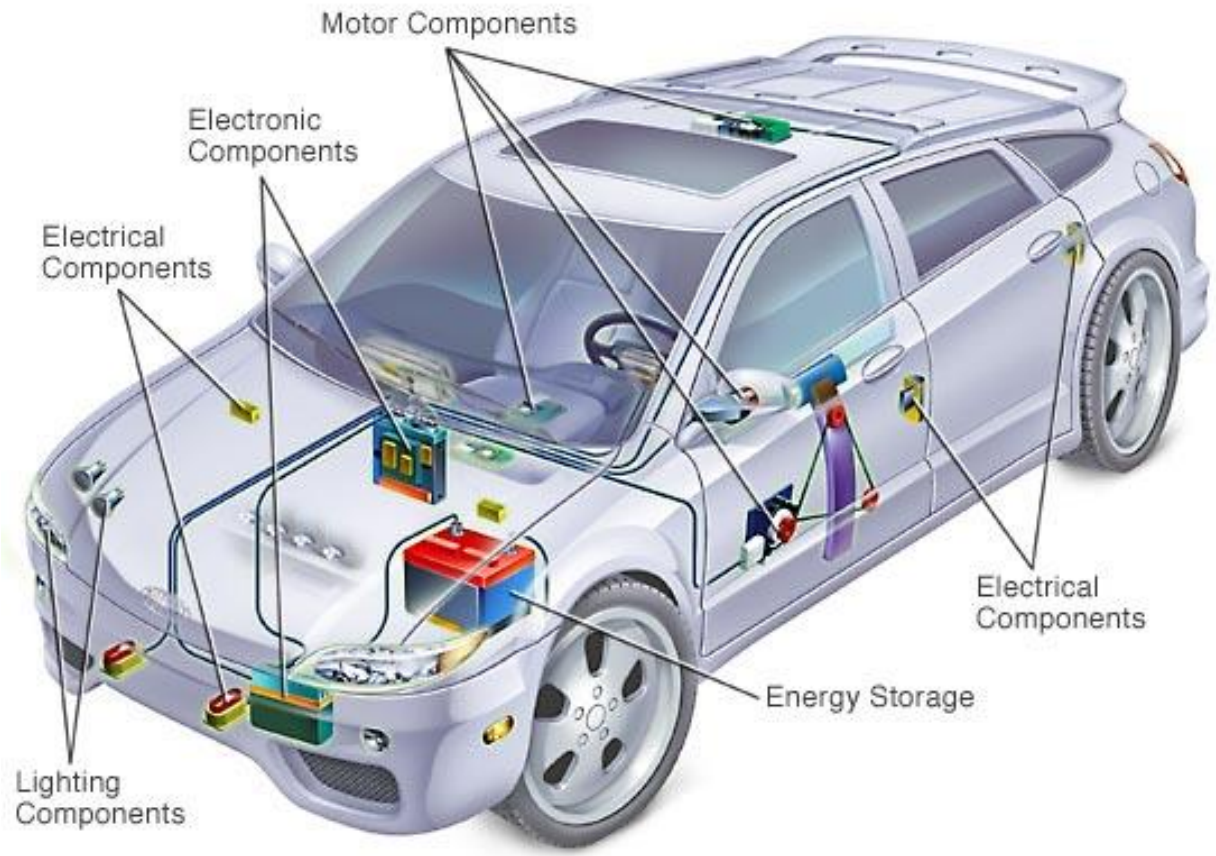
Ôn tập (3 tiết)

Contents

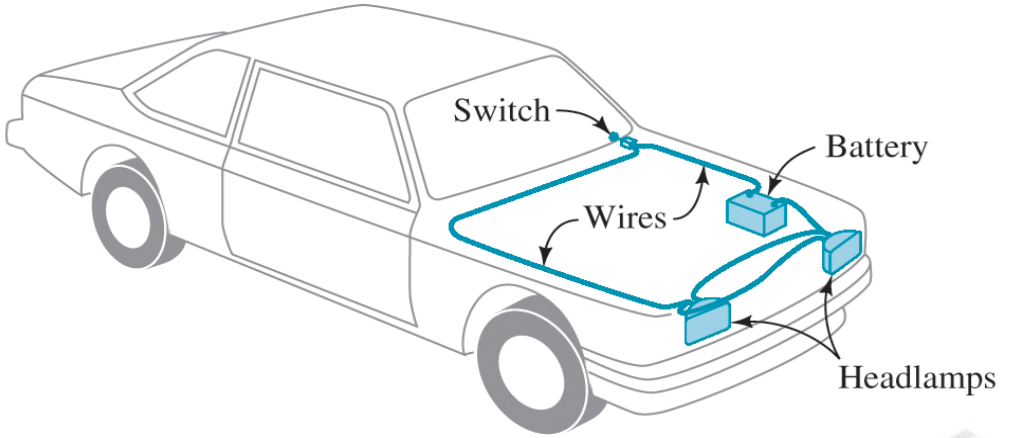
- *Electrical & Electronic Engineering*
- *Structure of the Atom*
- *Charge, Current, Voltage*
- *Power and Energy*
- *DC & AC*
- *Circuit: Open and Short Circuits*
- *Circuit Elements*

