Unit 1: Electronic Components and Signals

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Electronic Components and Signals	1a. Differentiate between the given active and passive electronic components. 1b. Calculate value of the given resistor and capacitor using colour code. 1c. Compare the characteristics of the given voltage and current source. 1d. Interpret with sketches the given signal.	1.1 Active and passive components 1.2 Resistor,capacitor,inductor symbols,working principles, applications,colour codes, specifications. 1.3 Voltage and Current Source 1.4 Signal waveform, Time and frequency domain representation, Amplitude, Frequency, Phase, Wavelength 1.5 Types of Signals: sinusoidal, triangular and square 1.6 Integrated Circuits – analog and digital.

❖ Active and Passive Components

Definition of Electronics:

1. The Institute of Radio Engineers (IRE) has defined electronics as follows: Electronics is a field of science and engineering, dealing with electronic devices and utilization of these devices.
2. The word electronics derives its name from the words electron and mechanics. Electronics has great importance in today's world as electronic devices are capable of doing many functions.
3. Some of the important functions are listed below:

1. Rectification
2. Amplification
3. Control
4. Generation
5. Conversion of light into electricity
6. Conversion of electricity into light.

4. Electronics helps in many ways in our day to day life. It helps us in the following fields:

1. Industrial applications
2. Defence applications
3. Medical sciences
4. Communication and entertainment
5. Industrial Applications

❖ Application of electronics in any four different fields.

1. Industrial applications

Automatic control of various systems is becoming an important concept in industry...
Electronic circuits are used to control parameters, thickness, quality, weight and moisture content in various industrial applications.
They are also used to amplify weak signal.
Electronic circuits are used to convert one form of signal into
Another form. Calculators and computers are some other applications of electronics in industry.
Electronically controlled timers, welding, heating and systems and power stations are some other examples.

2. Defence applications

The most important application is RADAR which can find the exact position of enemy aircraft. The laser guided missiles and bombs is also important application of electronics in the defence field.

3. Medical sciences

Electronics helps doctors and scientists in the diagnosis and treatment of various diseases. Electronics is thus useful in saving mankind from a lot of suffering and pain.
Electronic instruments are used for precise measurement of various quantities. Some important examples where electronics is used in instrumentation are:

1. Cathode - ray oscilloscope (CRO)

2. Frequency counter

3. Signal generators

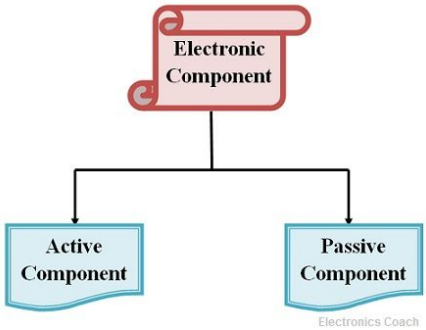
4. Strain gauges.

4. Communication and Entertainment

There are two types of communication taking place. One is wire communication or line communication and other is wireless communication. Telegraphy, telephony, telex and teleprinters are some examples of wire electronic communication
Examples of wireless electronic communication are Radio broadcasting, TV broadcasting, Satellite communication. The applications such as radio, TV, satellite TV are the examples of communication as well as entertainment.

