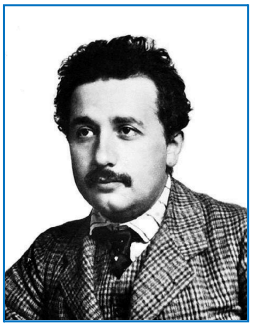
S.Ch.V.P.M.R.Government Degree College

Ganapavaram, West Godavari District



III Semester- Multi Disciplinary Course

BASIC ELECTRONICS

Study Material

(English Medium)

Scan the QR for softcopy of Study Material

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ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Multidisciplinary Courses Syllabus (w.e.f:2023-24A.B)

Single Major
SEMESTER-III
BASIC Electronics

Credits: 2 2 hrs/week

UNIT-I: (10 hrs)

Brief History of Electronics, Overview of Atom and its particles, Voltage, Current & Resistance. Ohms Law, Series and Parallel Circuits, Short and Open circuit. Usage of Digital multimeter.

Power Sources: DC and AC, Electrical energy, consumption of electrical power, Kilowatt hour (KWh). Batteries: How to Choose a Battery, types, lead acid batteries, Nickel – Cadmium, Lithium – Ion & Solar cell.

Identifying Phase, Neutral and Earth on power sockets, Electric tester, First aid for electric shock. Basics of House wiring, Overloading, electrical circuit protection using Fuses, MCBs, earthing and its necessity, awareness of electrical safety tools.

UNIT-II: (10 hrs)

Classification of solids according to electrical conductivity (Conductor, Semiconductor & Insulator). Intrinsic & Extrinsic Semiconductors. Vacuum Tubes, Diodes, Transistors, ICs & Relays: advantages, disadvantages, applications, and their uses.

Transducers and Sensors: Advantages, various parts, types, and applications, LED, IR LED, Photo Resistor & Photodiode (Symbol & applications of each)

DC Regulated Power Supply, IC Voltage Regulators, UPS

Home Appliances: Electric geyser, micro wave oven and refrigerator

UNIT-III: (10 hrs)

Basics of Communication Systems: Transmitter, Receiver, Channel i) wired channels ii) wireless channels, Modulation, Demodulation.

Daily usage of Electronic Devices include: Mobile phones, Digital Camera, audio & video systems, TV (Television), Computer, Laptop, LED lights, GPS, iPod and Tablets, Wi-Fi and Internet. Importance of energy efficiency in electrical appliances.

Electronics in different fields: Information processing, Medicine and research, Computers and other electronic instruments, Automation.

Resource Material

(1) Electrical technology by V.K. Mehta & Rohit Mehta (S. Chand & Company Pubs.)

(2) Few references from Wikipedia free Encyclopedia.

UNIT-I

Brief History of Electronics

Electronics is a branch of physics. It studies the flow of electrons.

Early Beginnings:

- **19th Century**: History of electronics began with the discovery of electricity. Michael Faraday and Maxwell discovered electromagnetism and electric currents.
- **1879:** Thomas Edison invented the electric light bulb. This is a major milestone in the history of electronics.

The Birth of Electronics:

- **1904:** Discovery of vacuum tube by Ambrose is the next step in the history of electronics. It is used in radios and computers.
- **1947**: Discovery of transistors is also an important step. Transistors are smaller and more efficient than vacuum tubes.

The Digital Age:

- **1958:** Discovery of Integrated Circuit (IC) is a major milestone in the digital age of electronics. Integrated Circuits are smaller and more efficient than transistors.Hence ICs are widely used in electronic devices.
- **1971**: Discovery of microprocessor is also a major milestone in the digital age of electronics. Microprocessor is also called the brain of a computer. Computers and electronic gadgets are invented using microprocessors.

Modern Electronics:

- **1980s-Present:**
  - ➔ Discovery of more powerful electronic devices like smartphones
  - ➔ Invention of Internet and wireless communication.

Overview of Atom and Its Particles

Atoms are the basic building blocks of matter. To understand the basics of electronics, we have to understand the structure of atoms.

★ Atom is the smallest unit of an element. Everything is made of atoms. Atoms are very small. Atoms consist of three main particles. They are

- ➔ Protons
- ➔ Neutrons
- ➔ Electrons

Structure of an Atom:

1. **Nucleus:**
   - Located at the center of the atom.
   - Contains protons and neutrons.
   - Almost all the mass of an atom is concentrated in the nucleus.
2. **Protons:**
   - Positively charged particles (+).
   - Protons are in the nucleus.
   - The number of protons in an element is called the atomic number (Z). For example hydrogen has 1 proton, Helium has 2 protons, Lithium has 3 protons etc…
3. **Neutrons:**
   - Neutral particles (no charge).
   - Neutrons are also in the nucleus
   - The number of neutrons in an element is called the neutron number (N).Neutrons add mass to the atom. For example hydrogen has 0 neutrons, Helium has 2 neutrons, Lithium has 3 neutrons etc…

4. **Electrons:**
    - Negatively charged particles (-).
    - Electrons revolve around the nucleus in orbits.
    - The number of electrons in an element is equal to the number of protons. For example hydrogen has 1 electron, Helium has 2 electrons, Lithium has 3 electrons etc..

