

EEE 101
INTRODUCTION
TO
ELECTRICAL AND ELECTRONICS
ENGINEERING

Course Information

- **Name of the Course:** Introduction to Electrical and Electronics Engineering

Lecturer 1: Dr. Seydi Kaçmaz

Lecturer 2: Dr. Mahmut Aykaç

Text Book and References:

- **1-** Earl D. Gates, Introduction to Basic Electricity and Electronics Technology, Delmar, Cengage Learning, 1st Edition, 2014
- **2-** Earl Gates, Introduction to Electronics, Delmar, Cengage Learning, 6th Edition, 2012
- **3-** Mulukutla S. Sarma, Introduction to Electrical Engineering, Oxford University Press, 2001

Grading: Midterm 1 (%30) + Midterm 2 (%30) + Final (%40)

Attendance: %70 Mandatory

Course Outline

- ▶ Fundamentals of Electricity
- ▶ Representation of Current, Voltage, Resistance, Ohm's law
- ▶ Electrical measurements - Meters
- ▶ Power and DC circuits
- ▶ Magnetism, Inductance and Capacitance
- ▶ AC circuits and measurements
- ▶ Transformers
- ▶ Semiconductor devices
- ▶ Linear electronics circuits
- ▶ Digital electronic circuits

CH1 - Fundamentals of Electricity

► OBJECTIVES

After completing this chapter, the student will be able to:

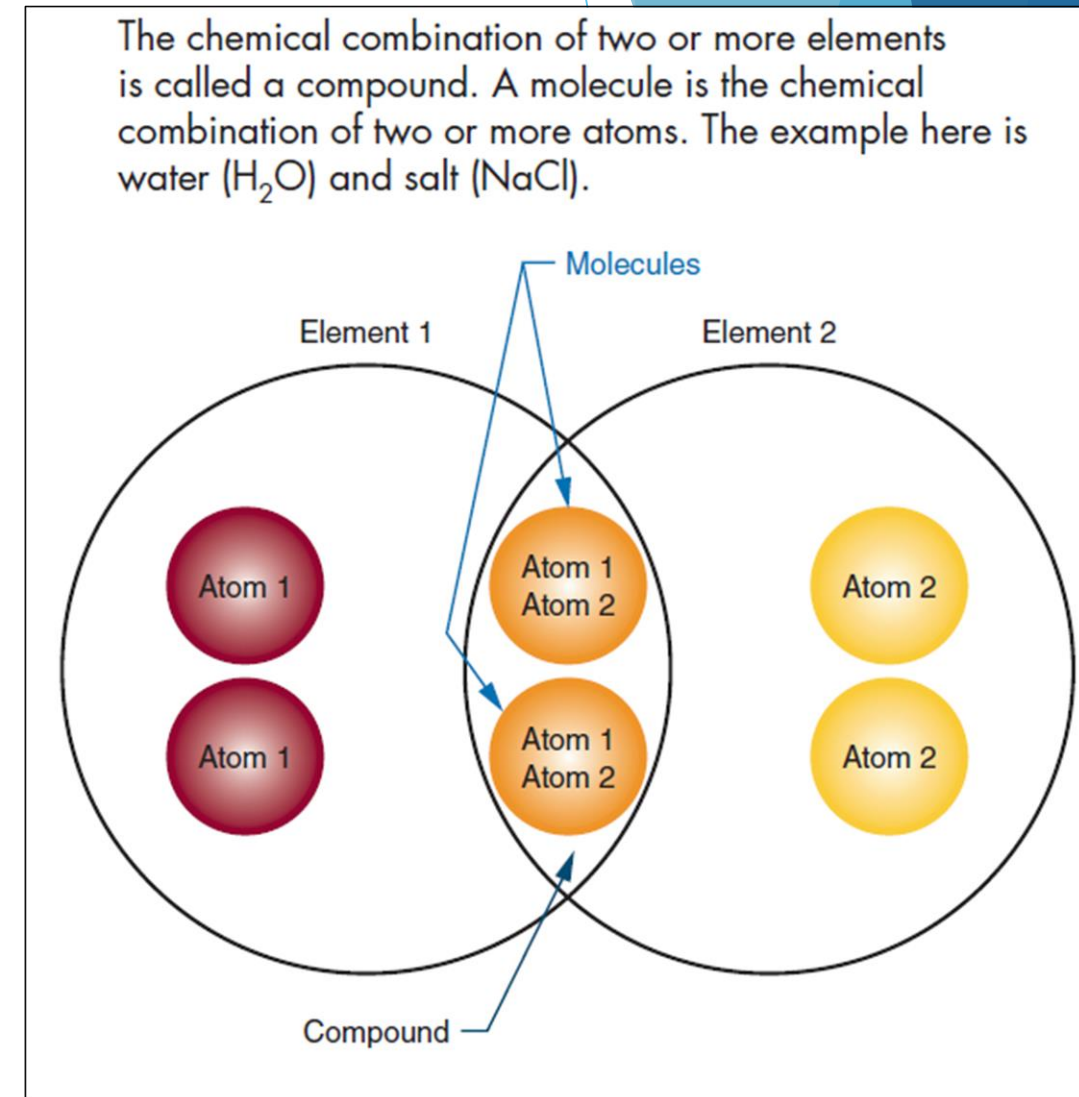
- Define atom, matter, element, and molecule.
- List the parts of an atom.
- Define the valence shell of an atom.
- Identify the unit for measuring current.
- Draw the symbol used to represent current flow in a circuit.
- Describe the differences among conductors,
- Insulators, and semiconductors.
- Explain the differences among potential, electromotive force, and voltage.
- Draw the symbol used to represent voltage.
- Identify the unit used to measure voltage.
- Define resistance, and identify the unit for measuring resistance.
- Identify characteristics of resistance in a circuit.
- Draw the symbol used to represent resistance in a circuit.

