

# **CHAPTER-1**

# **OVERVIEW OF ELECTRONIC COMPONENTS AND SIGNALS**

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# WHAT IS ELECTRONICS?

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- The branch of engineering which deals with current conduction through a vacuum or gas or semiconductor is known as electronics.
- Electronics essentially deals with electronic devices and their utilization. An electronic device is that in which current flows through a vacuum or gas or semiconductor.
- The electronic devices are capable of performing the following functions :
  - Rectification
  - Amplification
  - Control
  - Generation
  - Conversion of light into electricity
  - Conversion of electricity into light

# ACTIVE AND PASSIVE COMPONENTS

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- **ACTIVE COMPONENTS:** An active component is an electronic component **which supplies energy to a circuit or ability to control electron flow** (i.e. the flow of charge). All electronic circuits must contain at least one active component.
- Active component have two types:
- **Energy source: Voltage source and current source.**
- **Signal processing component which can process the electrical signal.**
  - All different types of transistors (BJT, FET, MOSFET, JFET)
  - Diodes (zener diode, photo diode, LED etc.)

# ACTIVE AND PASSIVE COMPONENTS

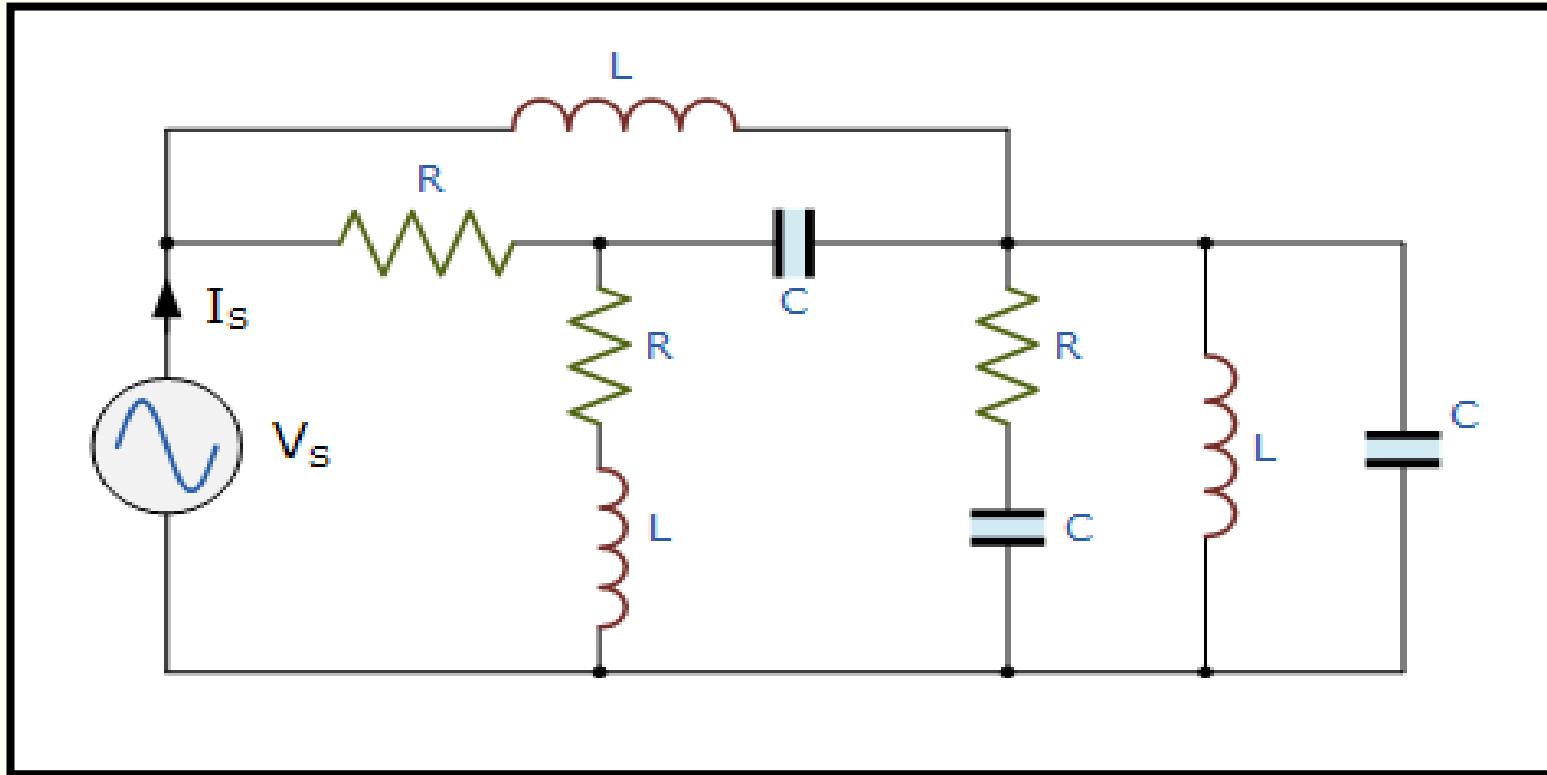
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- **PASSIVE COMPONENTS:** Electrical and electronic circuits consist of connecting together many different components to form a complete and closed circuit. **The three main passive components used in any circuit are the: Resistor, the Capacitor and the Inductor.** All three of these **passive components have one thing in common, they limit the flow of electrical current through a circuit but in very different ways.**
- Passive components consume electrical energy and therefore can not increase or amplify the power of any electrical signals applied to them, simply because they are passive and as such will always have a gain of less than one.

# ACTIVE AND PASSIVE COMPONENTS

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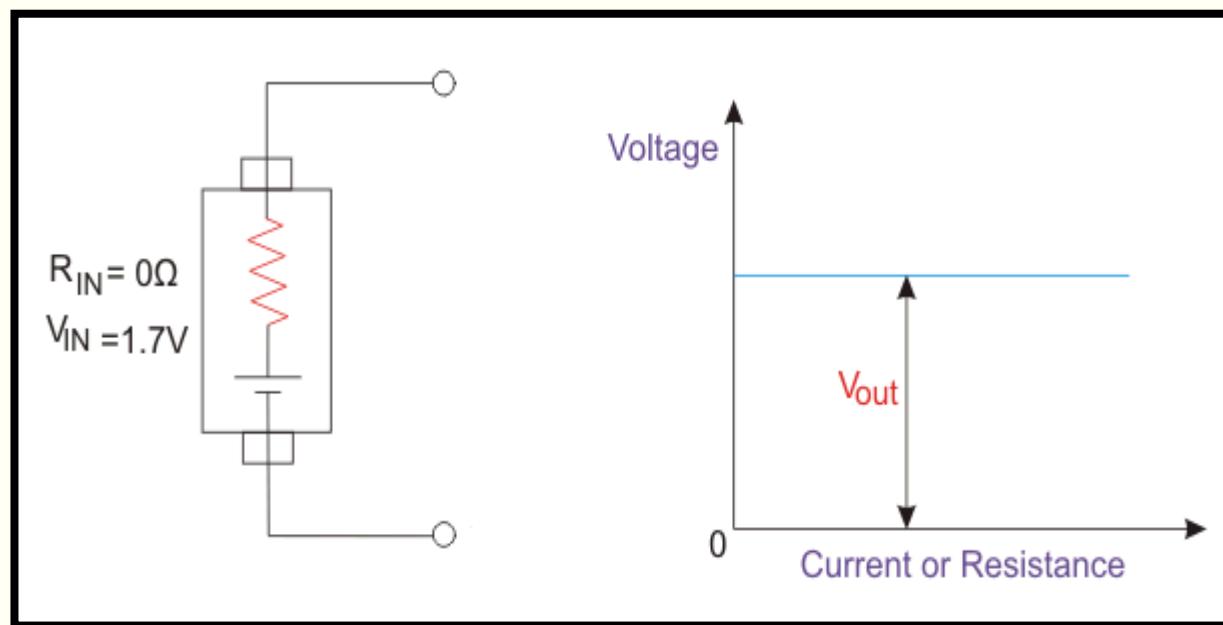