Electrical and Electronic Engineering

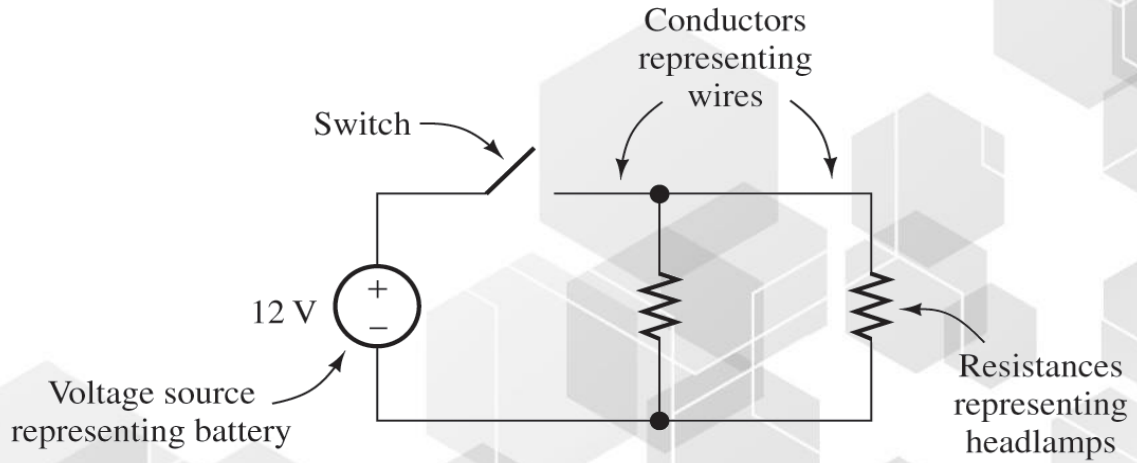
- **Example:**



- The headlight circuit. (a) The actual physical layout of the circuit. (b) The circuit diagram.



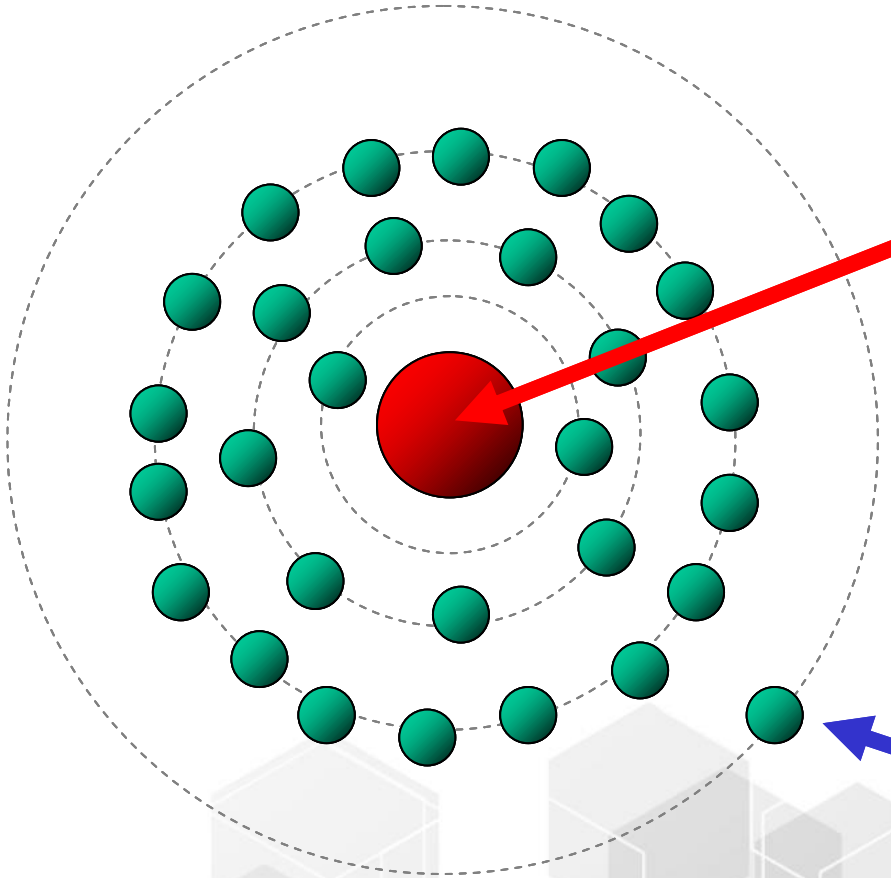
(a) Physical configuration



(b) Circuit diagram

Structure of the Atom

The valence electron is weakly bound to the nucleus. This makes copper an excellent conductor.