Fundamentals of Electricity

- ▶ Everything, whether natural or artificial, can be broken down into either an element or a compound. However, the smallest part of each of these is the atom.
- ▶ **The atom** is made up of protons, neutrons, and electrons.
- ▶ The protons and neutrons group together to form the center of the atom, called **the nucleus**.
- ▶ **The electrons** orbit the nucleus in shells located at various distances from the nucleus.
- ▶ When appropriate external force is applied to electrons in the outermost shell, they are knocked loose and become **free electrons**.
- ▶ The movement of free electrons is called **current**.
- ▶ The external force needed to create this current is called **voltage**.
- ▶ As it travels along its path, the current encounters some opposition, called **resistance**.

Matter, Elements, and Compounds

- ▶ **Matter** is anything that occupies space and has weight. It may be found in any one of three states: solid, liquid, or gas. Examples of matter include the air we breathe, the water we drink, the clothing we wear, and ourselves.
- ▶ Matter may be either an element or a compound.
- ▶ An **element** is the basic building block of nature.
- ▶ It is a substance that cannot be reduced to a simpler substance by chemical means. There are now over 100 known elements. Examples of elements are gold, silver, copper, and oxygen.
- ▶ The chemical combination of two or more elements is called a **compound**. A compound can be separated by chemical, but not by physical means. Examples of compounds are water, which consists of hydrogen and oxygen, and salt, which consists of sodium and chlorine.