Where: R is resistance, C is capacitance and L is inductance.

# ACTIVE COMPONENTS

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- **Voltage Sources:** Voltage source gives the voltage. It is DC type or AC type. Dc voltage available from battery while AC voltage is available from AC supply.
- **Ideal voltage source:** The voltage source which can deliver constant voltage to the circuit. The value of internal resistance is zero for ideal voltage source. There is no power wasted owing to internal resistance. All of its voltage of the ideal voltage source can drop perfectly to the load in the circuit.

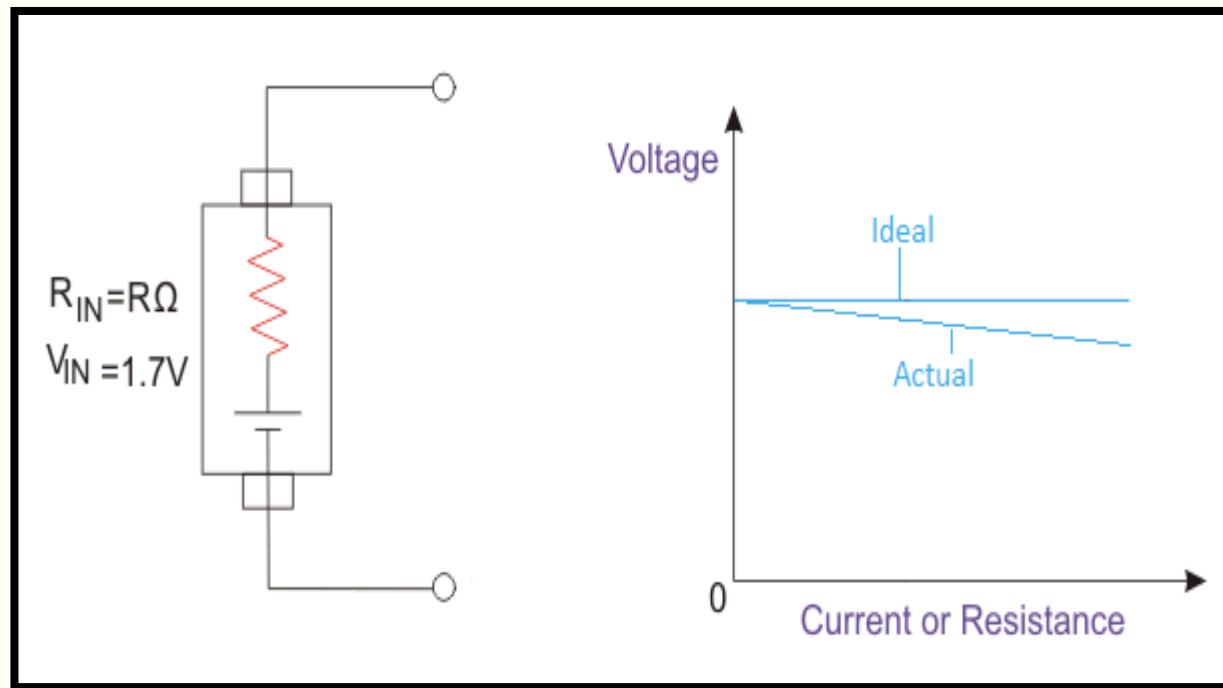


# ACTIVE COMPONENTS

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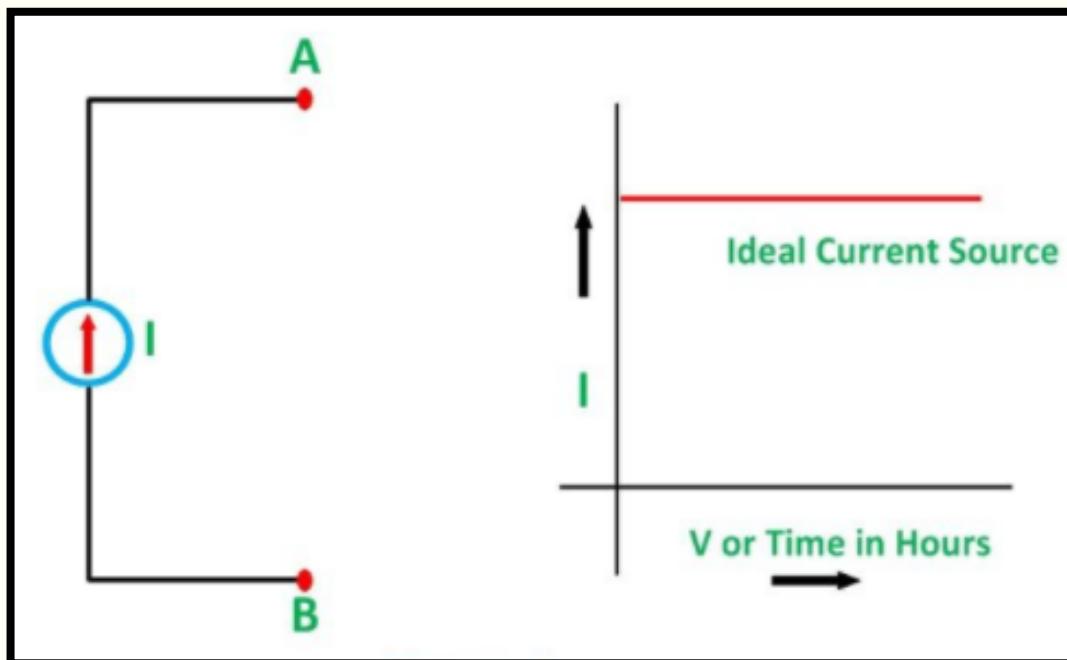
- **Practical voltage source:** practical voltage source having an internal resistance of  $R\Omega$ . Due to the internal resistance, there will be small amount of voltage drop in the  $R$ . So, the output voltage will be reduced to some volt from 1.7V.