Forces in the atom:

- **Electromagnetic Force:**
  Electrons revolve around the nucleus in orbits due to electromagnetic force.
- **Strong Nuclear Force:**
  Protons and neutrons in the nucleus are held together in the nucleus by the strong nuclear force. Strong nuclear force is stronger than the electromagnetic force.

Voltage, Current, Resistance, and Ohm's Law

It is necessary to understand Voltage (V), Current (I) and Resistance (R) to understand the basics of electronics.

Voltage (V):

- Voltage is known as potential difference.
- It is the reason for the flow of electricity.
- Voltage is measured in 'Volts' (V)
- Voltage is similar to pressure in a water tank. When pressure is high, more water flows. Similarly when voltage is high, more current flows.

Current (I):

- Current is the flow of electrons through a wire.
- It is the amount of charge flowing through the wire.
- Current is measured in 'Amperes' (A)
- Current is similar to the volume of water flowing through a pipe. More water flow means more current. When Analogy:

Resistance (R):

- Resistance is the opposition to the flow of electric current.
- Different materials have different resistances.
- Resistance is measured in ohms (Ω).
- Resistance is similar to the diameter of a water pipe. If the diameter of a pipe is small, less water flows through the pipe. Similarly when the resistance of a wire is large, less current flows through it.

Ohm's Law

- Ohm's Law gives the relationship between voltage, current, and resistance.
  Ohm's Law is written as:

$$V = I \times R$$

    - V is voltage (in volts)
    - I is current (in amperes).
    - R is resistance (in ohms).

Series and Parallel Circuits

An electrical circuit has a number of components like resistors, capacitors, batteries etc. These components can be connected in two ways.

➔ Series Circuit
➔ Parallel Circuit

Series Circuits:

- In a series circuit, components are connected end-to-end.

- Hence there is a single path for the electric current to flow.
- **Example**: In a string of holiday lights, where each bulb is connected to the next to form a series circuit.
- Characteristics:
    - **Current:** The same current flows through all components. If one component stops working, the entire circuit stops working.
    - **Voltage:** The total voltage is the sum of the voltages across each component.
    - **Resistance:** The total resistance in a series circuit is the sum of the resistances of all components.

$$R_{total} = R_1 + R_2 + R_3 + ...$$

Parallel Circuits:

- In a parallel circuit, components are connected across common points.
- Hence there are multiple paths for the electric current to flow.
- **Example**: In the wiring in your home, different components like TV, Refrigerator, Washing Machine are connected in parallel.
- Characteristics:
    - **Current:** The total current is the sum of the currents across each component. If one component stops working, the entire circuit does not stop working.
    - **Voltage**: The voltage across each component is the same.
    - **Resistance**: The total resistance in a parallel circuit is the inverse of the sum of the reciprocals of the resistances of all the components.

Comparing Series and Parallel Circuits

S.No	Series Circuit	Parallel Circuit
1	Components are connected end-to-end.	Components are connected across common points
2	Single path for current flow	Multiple paths for current flow
3	Current is same across all components	Voltage is same across all components
4	Total resistance is the sum of the resistances of all components.	Total resistance in a parallel circuit is the inverse of the sum of the reciprocals of the resistances of all the components.
5	**Example**: In a string of holiday lights, where each bulb is connected to the next to form a series circuit	**Example**: In the wiring in your home, different components like TV, Refrigerator, Washing Machine are connected in parallel.

Short Circuits and Open Circuits

S.No	Short Circuit	Open Circuit
1	Short circuit occurs when there is a direct connection between two points in a circuit.	Open circuit occurs when there is a break in the path of a circuit.
2	In case of short circuit, large amount of current flows through the circuit	In case of open circuit, no current flows through the circuit.
3	In case of short circuit, resistance is zero	In case of open circuit, resistance is infinity

4	Short circuit occurs when the insulation of the wire is damaged.	Open circuit occurs when there is a break in the wire.
5	Since a very large amount of current flows through the circuit, excessive heat is produced which can cause a fire accident.	Since no current flows through the circuit, the appliance will not function.
6	Short circuit can be prevented using MCBs, Fuses	Open circuit can be detected by checking continuity using a multimeter
7	**Example:** If the positive and negative terminals of a battery are directly connected with a wire, short circuit occurs.	**Example:** In a circuit with a battery and a bulb, if the wire connecting the bulb to the battery is broken, open circuit occurs.

DC and AC

Electricity flows in two different ways.

➔ Direct Current (DC)

➔ Alternating Current (AC)

Direct Current (DC):

- In Direct Current (DC), the electric current flows in one direction only.
- **Characteristics:**
  - **Constant Voltage:** Voltage in DC circuit is constant. It does ot change with time.
  - **Sources:** Sources of Direct Current (DC) are batteries, solar cells, and DC power supplies.
  - **Applications:** Direct Current (DC) is used for many electronic devices like flashlights, smartphones, laptops and electric vehicles.
- **Example:** A battery provides DC power. When you connect a battery to a light bulb, the current flows in one direction and the bulb glows.
- A device which converts DC to AC is called Inverter.