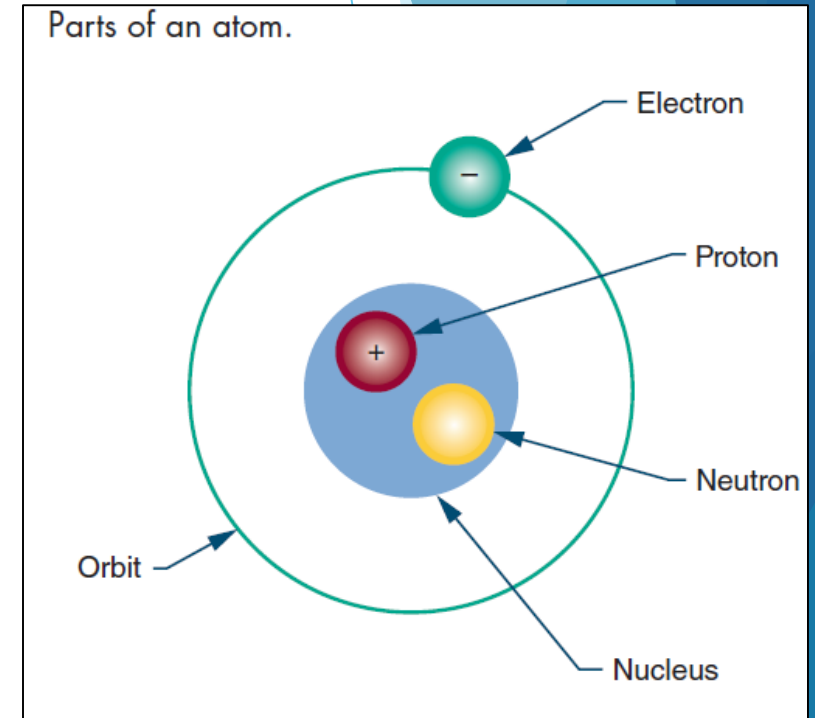


Matter, Elements, and Compounds

- ▶ The smallest part of the compound that still retains the properties of the compound is called a **molecule**. A molecule is the chemical combination of two or more atoms.
- ▶ An **atom** is the smallest particle of an element that retains the characteristic of the element.
- ▶ The physical combination of elements and compounds is called a **mixture**. Examples of mixtures include air, which is made up of oxygen, nitrogen, carbon dioxide, and other gases, and salt water, which consists of salt and water.

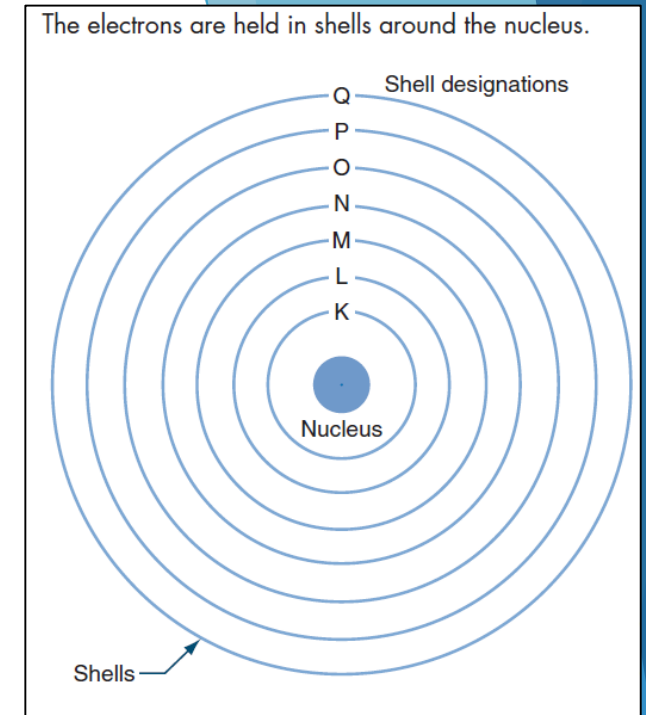
A Closer Look at Atoms

- ▶ As previously stated, an atom is the smallest particle of an element. Atoms of different elements differ from each other. If there are over 100 known elements, then there are over 100 known atoms.
- ▶ Every atom has a **nucleus**. The nucleus is located at the center of the atom.
- ▶ It contains positively charged particles called **protons** and uncharged particles called **neutrons**.
- ▶ Negatively charged particles called **electrons** orbit around the nucleus.
- ▶ The number of protons in the nucleus of the atom is called the element's **atomic number**. Atomic numbers distinguish one element from another.
- ▶ Each element also has an **atomic weight**. The atomic weight is the mass of the atom and is determined by the total number of protons and neutrons in the nucleus.
- ▶ Electrons do not contribute to the total mass of the atom; an electron's mass is only 1/1845 that of a proton and is not significant enough to consider.