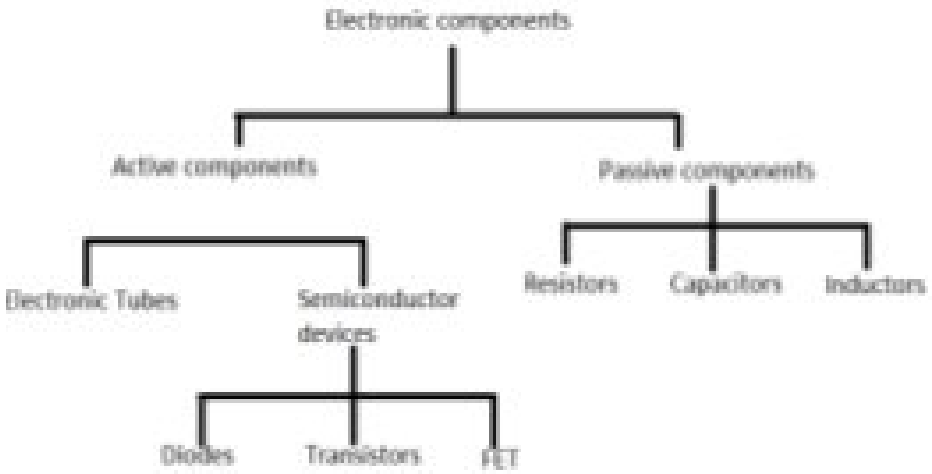
❖ Types of Electronic Components

1. **Active Components:**
An active device is the one which introduces gain. They can be broadly classified as electronic tubes and semiconductor devices. In modern times only the semiconductor devices are being used.
The examples of active devices are diodes, transistors, FET



2. Passive Components:

The passive component is the one which does not introduce any gain, i.e. they cannot amplify or process an electric signal.The examples of passive components are resistors, capacitors. Inductors etc



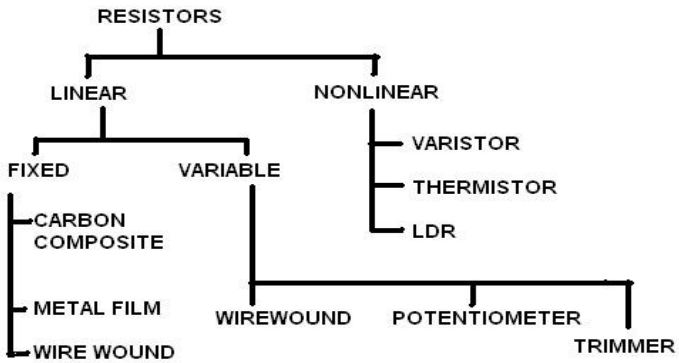
❖ Compare Active and Passive Components

ACTIVE COMPONENTS	PASSIVE COMPONENTS
• THEY REQUIRE AN EXTERNAL POWER SUPPLY TO OPERATE.	• THEY DO NOT REQUIRE AN EXTERNAL POWER SUPPLY TO OPERATE.
• THEY HAVE A FUNCTION OF GAIN.	• THEY HAVE NO FUNCTION OF GAIN.
• THEY PRODUCE ENERGY IN THE FORM OF VOLTAGE OR CURRENT.	• THEY STORE ENERGY IN THE FORM OF VOLTAGE OR CURRENT.
• EXAMPLE:SEMICONDUCTOR,DIODES AND TRANSISTORS.	• EXAMPLE:RESISTORS,CAPACITOR AND INDUCTORS.

❖ Resistor:

1. A resistor is an electrical component that limits or regulates (opposes) the flow of electrical current in an electronic circuit.
2. Resistor is an electronic component which provides the specified amount of opposition (resistance) to the flow of current.
3. A resistor can be a fixed value resistor or a variable resistor.
4. The value of a resistor is called resistance. It is denoted by R and the unit of resistance is Ohms.
5. The symbol of a fixed value resistance is as shown in Fig. whereas that of a variable resistance is shown in Fig. 

❖ Classification of RESISTOR



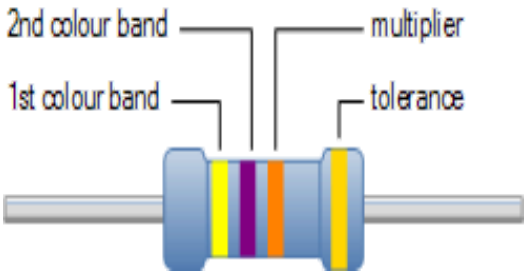
1. Linear Resistors:

Those resistors, which values change with the applied voltage and temperature, are called linear resistors. In other words, a resistor, which current value is directly proportional to the applied voltage Is known as linear resistors.

2.Non Linear Resistor- nonlinear resistors are those resistors, where the current flowing through it does not change according to Ohm's Law but, changes with change in temperature or applied voltage.