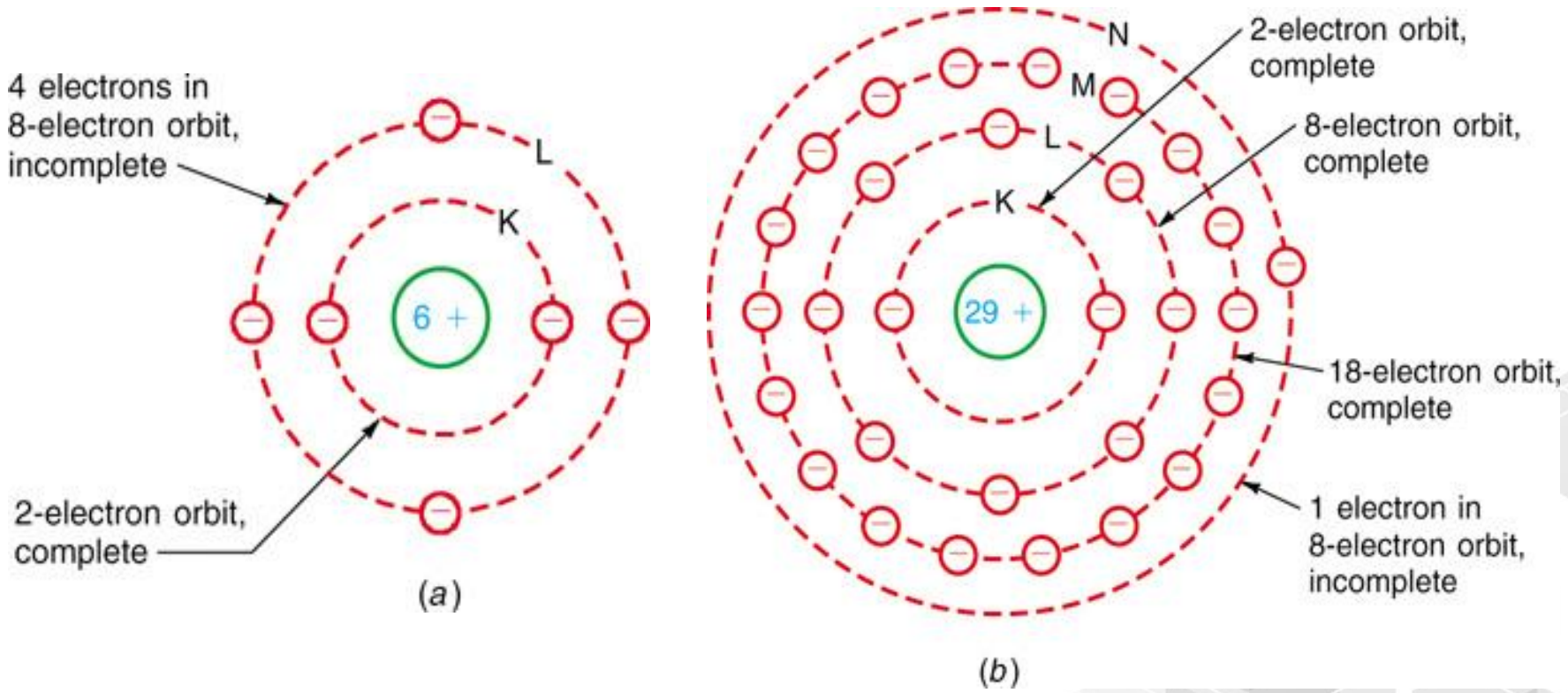


29 protons
atomic number = 29

29 electrons
(net charge = 0)

1 valence electron

Electrons and Protons in the Atom



Atomic structure showing the nucleus and its orbital rings of electrons. (*a*) Carbon (C) atom has 6 orbital electrons to balance 6 protons in the nucleus. (*b*) Copper (Cu) atom has 29 protons in the nucleus and 29 orbital electrons.