A Closer Look at Atoms

- ▶ The electrons orbit in concentric circles about the nucleus.
- ▶ Each orbit is called a **shell**. These shells are filled in sequence; K is filled first, then L, M, N, and so on (Figure 1).
- ▶ The maximum number of electrons that each shell can accommodate is shown in Figure 2. The outer shell is called the **valence shell**, and the number of electrons it contains is the **valence**.
- ▶ The farther the valence shell is from the nucleus, the less attraction the nucleus has on each valence electron. Thus the potential for the atom to gain or lose electrons increases if the valence shell is not full and is located far enough away from the nucleus.
- ▶ Conductivity of an atom depends on its valence band. The greater the number of electrons in the valence shell, the less it conducts. For example, an atom having seven electrons in the valence shell is less conductive than an atom having three electrons in the valence shell.



The number of electrons each shell can accommodate.

Shell Designation	Total Number of Electrons
K	2
L	8
M	18
N	32
O	18
P	12
Q	2

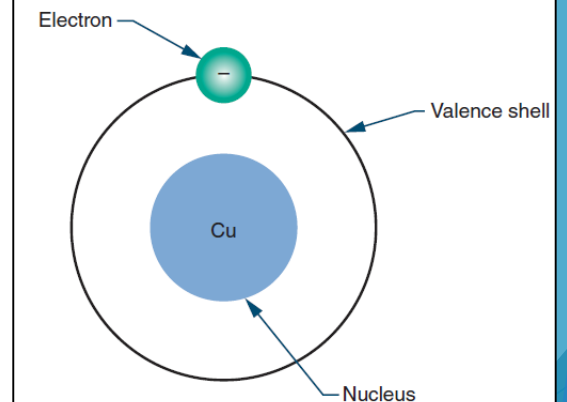
A Closer Look at Atoms

- ▶ Electrons in the valence shell can gain energy. If these electrons gain enough energy from an external force, they can leave the atom and become free electrons, moving randomly from atom to atom.
- ▶ Materials that contain a large number of free electrons are called **conductors**. Figure 1 compares the conductivity of various metals used as conductors.
- ▶ On the chart, silver, copper, and gold have a valence of 1 (Figure 2). However, silver is the best conductor because its free electron is more loosely bonded.
- ▶ **Insulators**, the opposite of conductors, prevent the flow of electricity. Insulators are stabilized by absorbing valence electrons from other atoms to fill their valence shells, thus eliminating free electrons.
- ▶ Materials classified as insulators are compared in Figure 3. Mica is the best insulator because it has the fewest free electrons in its valence shell. A perfect insulator has atoms with full valence shells. This means it cannot gain electrons.

Conductivity of various metals used as conductors.

Material	Conductance
Silver	High
Copper	
Gold	
Aluminum	
Tungsten	
Iron	
Nichrome	

Copper has a valence of 1.



Insulation properties of various materials used as insulators.

Material	Insulation Properties	
Mica	High	
Glass		
Teflon		
Paper (paraffin)		
Rubber		
Bakelite		
Oils		
Porcelain		
Air		Low