1.Thermisters
2.Varisters(VDR)
3. Photo Resistor or Photo Conductive Cell or LDR

❖ 4 -band Resistor Color Code



The colored bands are shown as: YELLOW , VIOLET, ORANGE and GOLD. Then the resistance using the color table is found as:

Color	1st	2nd	Multiplier	Tolerance
Black	0	0	1	
Brown	1	1	10	±1%
Red	2	2	100	±2%
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	±0.5%
Blue	6	6	1,000,000	±0.25%
Violet	7	7	10,000,000	±0.1%
Gray	8	8	100,000,000	±0.05%
White	9	9	1,000,000,000	
Gold			0.10	±5%
Silver			0.01	±10%
None				±20%

The first colour band (yellow) gives the first digit value of 4.

The second colour band (violet) gives the second digit value of 7.

This gives a two digit value of 47.

Multiply this by the value of the third band.

In this case, orange which has a value of 1000 or 1k, so the resistor has a resistive value of 47,000 ohms (47 × 1000 = 47000) or 47kΩ's.

The last band gives the resistors tolerance value and gold equals a tolerance range of ±5%.

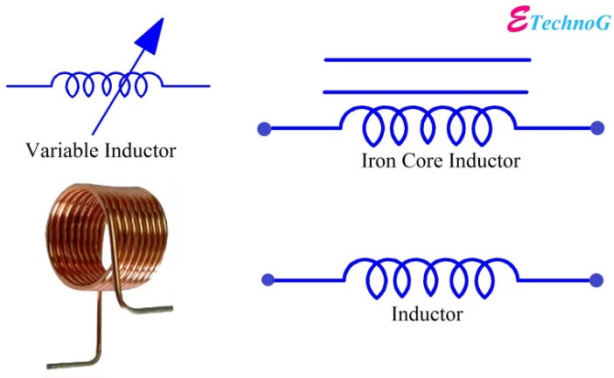
Then using the resistor colour wheel, the resistor has the following resistance:

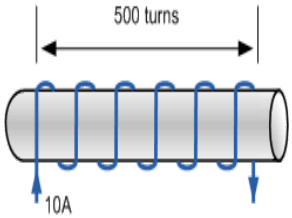
Yellow Violet Orange = 4 7 3 = 4 7 x 10^3 = 47000Ω or 47kΩ ±5%.

❖ Inductor

It is an electrical conductor that “opposes a change in the current”,

Inductance which is given the symbol **L** with units of **Henry**, (**H**)





$$L = \frac{V_L}{(di/dt)} = \frac{1\text{volt}}{1A/s} = 1\text{Henry}$$

Self Inductance of a Coil

$$L = N\frac{\Phi}{I}$$

Where:

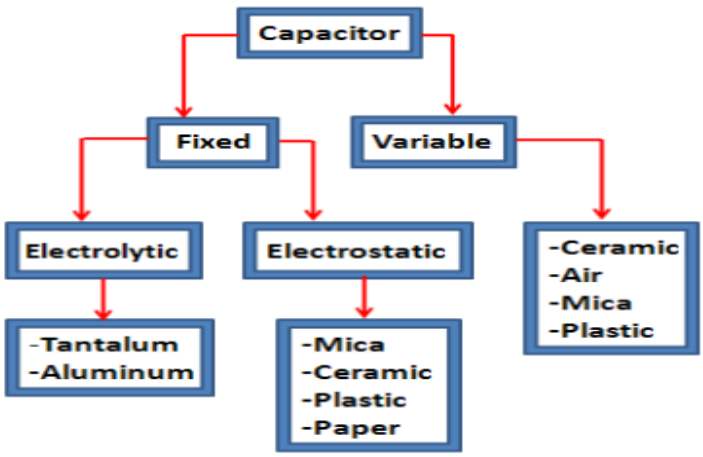
- L is in Henries
- N is the Number of Turns
- Φ is the Magnetic Flux Linkage
- I is in Amperes

❖ Capacitor-

It is a simple passive component that is used to “store electricity”.