# ACTIVE COMPONENTS

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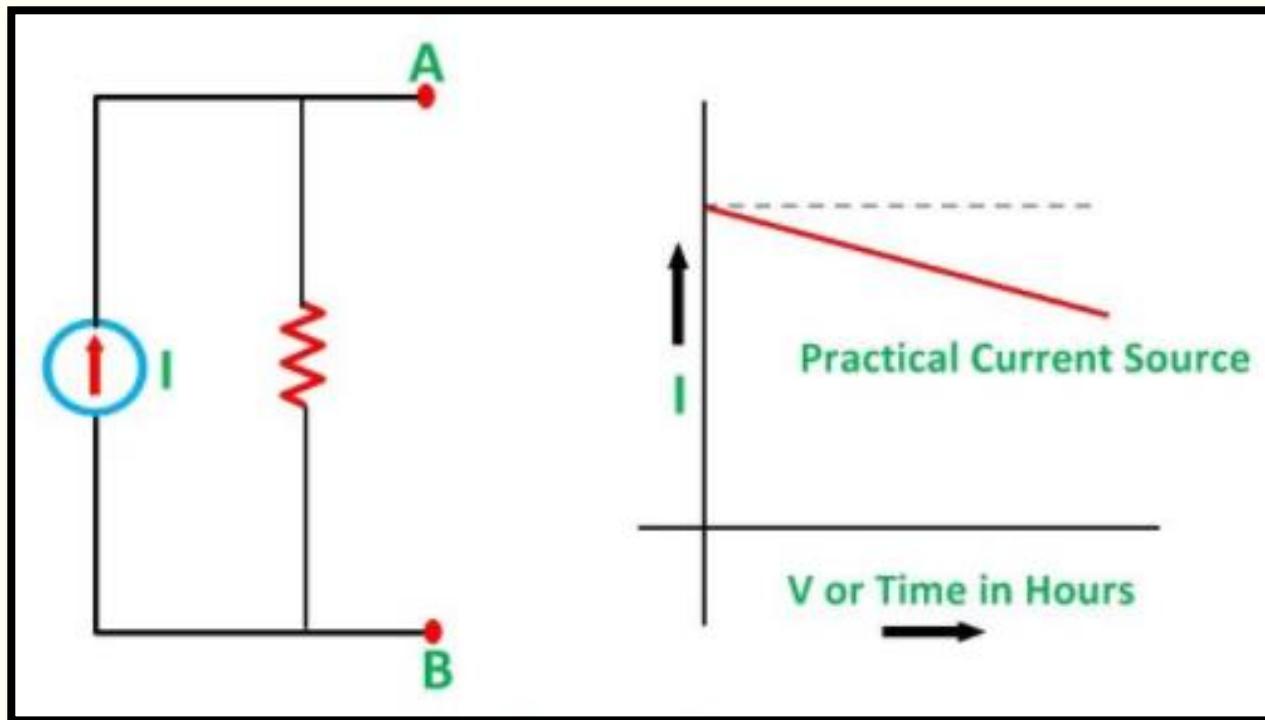
- **Current Sources:** Current source gives the current. It is DC type or AC type. Dc voltage available from battery while AC voltage is available from AC supply.
- **Ideal current source:** Ideal current sources are those sources that supply constant current to the load irrespective of their impedance. That means, whatever may be the load impedance; ideal current source always gives same current through it. It has infinite resistance.



# ACTIVE COMPONENTS

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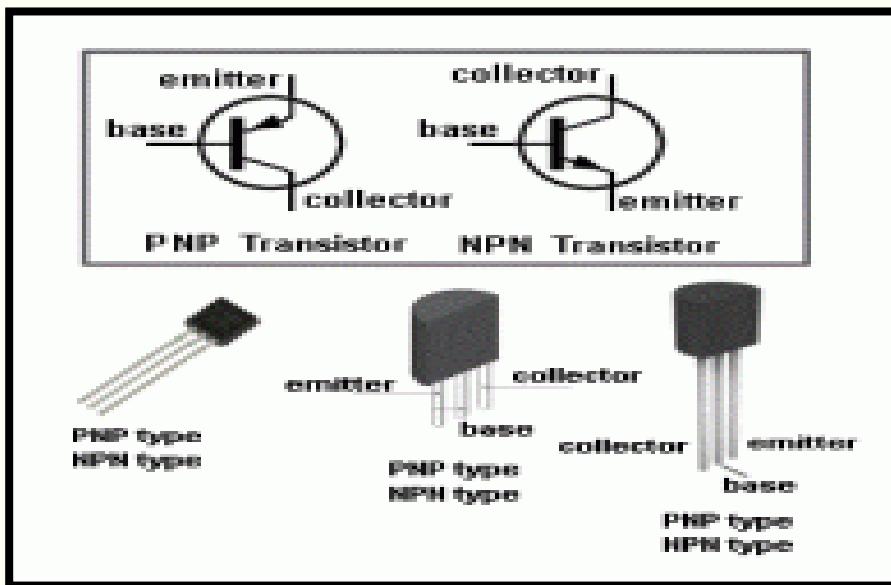
- **Practical current source:** Practical current source has resistance or impedance and it is connected to it. The current supplied by the current source decreases when the value of resistance or impedance increases.



# ACTIVE COMPONENTS

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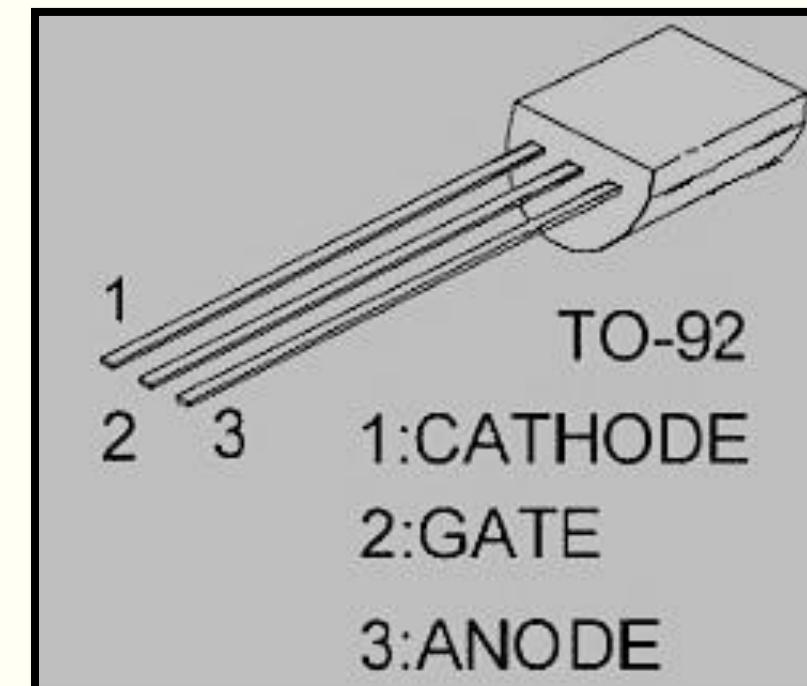
- **Transistors:** A transistor is a semiconductor devices. It is the fundamental building block of the circuitry in mobile phones, computers and several other electronic devices. Transistors are not voltage source or current source but transistors are also active component. This is because **transistors are able to amplify the power of a signal.** Transistors are used to amplify current by taking in a small voltage of energy and giving a larger output of energy. **A transistor is used in number of functions including voltage regulation, amplification, switching, signal modulation and oscillators.**



# ACTIVE COMPONENTS

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- **SCR:** Silicon Controlled Rectifiers or SCRs for short is a type of power electronics switch. **It has three terminals called Anode, Cathode, and Gate.** By default the switch is open and no current flows between the Anode and Cathode terminals of the SCR. **When a small current is applied to the gate pin, the switch is closed and a large amount of current can be allowed to pass between the Anode and Cathode terminals.**
- SCR's are mainly used in devices where the control of high power possibly coupled with high voltage, is demanded. Their operation makes them suitable for use in medium – to – high voltage AC Power control applications, such as lamp dimming, power regulators and motor control.