Charge

- **Charge** is a basic SI unit, measured in **Coulombs (C)**
- Counts the number of electrons (or positive charges) present.
- Charge of single electron is $1.602 * 10^{-19}\mathrm{C}$
- One Coulomb is quite large, $6.24 * 10^{18}$ electrons.
- In the lab, one typically sees (pC, nC, or μC)
- Charge is always multiple of electron charge

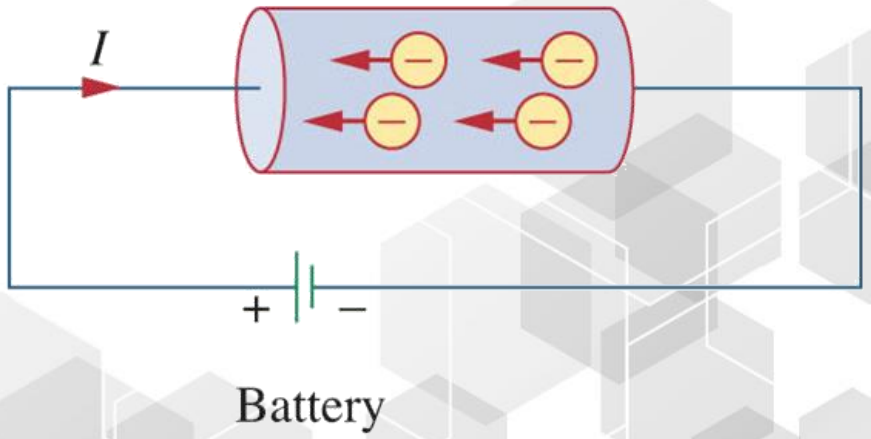
Current

- Current: The movement of charges

- Thus, we always note the direction of the equivalent positive charges, even if the moving charges are negative.
- **Current, *i***, is measured as charge moved per unit time through an element.
- Unit is Ampere (A),

is 1 Coulomb/second

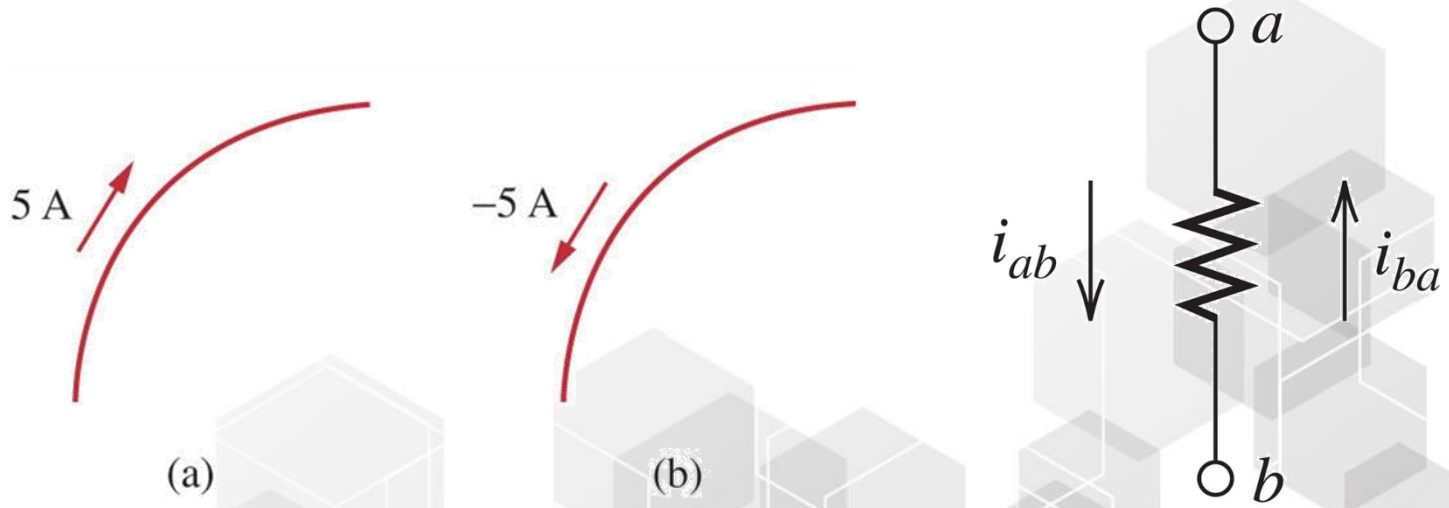
I= q/t = 1A = 1C/1s



The charge of 5 C moves past a given point in 1 s. How much is the current? (5A)

Direction of current

- The sign of the current indicates the direction in which the charge is moving with reference to the direction of interest we define.
- We need not use the direction that the charge moves in as our reference, and often have no choice in the matter.
- A positive current through a component is the same as a negative current flowing in the opposite direction.