By applying a voltage to a capacitor and measuring the charge on the plates, the ratio of the charge Q to the voltage V will give the capacitance value of the capacitor and is therefore given as

$C = Q/V$



❖ Signal:

1. Signals are physical quantity which contains variables information.
2. The signal is defined as any physical quantity that varies with time, frequency or any other independent variables.
3. Examples: Motion, sound, picture, video, traffic light…
4. Signal Examples:

- Electrical signals
- Acoustic signals
- Video signals
- Biological signals
- Noise: unwanted signal

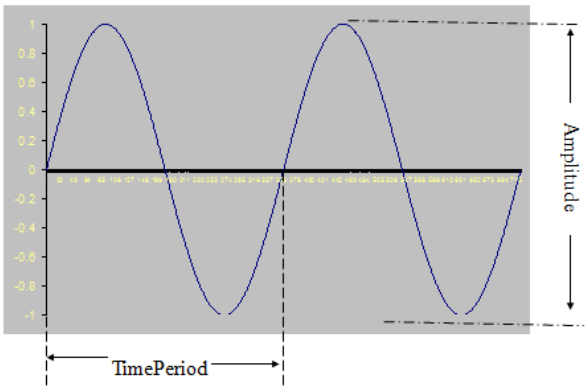
Electrical Signal:

- The dynamic signal representing electrical quantity either voltage or current is known as electrical signal.
- **Types of electrical signal:**

1)Analog Signal

2) Digital signal

Analog signal:



1. Signal having continuous values.
2. They can have infinite number of different values.
3. Ex: temperature, pressure, distance, sound.
    a. AM, FM for voice sound
    b. Traditional TV for analog video
    c. First generation cellular phone (analog mode)

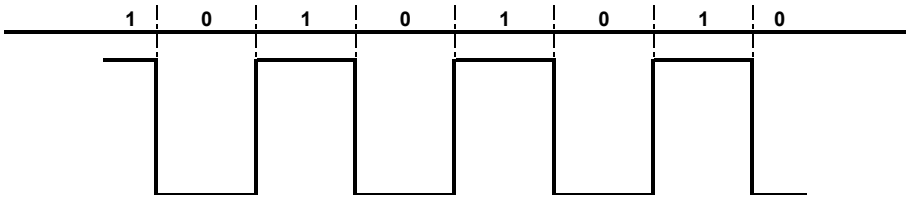
❖ Analog Signals

- Human Voice – best example
- Ear recognises sounds 20KHz or less
- AM Radio – 535KHz to 1605KHz
- FM Radio – 88MHz to 108MHz
- **Advantages:**
- major advantages of the analog signal is infinite amount of data.
- Density is much higher.
- easy processing.
- **Disadvantages:**
- Unwanted noise in recording.
- If we transmit data at long distance then unwanted disturbance is there.
- Generation loss is also a big con of analog signals.

❖ Digital signal

1. Signal having finite number of distinct value.
2. Not continuous signal.
3. Discrete signal.
4. Ex: binary, octal
    - 2G/3G cellular phone

- Data on your disk



Advantages:

- Because of their digital nature they can travel faster in over digital lines.
- Ability to transfer more data as compared to analog.

Disadvantages:

- Greater bandwidth is essential.
- Systems and processing is more complex.

Analogue Advantages

- Best suited for audio and video
- Consume less bandwidth
- Available world wide
- Less susceptible to noise