Alternating Current (AC):

- In Alternating Current (AC), the electric current does not flow only in one direction.The direction of electric current changes periodically.
- **Characteristics:**
  - **Variable Voltage:** Voltage in AC circuit is not constant. It changes periodically with time.
  - **Frequency:** Frequency of an AC circuit is defined as the number of times the current changes direction in one second. It is measured in Hertz (Hz). In India, AC frequency is 50 Hz.).
  - **Sources:** Sources are Alternating Current (AC) are power plants, signal generators.
  - **Applications:** The power supplied by the electricity department is AC. Hence most of the electrical appliances like Refrigerators, Motors, Air conditioning machines, Televisions etc use AC.
- **Example:** The electricity supplied to our home is AC.
- A device which converts AC to DC is called Rectifier.

Comparing DC and AC:

S.No	Direct Current (DC)	Alternating Current (AC)
1	Current direction is constant	Current direction changes periodically

2	Voltage is constant	Voltage changes periodically
3	Sources of DC are batteries, solar cells	Sources of AC are power plants, signal generators.
4	Used for flashlights, smartphones, laptops and electric vehicles.	Used for Refrigerators, Motors, Air conditioning machines, Televisions

Electrical Energy, Consumption of Electrical Power, Kilowatt-Hour (kWh)

Electrical Energy:

- Electrical energy is the energy that is produced by the movement of electrons.
- It can be converted into other forms, such as light, heat, or mechanical energy.
- Electrical energy is typically measured in joules (J) or kilowatt-hours (kWh).

Consumption of Electrical Power:

- Electrical power is the rate at which electrical energy is consumed or produced. It tells us how quickly energy is being used.
- Electrical Power is measured in watts (W).
- Electrical power can be calculated using the formula.

Electrical Power = Voltage X Current

Kilowatt-Hour (kWh):

- A kilowatt-hour (kWh) is a unit of electrical energy.
- It is equal to the energy used if a device with a power of one kilowatt (1000 watts) runs for one hour. It is commonly used by utility companies to measure electricity consumption.
- Electricity Bills: Utility companies charge for electricity based on the number of kilowatt-hours used. If the rate is 10 cents per kWh, using 1 kWh would cost 10 cents.

How to Choose a Battery, types, lead acid batteries, Nickel – Cadmium, Lithium – Ion & Solar cell.

Choosing the right battery depends on the following factors.

- ➔ Application
- ➔ Required power
- ➔ Life span
- ➔ Cost

1. Lead-Acid Batteries:

- Lead-acid batteries are one of the oldest and most widely used types of rechargeable batteries.
- Characteristics:
  1. **Power Output:**
     Power output of lead-acid batteries is high. Hence they are suitable for applications requiring high power.
  2. **Size:**
     Lead-acid batteries are very heavy. Their energy density is less.
  3. **Cost-Effectiveness:**
     Lead-acid batteries are relatively inexpensive.
  4. **Lifespan:**
     Lead-acid batteries have moderate lifespan. They can be recharged many times.
  5. **Uses:**
     Commonly used in cars, backup power systems (like UPS), and solar energy storage.

6. **Toxicity:**
   Lead is toxic. Hence environmentally harmful.

2. Nickel-Cadmium (Ni-Cd) Batteries:

- Ni-Cd batteries are rechargeable batteries known for their durability and long life.
- Characteristics:

1. **Power output:**
   Power output of Ni-Cd batteries is high. Hence they are suitable for applications requiring high power.
2. **Size:**
   Ni-Cd batteries are relatively light weight. Their energy density is high.
3. **Cost-Effectiveness:**
   Ni-Cd batteries are expensive.More expensive than lead-acid batteries but cheaper than Li-Ion
4. **Lifespan:**
   Lead-acid batteries have a long lifespan upto 20 years.
5. **Toxicity:**
   Cadmium is toxic. Hence environmentally harmful.
6. **Uses:**
   Used in power tools, medical equipment, and some emergency lighting.

3. Lithium-Ion (Li-Ion) Batteries:

- Li-Ion batteries are popular due to their high energy density and lightweight nature.

1. **Power output:**
   Power output of Li-Ion batteries is less. Hence they are suitable for applications requiring low power.
2. **Size:**
   Li-Ion batteries are relatively light weight. Their energy density is very high.
3. **Cost-Effective:**
   Li-Ion batteries are very expensive.More expensive than lead-acid batteries and Li-Ion batteries.
4. **Lifespan:**
   Li-Ion batteries have a long lifespan upto 20 years.
5. **Toxicity:**
   Li-Ion batteries do not contain toxic elements. Hence environment friendly.
6. **Uses:**

   Used in smartphones, laptops, electric vehicles, and many portable electronic devices.

4. Solar Cells:

- Solar cells, or photovoltaic cells, convert sunlight directly into electricity.

1. **Power output:**
   Power output of Solar cells is moderate. Hence they are suitable for applications requiring moderate power.
2. **Size:**
   Solar cells are relatively heavy. Their energy density is relatively low..
3. **Cost-Effective:**
   Even though the installation cost of solar cells is high, subsequently they reduce the electricity bills.
4. **Lifespan**:
   Solar cells have a long lifespan upto 20 years.

5. **Toxicity:**
   Solar cells do not contain toxic elements. They use sunlight which is a renewable energy source. Hence environment friendly.
6. **Uses:**
   Used in solar panels for homes, solar-powered gadgets, and remote area power systems.

Identifying Phase, Neutral and Earth on power sockets

Power sockets provide the connection point between electrical devices and the power supply. It is important to identify phase, neutral and earth.