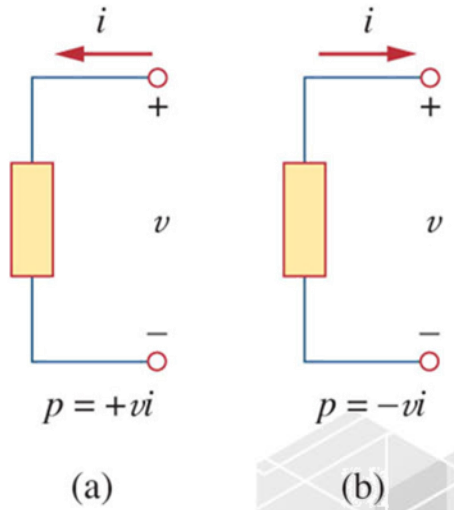
Voltage

- Electrons move when there is a difference in charge between two locations.
- This difference is expressed at the potential difference, or **voltage (V)**.
- It is always expressed with reference to two locations
- It is equal to the energy needed to move a unit charge between the locations.
- Positive charge moving from a higher potential to a lower yields energy.
- Moving from negative to positive requires energy.

We can say that the potential difference between two points is one volt when one joule of energy is expended in moving one coulomb of charge between those two points. Expressed as a formula,
1 V = 1 J/1 C
The general equation for any voltage can be stated as V = W/Q
where V is the voltage in volts, W is the work or energy in joules, and Q is the charge in coulombs.

What is the output voltage of a battery that expends 3.6 J of energy in moving 0.5 C of charge?
(7.2 V)

Power and Energy



- Voltage alone does not equal power.
- It requires the movement of charge, *i.e.* a current.
- **Power** *is the product of voltage and current*

$$p = vi$$

- It is equal to the rate of energy provided or consumed per unit time.
- It is measured in **Watts (W)**

Conservation of Energy

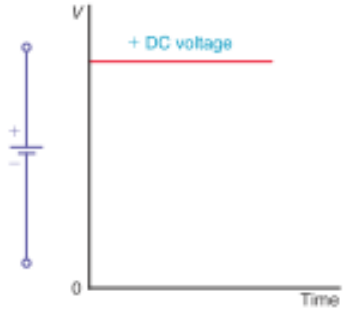
- In a circuit, energy cannot be created or destroyed.
- Thus, power also must be conserved
- The sum of all power supplied must be absorbed by the other elements.
- Energy can be described as watts x time.

  W = p x t

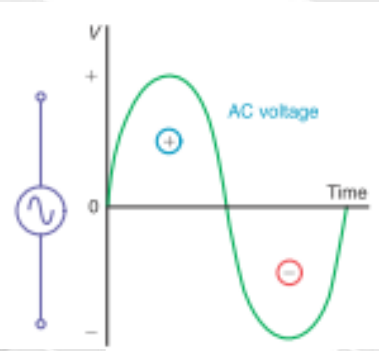
- Power companies usually measure energy in watt-hours

DC vs. AC

- **Direct Current (DC)** flows in only one direction, and remains constant with time
- Such current is represented by the capital *I*, time varying current uses the lowercase, *i*.
- A common source of DC is a battery.