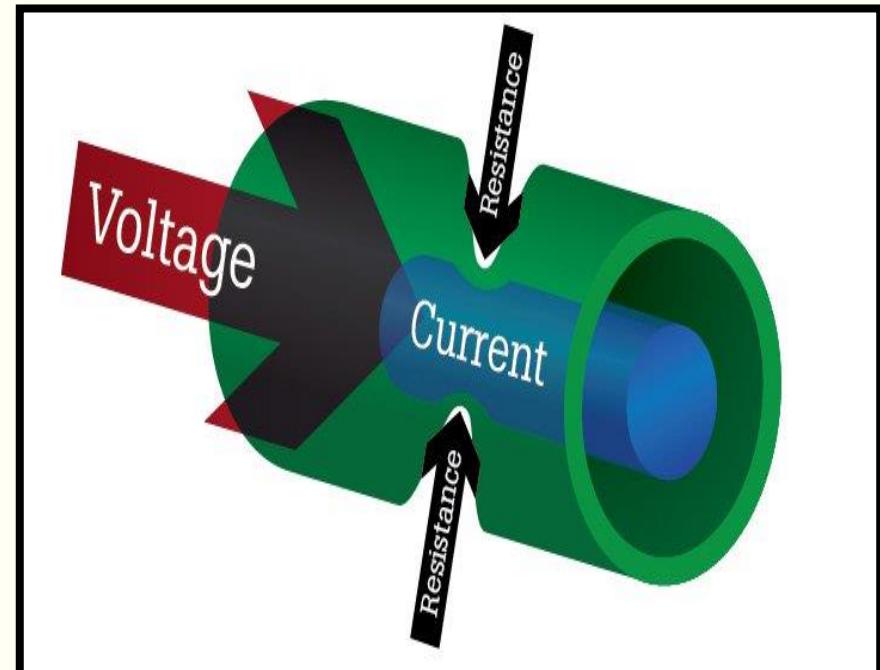


# PASSIVE COMPONENTS

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- **RESISTANCE:-** The property of material which oppose the flow of electrons is **known as resistance of the circuit.**
- It is denoted by **letter R.**
- It's unit is **ohm ( $\Omega$ ).**
- **R= V/I....(3).**
- Resistance id depends upon below mentioned factors .
  - **Length of material.**
  - **Cross sectional area.**
  - **Temperature.**
  - **Type of Material.**



# PASSIVE COMPONENTS

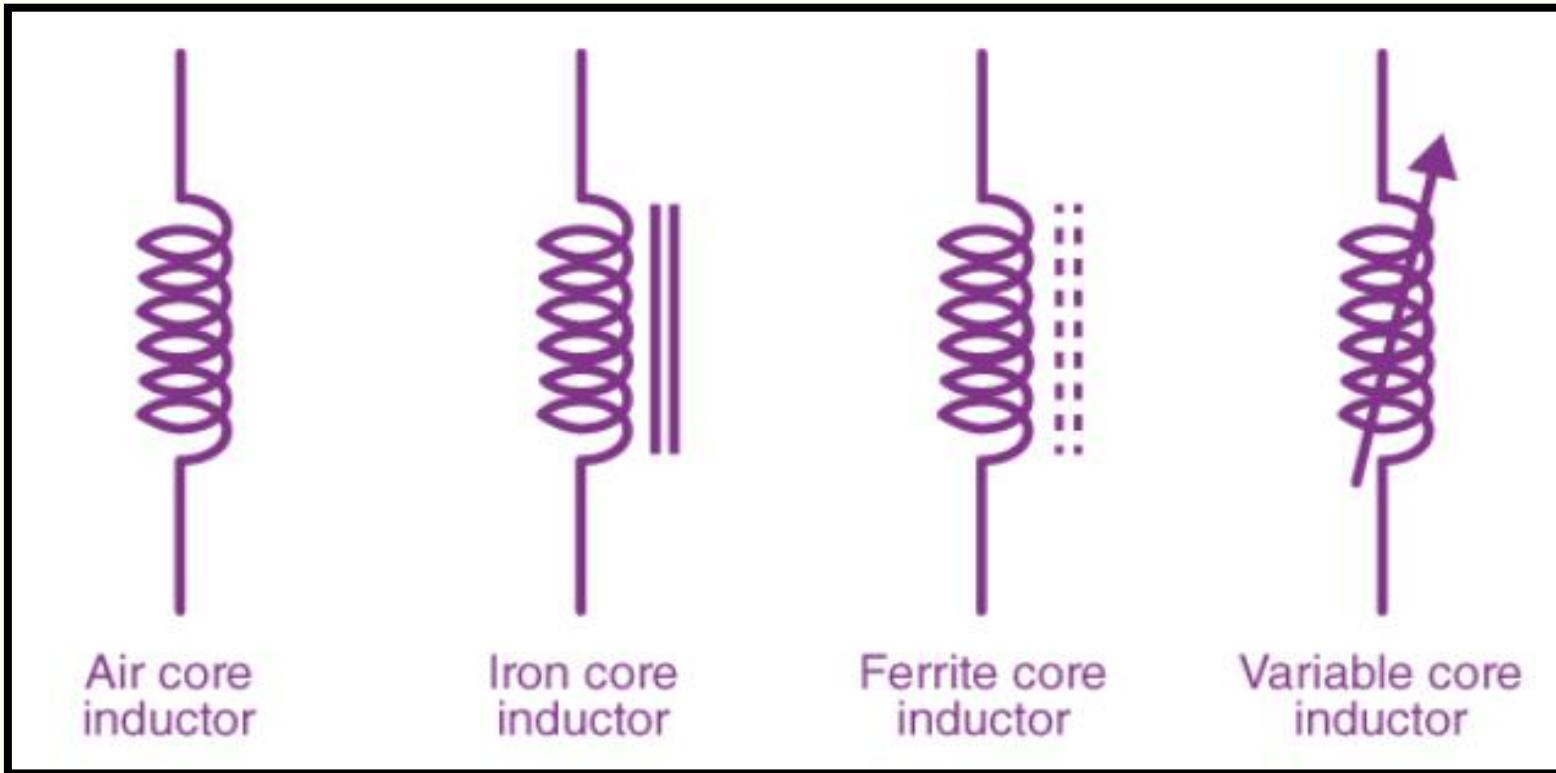
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- **INDUCTOR (L):-** Inductors much like conductors and resistors are simple components that are used in electronic devices to carry out specific functions.  
**Normally, inductors are coil-like structures that are found in electronic circuits. The coil is an insulated wire that is looped around the central core.**
- **Inductors are mostly used to decrease or control the electric spikes by storing energy temporarily in an electromagnetic field and then releasing it back into the circuit.**
- An inductor is a **passive component that is used in most power electronic circuits to store energy in the form of magnetic energy when electricity is applied to it.** One of the key properties of an **inductor is that it impedes or opposes any change in the amount of current flowing through it.** Whenever the current across the inductor changes it either acquires charge or loses the charge in order to equalize the current passing through it. The **inductor is also called a choke, reactor or just coil.**
- **The S.I. unit of inductance is henry (H) and when we measure magnetic circuits it is equivalent to weber/ampere. It is denoted by the symbol L.**