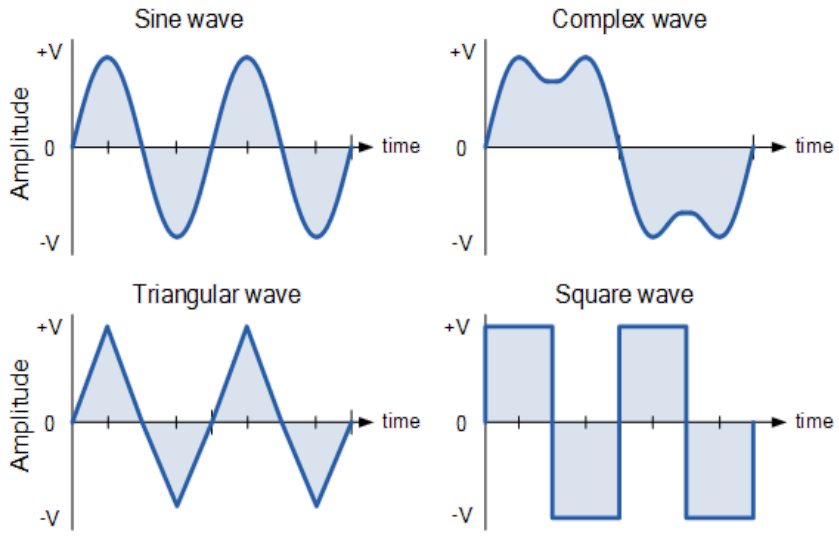
Digital Advantages

- Best for computer data
- Can be easily compressed
- Can be encrypted
- Equipment is more common and less expensive
- Can provide better clarity

❖ Comparison

Sr no	Parameter	Analog systems	Digital systems
1.	Type of signals processed	Analog signals	Digital signals
2.	Type of display	Analog meters	Digital displays using LED and LCD
3.	Accuracy	Less	More
4.	Design complexity	Difficult to design	Easier to design
5.	Memory	No memory	They have Memory
6.	Storage of information	Not Possible	Possible
7.	Effect of noise	More	Less
8.	Versatility	Less	More
9.	Distortion	More	Less
10.	Effect of temperature and ageing on performance	More	Less
11.	Communication between systems	Not easy	Easy
12.	Examples	Filters, amplifiers, power supplies, signal generators	Counters, resisters, microprocessors, Computers

❖ Types Analog Signals



1.**The Period, (T)** is the length of time in seconds that the waveform takes to repeat itself from start to finish. This can also be called the *Periodic Time* of the waveform for sine waves, or the *Pulse Width* for square waves.

2.<u>The Frequency</u>, (*f*) is the number of times the waveform repeats itself within a one second time period. Frequency is the reciprocal of the time period, ($f = 1/T$) with the unit of frequency being the *Hertz*, (Hz).

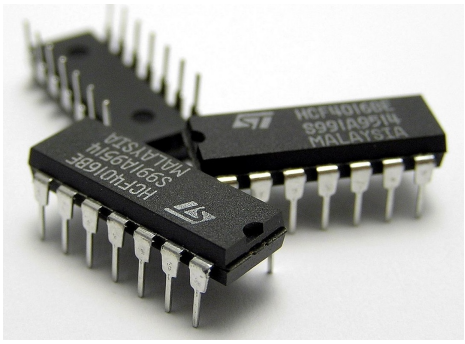
3.<u>The Amplitude</u> (A) is the magnitude or intensity of the signal waveform measured in volts or amps.

$$\text{Frequency},(f) = \frac{1}{\text{Periodic Time}} = \frac{1}{T} \text{ Hertz}$$

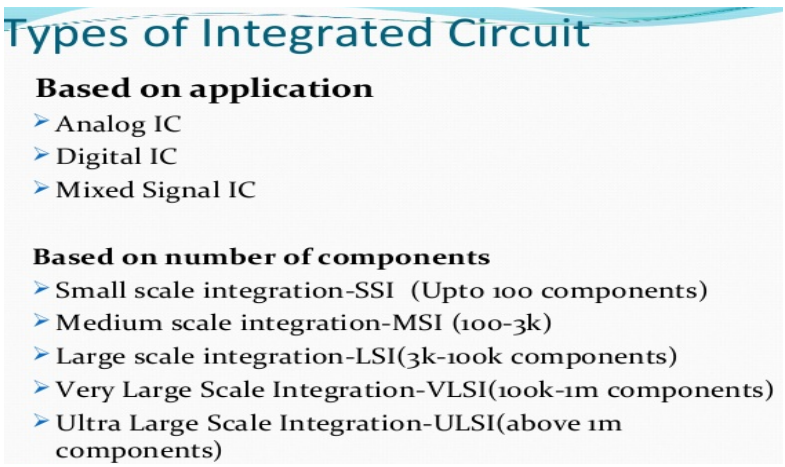
or

$$\text{Periodic Time},(T) = \frac{1}{\text{Frequency}} = \frac{1}{f} \text{ seconds}$$