1. Phase (Live):

- The phase wire carries the electrical current from the power source to the electrical device.
- Generally, the phase wire is color-coded. Common colors are red, brown, or black.
- In most sockets, the phase terminal is on the right side when facing the socket.

2. Neutral:

- The neutral wire completes the electrical circuit by carrying current back to the power source.
- The neutral wire is color-coded. The colour is generally blue or white.
- In most sockets, the neutral terminal is on the left side when facing the socket.

3. Earth (Ground):

- The earth wire provides a path for electrical current to safely return to the ground in case of a fault. Earth is necessary to prevent electric shocks.
- The earth wire is generally color-coded green, yellow, or green with a yellow stripe.
- In most sockets, the earth terminal is at the top or bottom of the socket.

First aid for electric shock

➔ Human body is a conductor of electricity. So when electric current accidentally passes through the human body it can cause external and internal injuries. This is called electric shock or electrocution.

Causes of Electric Shock:

- ❖ Power Lines
- ❖ Household Appliances
- ❖ Electric Machinery
- ❖ Lightning

First Aid:

- If a person is being electrocuted, the first thing to be done is to switch off the power supply or disconnect the source using an insulator like wood, cardboard or plastic to prevent further damage.
- When the power is switched off, the person may fall down due to jerks and have secondary injury. It should be avoided with proper support.
- If the person loses consciousness, he/she should be laid down with legs elevated relative to head.
- CPR should be done if the person has cardiac arrest.
- In case of burns, rinse the injury with cool water and apply antibiotic ointment to avoid infection.

Earthing and its Necessity

➔ Earthing means to connect an electrical system to earth through a conducting material like Iron, Copper , Aluminium etc. Earthing provides a low resistance path to the circuit if there is a leakage of current.It is an important safety mechanism of any electrical system.

Necessity of Earthing:

➔ Earthing provides an alternative path for the accidental leakage of current to flow towards earth.
➔ It protects humans from electric shock.
➔ It protects the electrical equipment from damage due to short circuits or high voltage.
➔ It protects tall buildings from lightning strikes.
➔ Earthing also provides voltage stabilization in sensitive electronic equipment.

Electrical circuit protection using fuses, MCBs

MCB means **M**iniature **C**ircuit **B**reaker. It is used to protect an electrical system incase of Overload and Short circuit by switching off or tripping the circuit automatically. It is a modern alternative to fuse.

Main components of MCB:

- ➔ Bimetallic Strip
- ➔ Solenoid
- ➔ Mechanical Latch
- ➔ Actuator Knob

Principle and Working:

Overload Protection: When an electrical circuit is overloaded, excessive current passes through the circuit. It causes the Bimetallic strip in the MCB to bend which releases a mechanical latch and trips the circuit.

Short Circuit Protection: When an electrical circuit is short circuited or has a faulty connection, a large amount of current suddenly passes through the circuit. It causes the Solenoid in the MCB to produce a magnetic field which releases a mechanical latch and trips the circuit within milliseconds.

Types of MCBs :

There are 6 different types of MCBs which are A,B,C,D, K and Z depending on the range of tripping current.

S.No	Type	Tripping Current	Operating Time
1	Type A	2 to 3 times the rated current	0.04 to 13 Sec
2	Type B	3 to 5 times the rated current	0.04 to 13 Sec
3	Type C	5 to 10 times the rated current	0.04 to 5 Sec
4	Type D	10 to 20 times the rated current	0.04 to 3 Sec
5	Type K	8 to 12 times the rated current	<0.1 Sec
6	Type Z	3 to 5 times the rated current	<0.1 Sec

UNIT-II

Classification of solids according to electrical conductivity

Materials are classified into 3 types based on the flow of electric current through them.

- ➔ Conductors
- ➔ Insulators
- ➔ Semiconductors

Conductors:

- ➔ Materials that allow electric current to flow through them easily are known as conductors.

Examples: copper, aluminum, gold, and silver.

Properties:

1. **High Electrical Conductivity:**
   Conductors have a large number of free electrons that can move easily. Hence their electrical conductivity is very high.
2. **Low Resistance:**
   Conductors have very low resistance.
3. **Applications:**
   Used in wires, cables, and electronic components to connect different parts of a circuit.

Insulators:

- ➔ Materials that do not allow electric current to flow through them are known as Insulators.

Examples: Common insulators include rubber, glass, plastic, and wood.

Properties:

1. **Low Electrical Conductivity:**
   Insulators have very few free electrons. Hence their electrical conductivity is very low.
2. **High Resistance:**
   Insulators have very high resistance.
3. **Applications**:
   Used to coat or encase wires and components to prevent accidental electric shocks and short circuits.

Semiconductors:

- ➔ Materials that have electrical conductivity between that of conductors and insulators are called semiconductors.

Examples: Silicon, Germanium, Gallium Arsenide

Properties:

1. **Moderate Electrical Conductivity:**
   Semiconductors have conductivity that can be controlled and modified by adding impurities. This process is called doping.
2. **Variable Resistance:**
   Semiconductors have variable resistance.
3. **Applications:**
   Semiconductors are the foundation of modern electronic devices. They are used in transistors, diodes, solar cells, and integrated circuits (ICs).

Intrinsic and Extrinsic Semiconductors

- ➔ Materials that have electrical conductivity between that of conductors and insulators are called semiconductors.