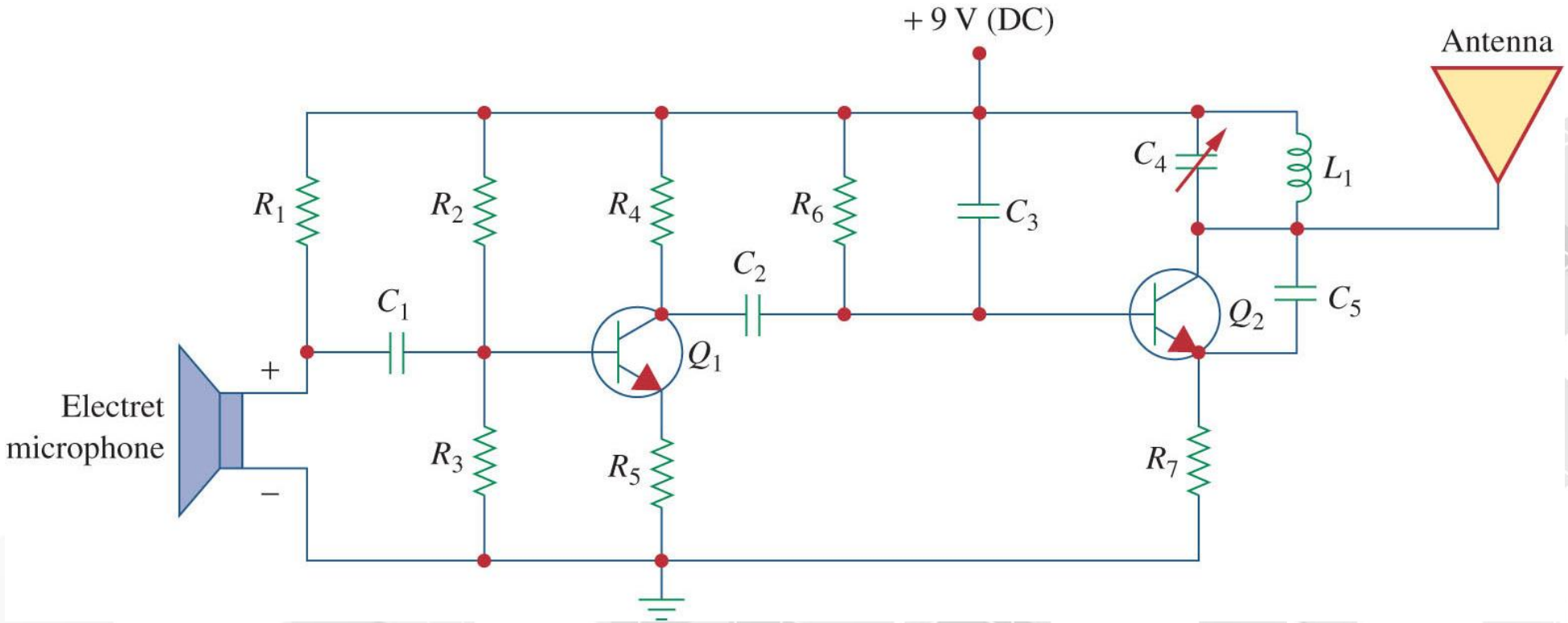
- **Alternating Current (AC)** periodically reverses direction, varies as sinusoidal shape with time
- Civil electric is an example of AC



DC Voltage	AC Voltage
Magnitude remains constant or steady with fixed polarity	Varies in magnitude and reverses in polarity
Steady DC voltage cannot be stepped up or down by a transformer	Varying AC voltage can be stepped up or down with a transformer for electric power distribution
Schematic symbol for DC voltage source.	Schematic symbol for sine wave AC voltage source.
The type of voltage available at the terminals of a battary.	The type of voltage available at the output of a rotary generator such as an alternator.
Heating effect is the same for direct or alternating current	

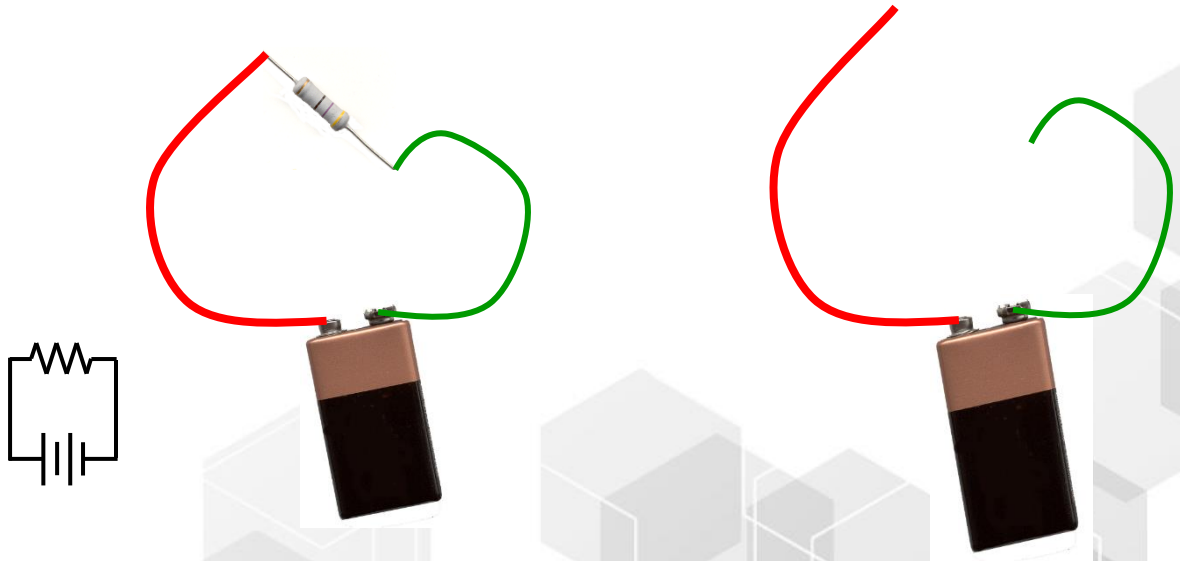
What is a circuit?