❖ <u>Integrated Circuits</u>:

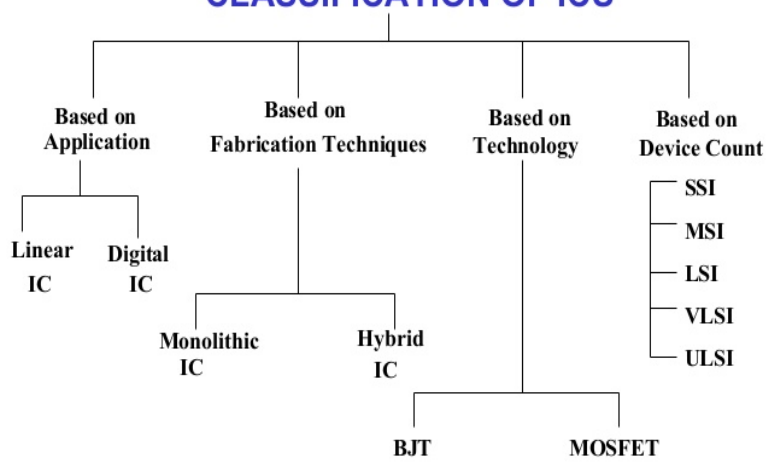


An integrated circuit is electronic circuit consisting of active & passive components that are joined together on a single small crystal chip of semiconductor material, usually silicon or on a single insulating substrate such as, glass, ceramic



	Level of integration	Number of active devices per chip
1.	Small scale integration (SSI)	less than 100
2.	Medium scale integration (MSI)	100 - 1000
3.	Large scale integration (LSI)	1000 - 100,00
4.	Very large scale integration (VLSI)	over 100,00
5.	Ultra large scale integration (VLSI)	over 1 million

CLASSIFICATION OF ICS



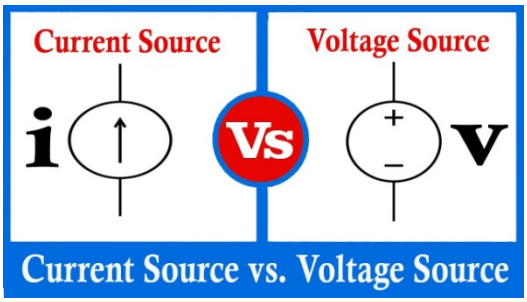
Advantages of Integrated Circuits

- Low cost
- Low power consumption
- Occupies less space
- Faster operation due to reduction of stray capacitance and inductance.
- Mass scale production is possible.
- Easy to put into various applications without knowing the underlying complexity.
- Billions of transistor can be fabricated on a single chip

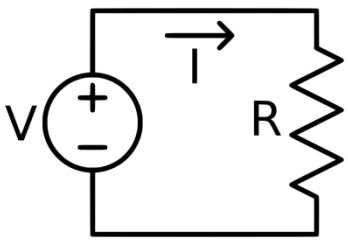
Disadvantage

- The power rating for most of the IC's does not exceed more than 10 watts. Thus it is not possible to manufacture high power IC's.
- High grade P-N-P assembly is not possible.
- It is difficult to achieve low temperature coefficient.
- The IC will not work properly if wrongly handled or exposed to excessive heat.
- It is difficult to fabricate an IC with low noise.