Examples: Silicon, Germanium, Gallium Arsenide

Semiconductors are classified into two types.

- ➔ Intrinsic Semiconductors
- ➔ Extrinsic Semiconductors

1.Intrinsic Semiconductors:

Semiconductors which are pure and do not contain any impurities are called intrinsic semiconductors.

Examples: Silicon (Si), Germanium (Ge)

- ➔ Intrinsic semiconductors are composed solely of the semiconductor material. They do not contain any impurities.
- ➔ In intrinsic semiconductors, charge carriers are generated by thermal energy. There are two types of charge carriers.
    1. Electrons
    2. Holes
- ➔ In intrinsic semiconductors, the number of electrons is equal to the number of holes. Hence the intrinsic semiconductors are electrically neutral.
- ➔ Intrinsic semiconductors are used in research and development to understand the fundamental properties of semiconductor materials.

3. Extrinsic Semiconductors:

Semiconductors which are not pure and doped with impurities are called extrinsic semiconductors.

- ➔ Extrinsic semiconductors are doped with impurities like boron, gallium, arsenic etc..
- ➔ In extrinsic semiconductors, charge carriers are generated by thermal energy. There are two types of charge carriers.
    1. Electrons
    2. Holes
- ➔ In extrinsic semiconductors, the number of electrons is not equal to the number of holes. Hence the extrinsic semiconductors are not electrically neutral.
- ➔ Intrinsic semiconductors are used in diodes, transistors, ICs etc.
- ➔ Electrical properties of semiconductors are modified due to doping. Doping is of two types.

Extrinsic semiconductors are classified into two types based on doping.

- ★ N-type semiconductors
- ★ P-type semiconductors

N-type Semiconductor:

- ➔ N-type semiconductors are formed by doping with pentavalent impurities.
- ➔ Examples of pentavalent impurities are Phosphorus, Arsenic, Antimony
- ➔ In N-type semiconductors, electrons are majority charge carriers.
- ➔ In N-type semiconductors, holes are minority charge carriers

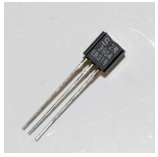
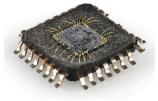
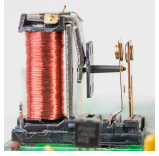
P-type Semiconductor:

- ➔ P-type semiconductors are formed by doping with trivalent impurities.
- ➔ Examples of trivalent impurities are Boron, Gallium, Indium
- ➔ In P-type semiconductors, holes are majority charge carriers.
- ➔ In P-type semiconductors, electrons are minority charge carriers

Applications of P-type and N-type semiconductors:

1. Diodes
2. Transistors
3. Integrated Circuits (ICs)

Vacuum tubes, Diodes, Transistors & ICs-Advantages-Disadvantages, Applications & Uses

Component	Image	Advantages	Disadvantages	Applications	Uses
Vacuum Tubes		➔ High power capability ➔ Good high-frequency performance	• Large and bulky • High power consumption • Generate a lot of heat • Shorter lifespan	★ Early computers ★ Radios ★ Televisions	❖ Amplification of audio and radio signals ❖ Oscillators ❖ Switching circuits
Diodes		➔ Small and lightweight ➔ High-speed switching ➔ Reliable and long-lasting ➔ Energy-efficient	• Can only handle limited current • Sensitive to heat and radiation	★ Rectifiers ★ Light Emitting Diodes (LEDs)	❖ Converting AC to DC in power supplies ❖ Voltage regulation
Transistors		➔ Small and lightweight ➔ High-speed switching ➔ Reliable and long-lasting ➔ Energy-efficient	• Can only handle limited current • Sensitive to heat and radiation	★ Amplifiers ★ Oscillators ★ Signal processing ★ Power regulation	❖ Switching applications in digital circuits ❖ Voltage regulation ❖ Signal amplification
Integrated Circuits (ICs)		➔ Very compact size ➔ Low power consumption ➔ Reliable and long-lasting ➔ Cost-effective for mass production	• Can be complex to design • Limited power handling capacity • Hard to repair if damaged • Initial design cost is high	★ Microprocessors ★ Memory devices ★ Sensors and actuators	❖ Computers ❖ Mobile Phones ❖ Consumer electronics ❖ Industrial automation
Relays		➔ Electrically isolate input from output ➔ Can switch high voltages and currents ➔ Simple and reliable operation	• Mechanical parts wear out over time • Slower switching speed compared to transistors • Consumes more power to operate	★ Switching circuits ★ Automation systems ★ Motor control	❖ Controlling high power devices ❖ Protection circuits ❖ Home appliances

Transducers and Sensors: Advantages, Parts, Types & Applications

- **Transducers:**
  ➔ Transducer is a device that converts one form of energy into another.
  Example: Microphone (Converts sound energy into electrical signals)

- **Sensors:**
  ➔ A sensor is a device that detects changes in the environment and sends this information to other devices.
  Example: Thermistor, Photo diode, Horoscope etc

Advantages

- Accuracy.
- Automation
- Versatility
- Real-Time Data

Parts of Transducers and Sensors:

- **Sensing Element**
  Sensing element detects the physical quantity.

- **Transduction Element:**
  Transduction element converts the detected physical quantity into an electrical signal.

- **Signal Conditioning Circuit:**
  Signal conditioning circuit amplifies the electrical signal.