# PASSIVE COMPONENTS

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DIFFERENT TYPES OF INDUCTOR

# PASSIVE COMPONENTS

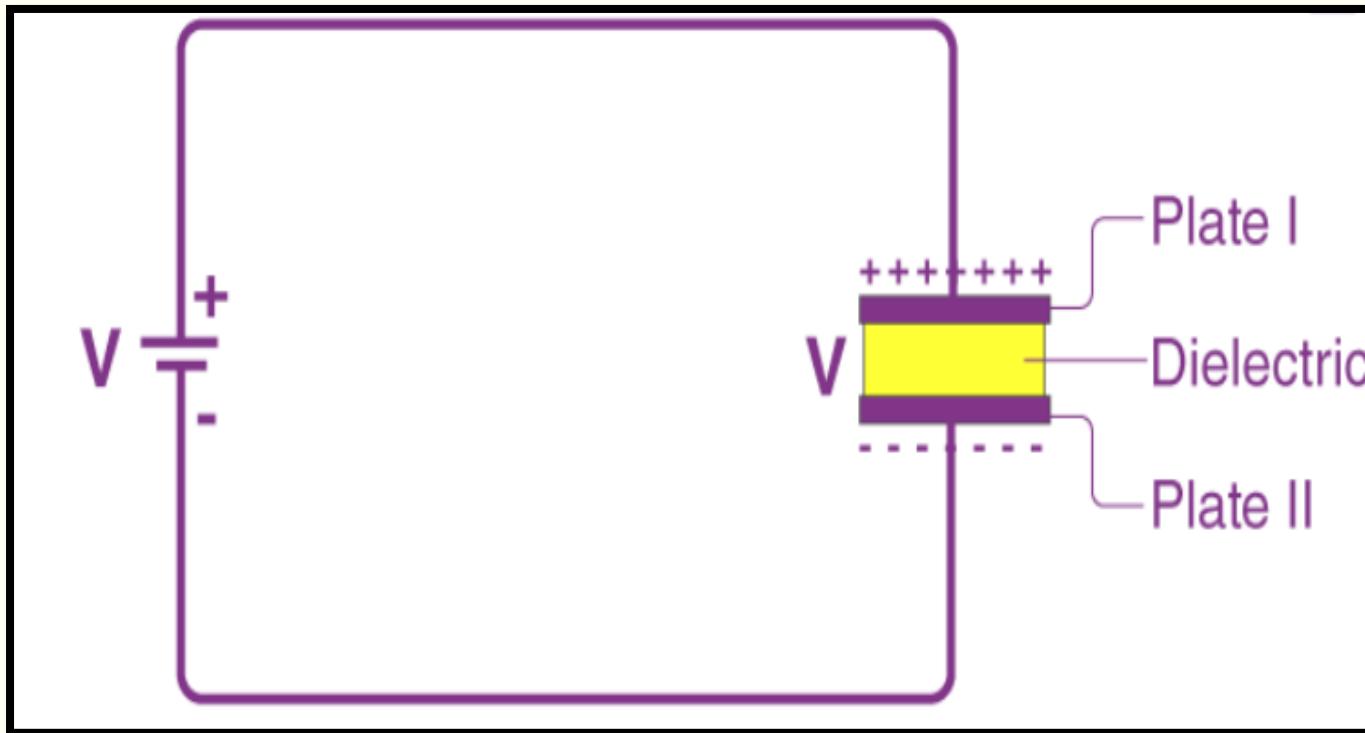
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- **CAPACITOR:-** A capacitor is a little like a battery but they work in completely different ways. A battery is an electronic device that converts chemical energy into electrical energy whereas a **capacitor is an electronic component that stores electrostatic energy in an electric field.**
- **capacitor is a two-terminal electrical device that possesses the ability to store energy in the form of an electric charge.** It consists of two electrical conductors that are separated by a distance. The **space between the conductors may be filled by vacuum or with an insulating material known as a dielectric.** The **ability of the capacitor to store charges is known as capacitance.**
- Capacitors store energy by holding apart pairs of opposite charges. The **simplest design for a capacitor is a parallel plate**, which consists of two metal plates with a gap between them. But, different types of capacitors are manufactured in many forms, styles, lengths, girths, and materials.

# PASSIVE COMPONENTS

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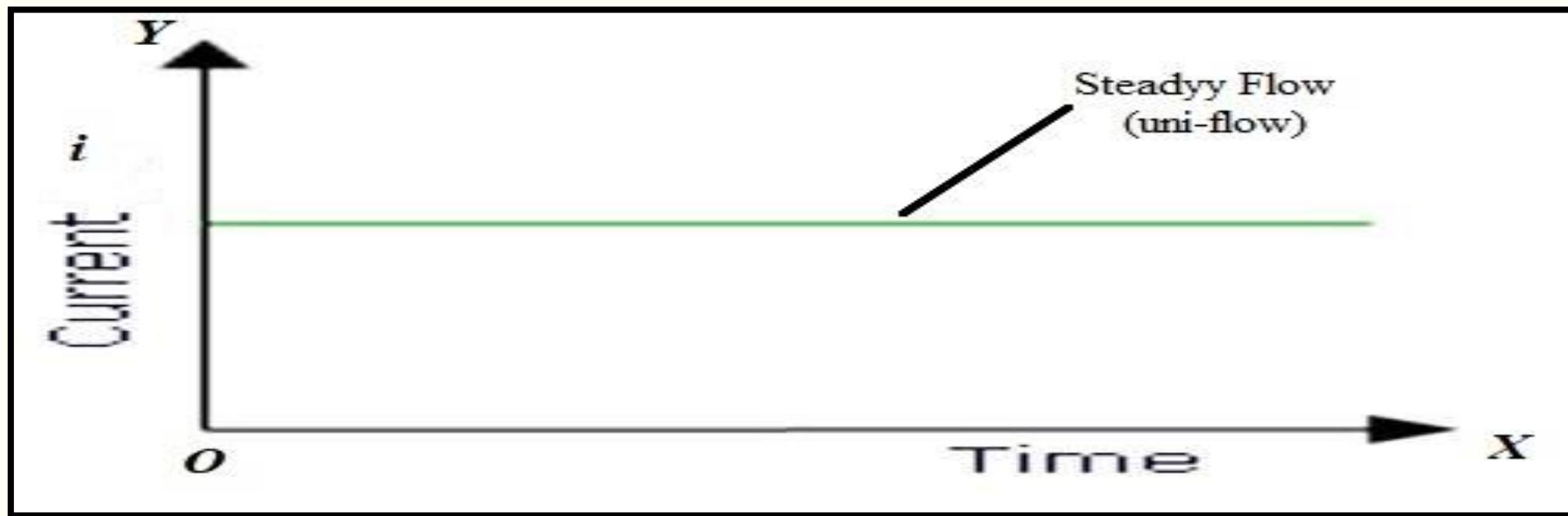