A Closer Look at Atoms

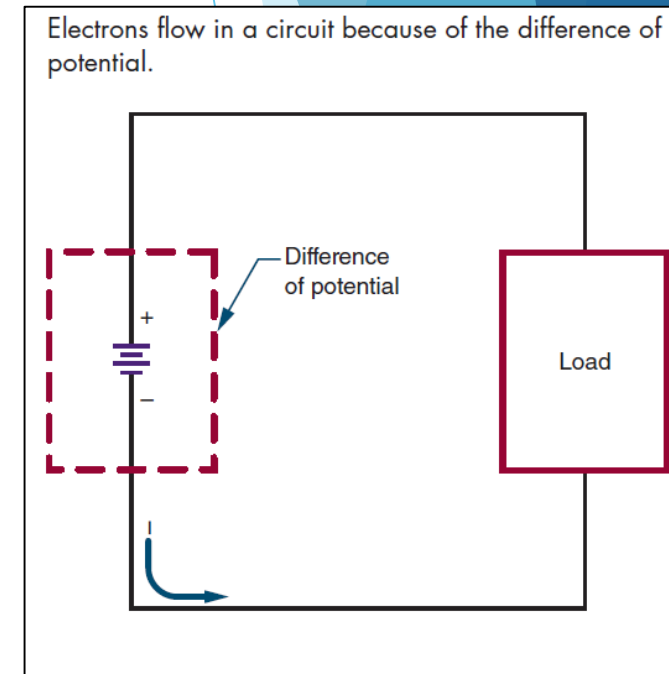
- ▶ Halfway between conductors and insulators are **semiconductors**.
- ▶ Semiconductors are neither good conductors nor good insulators but are important because they can be altered to function as conductors or insulators. Silicon and germanium are two semiconductor materials.
- ▶ An atom that has the same number of electrons and protons is identified as an electrically balanced atom.
- ▶ A balanced atom that receives one or more electrons is no longer balanced. It is said to be negatively charged and is called a **negative ion**.
- ▶ A balanced atom that loses one or more electrons is said to be positively charged and is called a **positive ion**.
- ▶ The process of gaining or losing electrons is called **ionization**. Ionization is significant in current flow.

Current

- ▶ Given an appropriate external force, the movement of electrons is from negatively charged atoms to positively charged atoms. This flow of electrons is called **current (I)**.
- ▶ The symbol “I” is used to represent current.
- ▶ The amount of current is the sum of the charges of the moving electrons past a given point.
- ▶ An electron has a very small charge, so the charge of $6,24 \times 10^{18}$ electrons is added together and called a **coulomb (C)**.
- ▶ When 1 coulomb of charge moves past a single point in 1 second, it is called an **Ampere (A)**.
- ▶ The ampere is named for the French physicist André Marie Ampère (1775-1836), one of the early founders of the science of electromagnetism, which he called electrodynamics. Current is measured in amperes.

Voltage

- ▶ When there is an excess of electrons (negative charge) at one end of a conductor and a deficiency of electrons (positive charge) at the opposite end, a current flows between the two ends as long as this condition persists.
- ▶ The source that creates this excess of electrons at one end and the deficiency at the other end represents the **potential**, or the ability of the source to perform electrical work.
- ▶ The actual work accomplished in a circuit is a result of the **difference of potential** available at the two ends of a conductor. This difference of potential causes electrons to move or flow in a circuit and is referred to as **electromotive force (emf)** or **voltage**.
- ▶ Voltage is the force that moves the electrons in the circuit. Think of voltage as the pressure or pump that moves the electrons.
- ▶ The symbol **e** is used in electronics to represent voltage. The unit for measuring voltage is the **volt (V)**, named for Count Alessandro Volta (1745-1827), inventor of the first cell to produce electricity.



Resistance

- ▶ As the free electrons move through the circuit, they encounter atoms that do not readily give up electrons. This opposition to the flow of electrons (the current) is called **resistance (R)**.
- ▶ Every material offers some resistance or opposition to current flow. The degree of resistance of a Material depends on its size, shape, and temperature.
- ▶ Materials with a low resistance are called conductors. Conductors have many free electrons and offer little resistance to current flow. As previously mentioned, silver, copper, gold, and aluminum are examples of good conductors.
- ▶ Materials with a high resistance are called *insulators*. Insulators have few free electrons and offer a high resistance to current flow. As previously mentioned, glass, rubber, and plastic are examples of good insulators.
- ▶ Resistance is measured in **ohms**, a unit named for the German physicist and mathematician George Simon Ohm (1787-1854). In 1827, Ohm published a paper acknowledging the mathematical relationship among current, voltage, and resistance known as **Ohm's law**. The symbol for the ohm is the Greek letter omega (Ω).