- An electric circuit is an interconnection of electrical elements.
- It may consist of only two elements or many more:



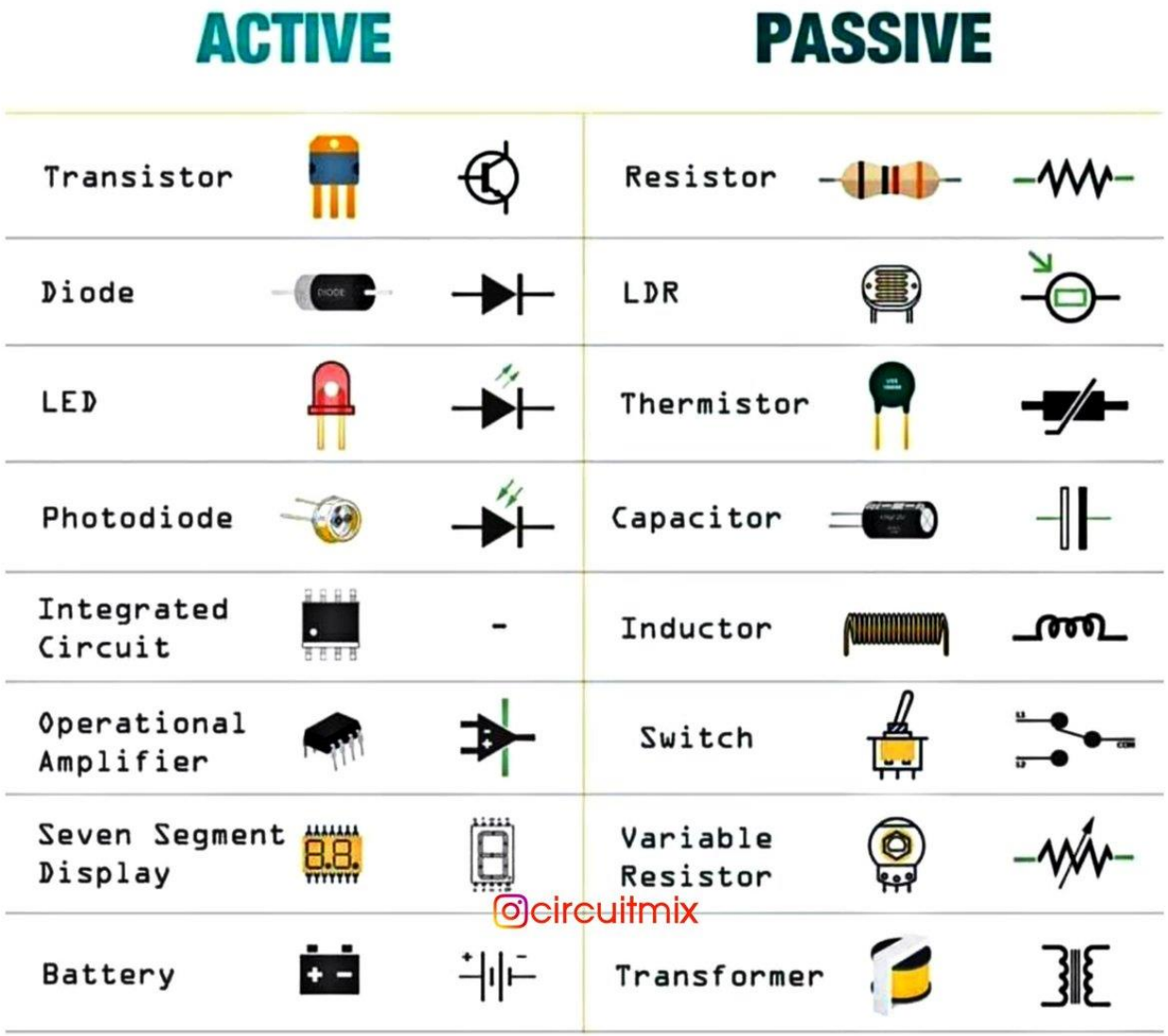
Close, Open and Short Circuits

- When a current path is broken (incomplete) the circuit is said to be **open**. The resistance of an open circuit is infinitely high. There is no current in an open circuit.
- When the current path is closed but has little or no resistance, the result is a **short circuit**. Short circuits can result in too much current.