A Battery is Connected Across A Parallel Plate Capacitor

# SIGNALS

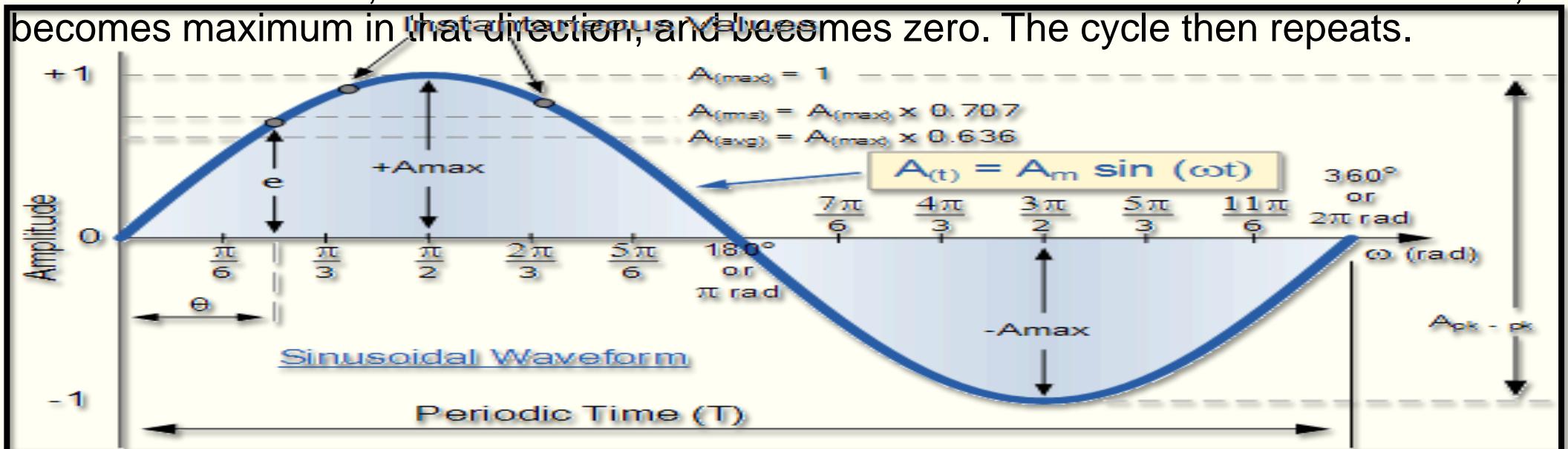
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- **DIRECT CURRENT:-** In direct current there is no change in the direction of electric current. In figure below there is no change in the magnitude of the current.
- Direct current (DC) is an electric current that is **uni-directional**, so the flow of charge is always in the same direction. As opposed to alternating current, the direction and amperage of direct currents do not change. It is used in many household electronics and in all devices that use batteries.



# SIGNALS

- **ALTERNATING CURRENT:-** Alternating current (AC) is an electric **current** which periodically reverses direction, in contrast to direct **current** (DC) which flows only in one direction.
- In alternating current, the magnitude and the direction of current are changing continuously. Graph of electric current varying sinusoidally is shown in figure.
- From the graph it is seen that the value of current increases in direction from zero, becomes maximum, then decreases to zero and increases in reverse direction, becomes maximum in that direction, and becomes zero. The cycle then repeats.