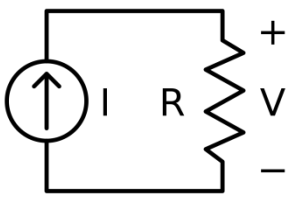
❖ Voltage source & Current source

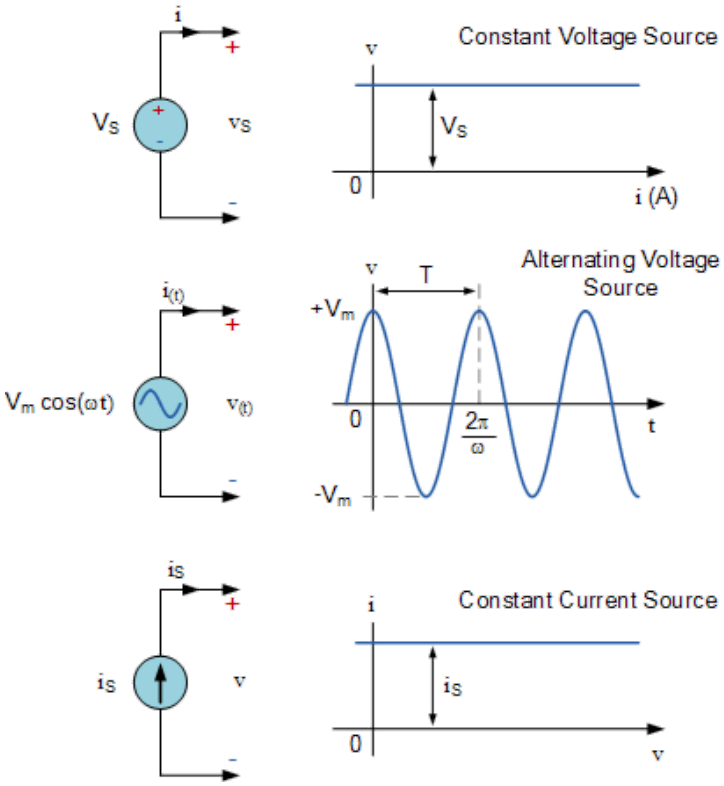


A voltage source is **a two-terminal device which can maintain a fixed voltage**. An ideal voltage source can maintain the fixed voltage independent of the load resistance or the output current.



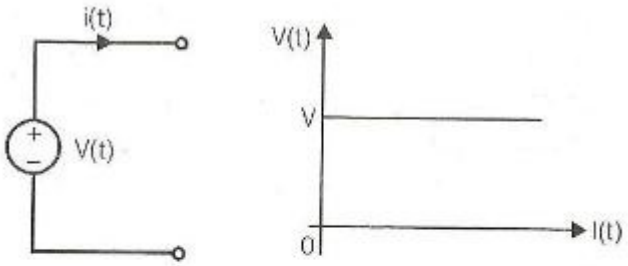
A current source is **an electronic circuit that delivers or absorbs an electric current which is independent of the voltage across it**.



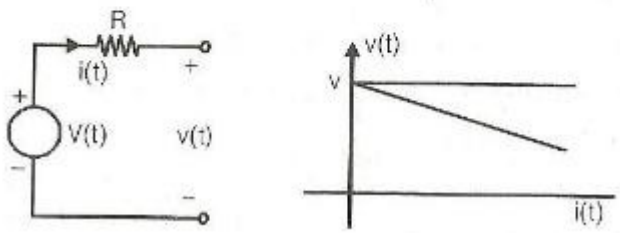


❖ V-I Characteristics

Ideal Voltage Source:



Practical Voltage Source:



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Introduction:

Classification of the Materials:
The materials used for the manufacturing of the electronic devices and components can be broadly categorized into four categories as :

1. Conductors.
2. Insulators.
3.Semiconductor materials.
4.Magnetic materials.

Conductors :

1. Conductors are those materials which allow the current to flow through them easily. These materials therefore have a low resistivity and high conductivity. Examples of conductors are the metals such as copper,aluminium etc. Metals generally have a positive temperature coefficient of resistivity.
2. Insulating Materials:
   Insulating materials are the materials which do not allow the electric current to flow through them. Thus they have a low conductivity or high resistivity.Examples of the insulating materials are paper, plastic ceramic, mica, wood etc. The other important points about the insulating materials are as follows:
   The insulators are characterized by permittivity. It is also called the dielectric constant. The permittivity is greater than 1.Insulators are used in the manufacturing of capacitors.
3. Semiconductor Materials :
   The resistance of semiconductor materials is in between that of the insulators and conductors. The semiconductor materials have a negative temperature coefficient that means with increase in temperature the resistance 'decreases. Silicon and Germanium are the most widely used semiconductor materials.
   These are used to manufacture the devices such as diodes, transistors, photo-devices etc.