- **Output Interface:**
  Output interface connects the sensor to other devices such as displays or controllers.

Types of Transducers and Sensors:

- Temperature Sensors:
  ★ Thermocouples
  ★ Thermistors
- Pressure Sensors:
  ★ Piezoelectric Sensors
  ★ Strain Gauge Sensors
- Light Sensors:
  ★ Photodiodes
  ★ Photovoltaic Cells
- Motion Sensors:
  ★ Accelerometers
  ★ Gyroscopes
- Proximity Sensors:
  ★ Ultrasonic Sensors
  ★ Infrared Sensors

Applications

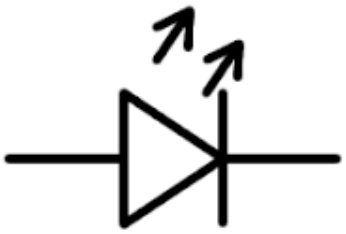
- Medical Field:
  - Heart Rate Monitors
  - Thermometers
- Automotive Industry
  - Airbag Systems
  - Tire Pressure Monitoring

- Consumer Electronics:
    - Smartphones
    - Cameras
- Industrial Automation
    - Robotics
    - Process Control
- Environmental Monitoring
    - Weather Stations
    - Pollution Control

LED, IR LED, Photo Resistor & Photo Diode (Symbol & Applications of each)

1. LED (Light Emitting Diode)

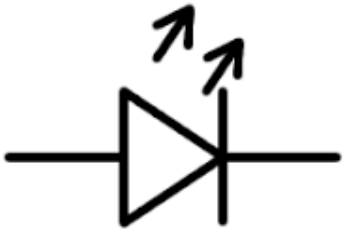
- Symbol:



- **Application**: LEDs are used in a variety of applications such as indicator lights on electronic devices, digital displays, flashlights, and backlighting for TVs and monitors due to their energy efficiency and long lifespan.

2. IR LED (Infrared Light Emitting Diode)

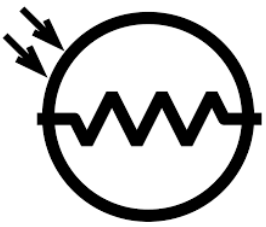
- Symbol:



- **Application:** IR LEDs are commonly used in remote controls for TVs and other electronics, as well as in security systems, night-vision devices, and infrared communication systems.

3. Photoresistor (Light Dependent Resistor, LDR)

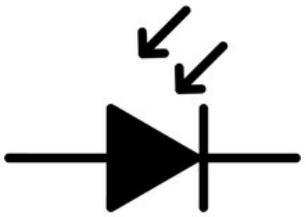
- Symbol:



- **Application:** Photoresistors are used in light-sensitive applications such as street lights that turn on automatically at dusk, light meters, and alarm systems that detect changes in light levels.

4. Photodiode

- Symbol:



- **Application:** Photodiodes are used in various applications including light meters, solar panels, optical communication devices, and safety equipment such as smoke detectors. They are valued for their quick response to changes in light intensity.

Home Appliances-Electric Geyser

➔ Electric geyser is a home appliance that heats water using electricity. It provides hot water for various purposes like bathing, washing dishes, and cleaning.

Components:

Electric geyser contains the following parts.

- **Heating Element :**
  Heating element converts electrical energy into heat energy
- **Thermostat:**
  Thermostat monitors the temperature and turns off the unit automatically when the desired temperature is reached.
- **Water Tank**:
  Water tank stores the water to be heated.
- **Water Inlet and Outlet**:
  Water Inlet draws cold water and the outlet supplies the heated water.

Working:

1. When the geyser is switched ON, thermostat measures the temperature of water.
2. If the water is not hot enough, it turns on the heating element.
3. The heating element converts the electrical energy into heat energy and heats the water.
4. When the water is sufficiently heated, the thermostat turns off the heating element automatically.
5. The heated water flows out from the water tank through the water outlet and cold water enters the tank through the inlet. The process continues.

Types of Electric Geysers:

- Storage Water Heaters
- Instant Water Heaters

Advantages:

★ Convenience

★ Efficiency
★ Safety
★ Adjustable Temperature

Home Appliances-Microwave Oven

➔ Microwave oven is a home appliance that cooks food using microwave radiation. It's popular for its speed and convenience.

Components:

- **Magnetron:**
  Magnetron generates microwaves. Microwaves are nothing but electromagnetic waves like radio waves.
- **High voltage transformer:**
  High voltage transformer provides a voltage of 2100 volts required for the magnetron.
- **Wave Guide:**
  Wave Guide concentrates the microwaves onto the food.
- **Cooking chamber:**
  Cooking chamber is a cavity for heating the food.
- **Thermostat**:
  Thermostat monitors the temperature and turns off the unit automatically when the desired temperature is reached.

Working:

1. When the oven is switched ON, electric current passes through the transformer.
2. The transformer increases the voltage to 2100 volts and supplies it to the magnetron after rectification.
3. The magnetron generates high frequency microwaves.
4. The microwaves are concentrated on to the food placed in the cooking chamber using the wave guide.
5. WHen the desired temperature is reached, thermostat turns off the unit.