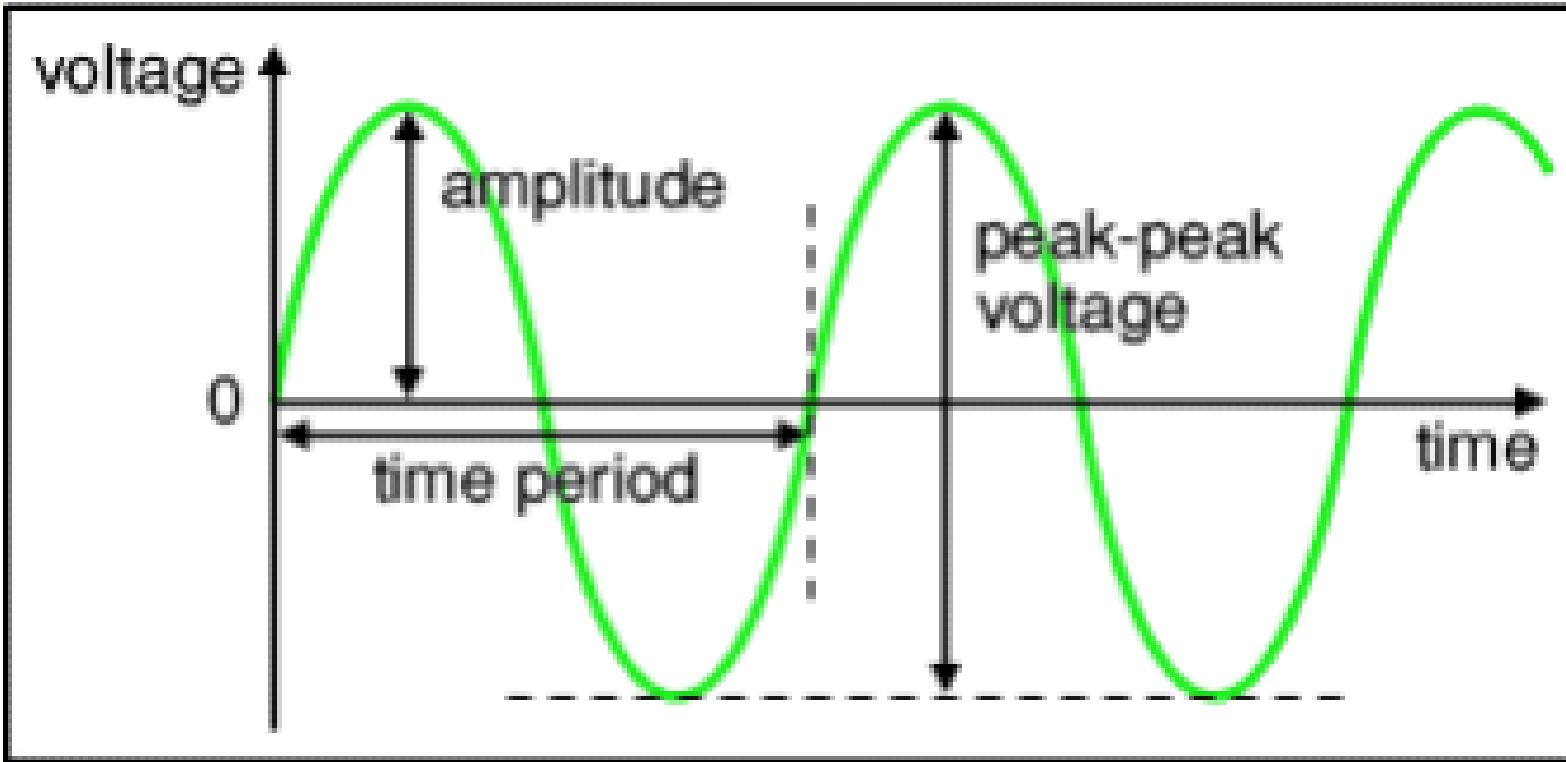


# COMPARISON BETWEEN A.C & D.C

Comparison Basis	AC	DC
Energy Transmission Capacity	Travels over long distance with minimal Energy loss	Large amount of energy is lost when sent over long distances
Generation Basics	Rotating a Magnet along a wire.	Steady Magnetism along a wire
Frequency	Usually 50Hz or 60Hz depending on Country	Frequency is Zero
Direction	Reverses direction periodically when flowing through a circuit	It steady constant flow in one direction.
Current	Its Magnitude Vary with time	Constant Magnitude
Source	All forms of AC Generators and Mains	Cells, batteries, Conversion from AC
Passive Parameters	Impedance (RC, RLC, etc)	Resistance Only
Power Factor	Lies between 0&1	Always 1
Waveform	Sinusoidal, Trapezoidal, Triangular and Square	Straight line, sometimes Pulsating.

# SIGNALS

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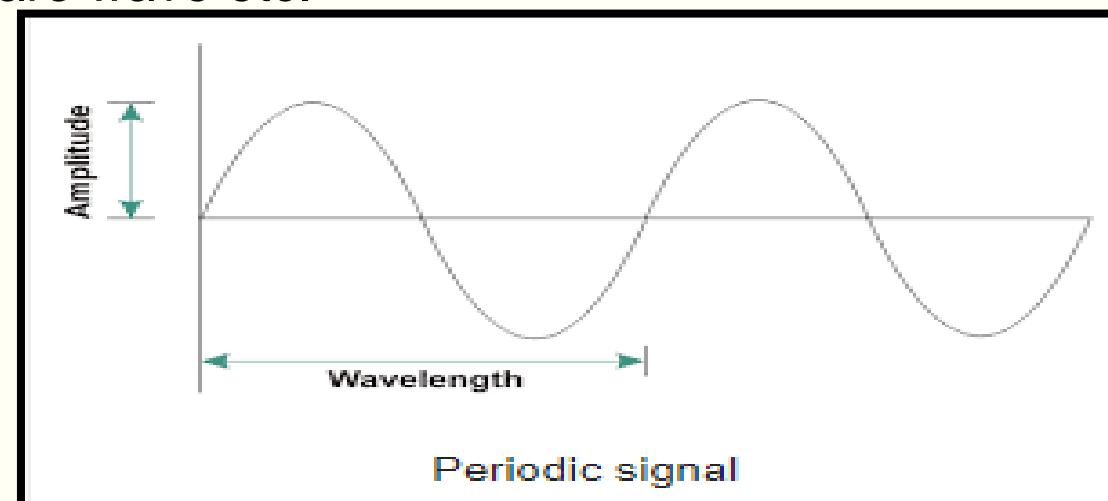
Properties of Electrical Signals

# SIGNALS

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- **PERIODICAL SIGNALS:** A CT signal which repeats it self after a fixed time period is called as a periodic signal. The periodicity of a CT signal can be defined mathematically as follows:
  - $x(t) = x(t+T_0)$ .
  - Where ;
  - $T_0$  = periodic of signal  $x(t)$ .
  - periodic signal are sine wave, cosine wave, square wave etc.

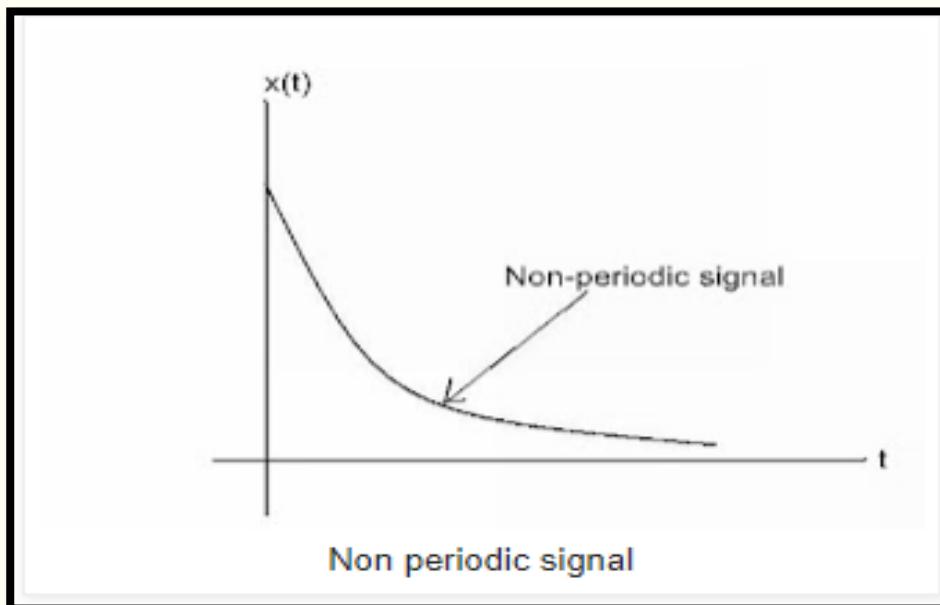


# SIGNALS

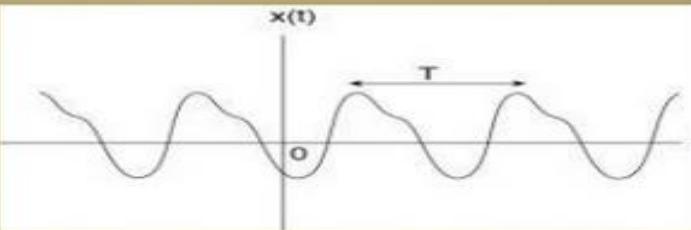
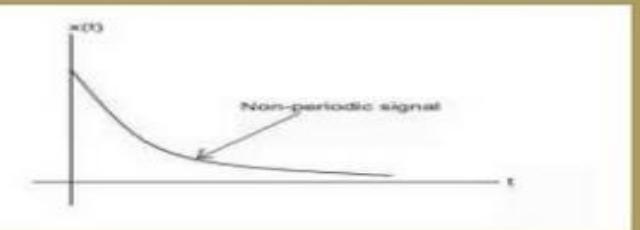
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- **NON-PERIODICAL/APERIODIC SIGNALS:** A CT signal which does not repeat itself after a fixed time period or does not repeat at all is called as a non periodic signal. The non periodic signal do not satisfy the condition of periodicity stated in equation:
- $x(t) \neq x(t+T_0)$ .
- Sometimes it is said that an aperiodic signal has a periodic  $T_0 = \infty$ . Figure shows a decaying exponential signal.