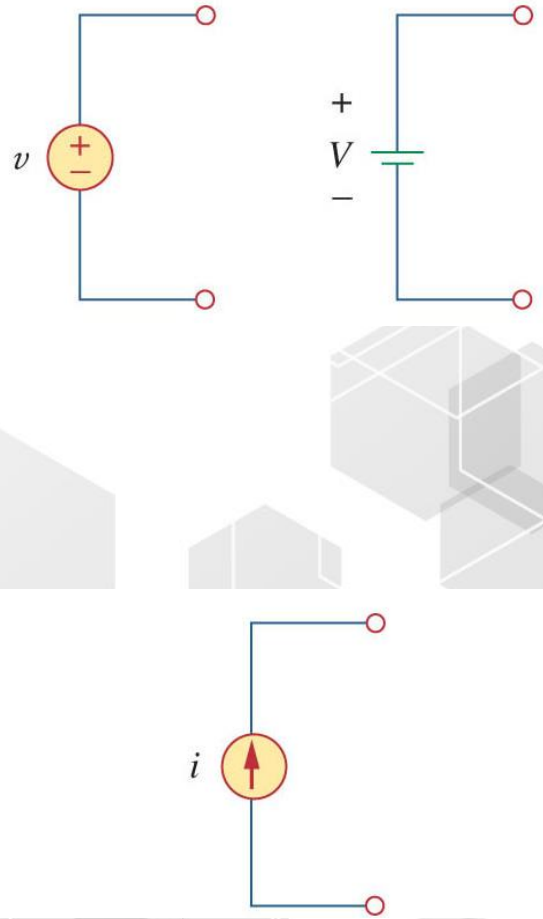
Circuit Elements

- Two types:
  - **Active**
  - **Passive**
- Active elements can generate energy
  - Generators
  - Batteries
  - Operational Amplifiers
- Passives absorb energy
  - Resistors
  - Capacitors
  - Inductors



Ideal Sources

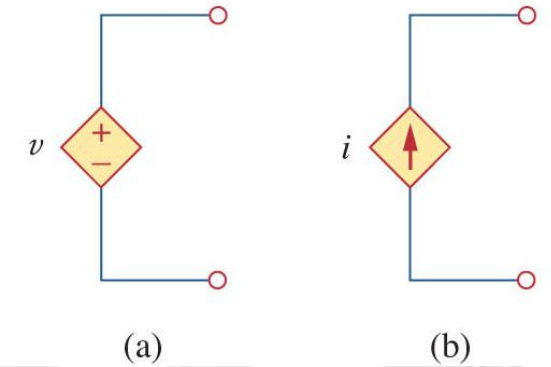
- Ideal Voltage Source:
  - An ideal voltage source has no internal resistance.
  - It also can produce any amount of current needed to establish the desired voltage at its terminals.
  - Thus, we can know the voltage at its terminals, but we don't know in advance the current.
- Ideal Current Source:
  - Current sources are the opposite of the voltage source:
  - They have infinite resistance
  - They will generate any voltage to establish the desired current through them.
  - We can know the current through them in advance, but not the voltage.

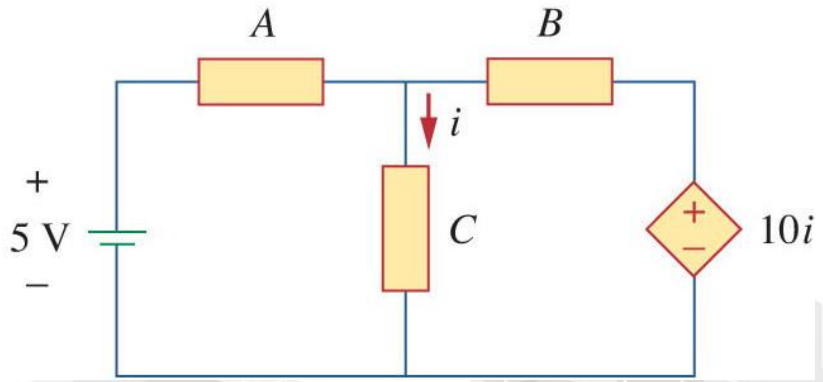


Dependent Sources

- A dependent source has its output controlled by an input value.
- Represented as a diamond
- Four types:

✓ A voltage-controlled voltage source (VCVS).
✓ A current-controlled voltage source (CCVS).
✓ A voltage-controlled current source (VCCS).
✓ A current-controlled current source (CCCS).





Multimeters

- A multimeter (VOM/DMM) is a device used to measure the voltage, current, or resistance in a circuit.

VOM
(analog)

DMM
(digital)

Chapter 1. Questions and Exercises

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Discussion: Application of electric elements in your work

Problems in Chapter 1:

Mitchel E. Schultz, **Grob's Basic Electronics** 12th Ed., Mc Graw-Hill Education (2015).

Problems in Chapter 1:

Agarwal, A. and Lang, J.H. **Foundations of Analog and Digital Electronic Circuits**, Elsevier (2005).