Advantages:

- Speed
- Efficiency
- Convenience
- Versatility

Home Appliances-Refrigerator

➔ Refrigerator is a home appliance used to produce and maintain low temperatures of the order of 4^0C to 5^0C

Components:

- Compressor
- Evaporator:
- Condenser
- Refrigerant
- Expansion valve
- Thermostat

Working:

1. When the refrigerator is switched ON, the liquid refrigerant passes through the expansion valve and is cooled due to expansion.
2. The cooled refrigerant which has a low boiling point flows through evaporator coils to extract
3. heat from the food items and evaporates.Hence cooling is produced due to the evaporation
4. of the refrigerant.
5. The evaporated gas refrigerant which has a low pressure then enters the compressor and

6. becomes a hot high pressure gas.
7. The high pressure gas then passes through the condenser coils and condenses into liquid
8. by losing heat to the surroundings.
9. The cooled refrigerant again passes through the expansion value and the cycle repeats.

Advantages:

- Food Preservation
- Convenience
- Safety
- Energy Efficiency

UNIT-III

Basics of communication system: Transmitter, Receiver, Channel (Wired channels, Wireless channels), Modulation and Demodulation

➔ Communication system is a set of tools and techniques that allows the transfer of information from one place to another.

Main Components of a Communication System:

Transmitter:

- Transmitter is the device which sends the information.
- It takes the original message and converts it into an electrical signal.
- The electrical signal travels through the channel.
- Example: In a radio station, the microphone captures the voice, and the transmitter converts it into radio waves.

Receiver:

- Receiver is the device which receives the information.
- It receives the transmitted signal and converts it back into the original message.
- Example: In a radio, the receiver picks up the radio waves and converts them back into sound.

Channel:

- The channel is the medium through which the signal travels from the transmitter to the receiver.

Channels are of two types.

➔ Wired Channels
➔ Wireless Channels

Wired Channels:

- Wired channels use physical connections like cables to transmit signals.
- **Examples:** Telephone lines, Ethernet cables.
- **Advantages**: Generally more reliable and less susceptible to interference.

Wireless Channels:

- Wireless channels use electromagnetic waves to transmit signals without physical connections.
- **Examples**: Radio waves, microwaves, infrared signals.
- **Advantages:** Allow mobility and are easier to use.

Modulation and Demodulation:

Modulation:

- Modulation is the process of converting the original message into an electrical signal which can be transmitted through the channel.
- Some characteristics of the signal like amplitude, frequency or phase are modified to encode the original message. It involves altering some characteristic of a carrier signal (like amplitude, frequency, or phase) based on the information in the original message.

- Example: In FM radio, the frequency of the signal is modified in accordance with the original message.

Demodulation:

- Demodulation is the reverse process of modulation.
- It converts the transmitted signal back into the original message at the receiver end.
- Example: In an FM radio receiver, the varying frequency signal is converted back into sound.

Daily Usage of Electronic Devices: Mobile Phone

Daily Usage of Mobile Phones:

1. **Communication:**
   - Essential for communication through calls, messages.
   - Used for sending and receiving emails.
   - Tools like Zoom, Skype, and Microsoft Teams allow for video conferencing.
2. **Internet Browsing:**
   - Accessing information, reading news, shopping online, and visiting websites for various purposes.
3. **Education:**
   - Access to educational content, online courses, and virtual classrooms through platforms like Google Classroom.
   - Using the internet for research, accessing academic papers, and gathering information for assignments and projects.
4. **Creativity and Design:**
   - Using software like Adobe Photoshop and Illustrator for creating and editing images and graphics.
5. **Financial Management:**
   - Managing bank accounts, paying bills, and transferring money online.
6. **Health and Fitness:**
   - Consult with doctors and healthcare providers through video calls and online platforms.
   - Access workout routines, track your fitness progress, and join virtual fitness classes
7. **News and Information:**
   - Televisions are a vital source of current events, weather updates, and breaking news through dedicated news channels.
8. **Entertainment**:
   - Watching movies, TV shows, and series to provide hours of entertainment.

Daily Usage of Electronic Devices: Digital Camera

How Digital Cameras Work:

Basic Components:

- Lens
- Image Sensor
- Processor
- Memory Card
- LCD Screen/Viewfinder

Working:

- When we press the shutter button, light hits the sensor.
- The sensor records the light and converts it into an electrical signal.

- The processor processes the signal into a digital image file, which is then saved to the memory card.

Daily Usage of Digital Cameras:

1. Capturing Memories
2. Social Media and Sharing
3. Creative Expression
4. Professional Use
5. Education and Learning
6. Documentation

Daily Usage of Electronic Devices: Television

Basic Components:

- **Display Screen:**
  The screen displays images and videos. Modern TVs use LCD (Liquid Crystal Display), LED (Light Emitting Diode), or OLED (Organic LED) technology
- **Tuner:**
  The tuner receives broadcast signals from antenna, cable, or satellite sources and converts them into audio and video signals.
- **Speakers:**
  Built-in speakers play the audio.
- **Remote Control:**
  Allows users to control the TV from a distance

Daily Usage of Televisions:

1. **Entertainment**:
   Watching movies, TV shows, and web series for entertainment.
2. **News and Information:**
   Source of current events, weather updates, and breaking news through dedicated news channels.
3. **Sports:**
   Watch live sports events, from local games to international tournaments, providing a front-row experience.
4. **Fitness and Wellness:**
   Fitness apps and programs that guide viewers through workouts, yoga sessions, and other exercise routines.
5. **Education:**
   - Access to educational content, online courses, and virtual classrooms through platforms like Google Classroom.
   - Using the internet for research, accessing academic papers, and gathering information for assignments and projects.

Daily Usage of Electronic Devices: Computer/Laptop

Basic Components:

- **Central Processing Unit (CPU):**
  - CPU is the brain of the computer. It performs calculations and executes instructions.
- **Memory (RAM):**
  - RAM is temporary memory that helps CPU access data quickly.

- **Storage (Hard Drive or SSD):**
  - Stores all the files, applications, and the operating system.
- **Display:**
  - The screen shows visual output from the computer.
- **Keyboard and Mouse**
  - Input devices that allow you to interact with the computer.

★ **Operating System:**
- Software that manages hardware and software resources. Common operating systems include Windows, macOS, and Linux.

Daily Usage of Computers and Laptops:

1. **Communication:**
   - Essential for communication through calls, messages.
   - Used for sending and receiving emails.
   - Tools like Zoom, Skype, and Microsoft Teams allow for video conferencing.
2. **Internet Browsing:**
   - Accessing information, reading news, shopping online, and visiting websites for various purposes.
3. **Education:**
   - Access to educational content, online courses, and virtual classrooms through platforms like Google Classroom.
   - Using the internet for research, accessing academic papers, and gathering information for assignments and projects.
4. **Creativity and Design:**
   - Using software like Adobe Photoshop and Illustrator for creating and editing images and graphics.
5. **Financial Management:**
   - Managing bank accounts, paying bills, and transferring money online.
6. **Health and Fitness:**
   - Consult with doctors and healthcare providers through video calls and online platforms.
   - Access workout routines, track your fitness progress, and join virtual fitness classes
7. **News and Information:**
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8. **Entertainment**:
   - Watching movies, TV shows, and series to provide hours of entertainment.

Daily Usage of Electronic Devices: Wifi and Internet

WiFi

➔ WiFi is a technology that allows devices like smartphones, laptops, tablets, and smart home gadgets to connect to the internet wirelessly. It uses radio waves to transmit data between your device and the internet.

Internet?

➔ The internet is a global network of interconnected computers for the exchange of information.

Daily Usage of WiFi and Internet:

1. **Communication:**
   - Essential for communication through calls, messages.
   - Used for sending and receiving emails.
   - Tools like Zoom, Skype, and Microsoft Teams allow for video conferencing.
2. **Internet Browsing:**
   - Accessing information, reading news, shopping online, and visiting websites for various purposes.
3. **Education:**
   - Access to educational content, online courses, and virtual classrooms through platforms like Google Classroom.
   - Using the internet for research, accessing academic papers, and gathering information for assignments and projects.
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8. **Entertainment**:
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Importance of energy efficiency in electrical appliances

➔ Energy efficiency in electrical appliances means to use less electricity without losing performance.

Importance of energy efficiency:

1. **Cost Savings:**
   Energy-efficient appliances use less power, Hence the electricity bill will be less.

2. **Environmental Benefits:**
   Since energy-efficient appliances use less power, they reduce greenhouse gas emissions. Hence it also helps to conserve natural resources like coal, oil and natural gas which are used to produce electricity.

3. **Longer Appliance Lifespan:**
   Energy-efficient appliances have a longer life span as they use advanced technology.

4. **Energy Security:**
   Energy-efficient appliances reduce the energy demand. Hence energy security is achieved.

Examples of Energy-Efficient Appliances:

1. LED Lights:
2. Energy Star Appliances:
3. Smart Thermostats

Electronics in different fields: Information processing, Medicine and research, computers and other electronic instruments, Automation

Electronics plays an important role in various fields like Information processing, Medicine and research, computers, Automation

1. Information Processing:

- **Computers:**
  Computers perform complex calculations, data analysis, and run various software applications.
- **Data Centers:**
  Servers and storage devices to handle massive amounts of data for organizations.
- **Digital Communication:**
  Electronics convert analog signals to digital, allowing efficient transmission and reception of data through mobile networks, satellite communication.

2. In Medicine & Research

1. **Diagnostic Tools:**
   - **X-Rays and CT Scans**: Provides detailed images of the body to identify fractures and internal conditions.
   - **MRI (Magnetic Resonance Imaging):** Provides detailed images of organs and tissues using magnets and radio waves.
   - **Ultrasound:** Provides detailed images of organs and fetal development using sound waves
   - **ECG (Electrocardiogram)**: Measures heart activity.
2. **Treatment Devices:**
   - **Pacemakers**: Regulate heartbeats in patients with heart rhythm disorders.
   - **Defibrillators**: Deliver electric shocks to restore normal heart rhythms during cardiac arrest.
   - **Insulin Pumps**: Manage diabetes by delivering insulin continuously.
3. **Research Tools:**
   - **Microscopes:** Provide high magnification for studying cells and microorganisms.
   - **DNA Sequencers:** Determine the sequence of DNA for genetic research and personalized medicine.
   - **Laboratory Automation:** Automate repetitive tasks, increasing efficiency and accuracy in research.

3. Computers and Other Electronic Instruments:

- Personal Computers and Laptops
- Smartphones and Tablets
- Digital Cameras
- Audio and Video Systems
- GPS Devices