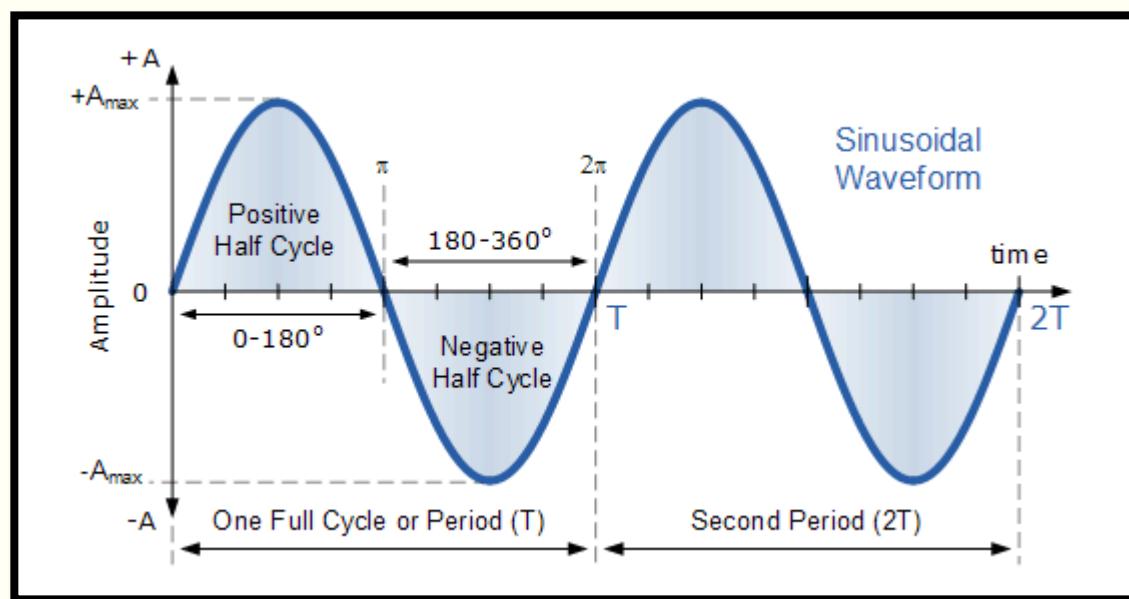
# COMPARISON BETWEEN PERIODIC AND NON PERIODIC / APERIODIC SIGNALS

Periodic Signal	Aperiodic Signal
<ul style="list-style-type: none"><li><input type="checkbox"/> A signal which repeats itself after a specific interval of time is called periodic signal.</li><li><input type="checkbox"/> A signal that repeats its pattern over a period is called periodic signal</li><li><input type="checkbox"/> They can be represented by a mathematical equation</li><li><input type="checkbox"/> Their value can be determined at any point of time</li></ul>	<ul style="list-style-type: none"><li><input type="checkbox"/> A signal which does not repeat itself after a specific interval of time is called aperiodic signal.</li><li><input type="checkbox"/> A signal that does not repeats its pattern over a period is called aperiodic signal or non periodic.</li><li><input type="checkbox"/> They cannot be represented by any mathematical equation</li><li><input type="checkbox"/> Their value cannot be determined with certainty at any given point of time</li></ul>
<ul style="list-style-type: none"><li><input type="checkbox"/> They are deterministic signals</li><li><input type="checkbox"/> Example: sine cosine square sawtooth etc</li></ul>	<ul style="list-style-type: none"><li><input type="checkbox"/> They are random signals</li><li><input type="checkbox"/> Example: sound signals from radio , all types of noise signals</li></ul>
<ul style="list-style-type: none"><li><input type="checkbox"/> Figure:</li></ul>	<ul style="list-style-type: none"><li><input type="checkbox"/> Figure:</li></ul>
	

# DIFFERENT TYPES OF SIGNALS WAVEFORM

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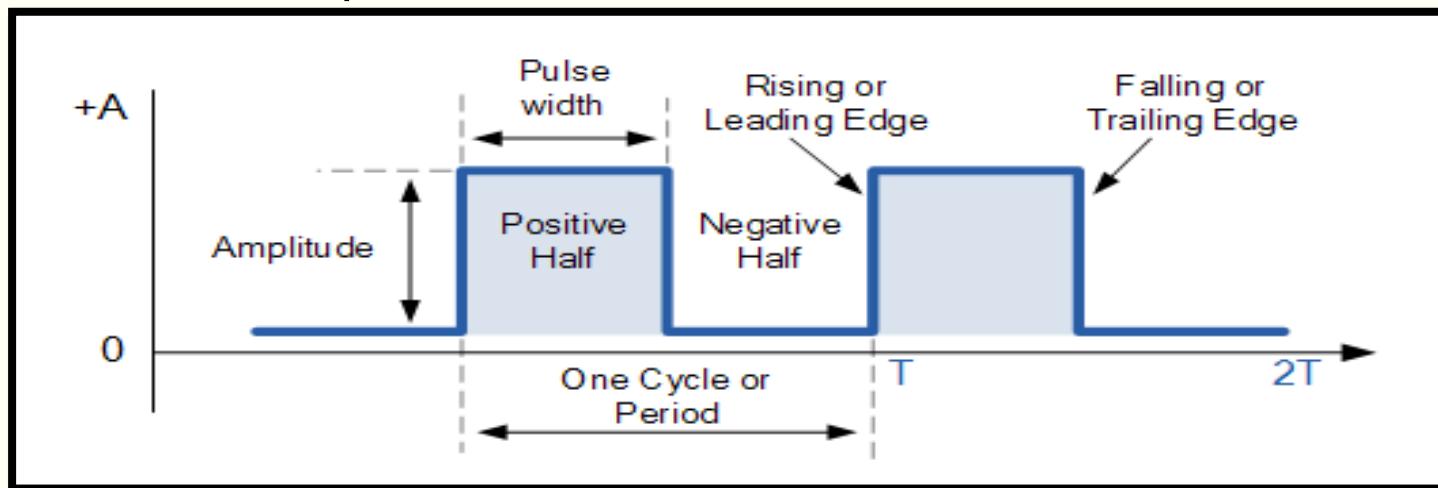
- **A SINE WAVEFORM:** The AC (Alternating Current) mains waveform in your home is a sine wave and one which constantly alternates between a maximum value and a minimum value over time.
- The amount of time it takes between each individual repetition or cycle of a sinusoidal waveform is known as its “periodic time” or simply the Period of the waveform. In other words, the time it takes for the waveform to repeat itself.



# DIFFERENT TYPES OF SIGNALS WAVEFORM

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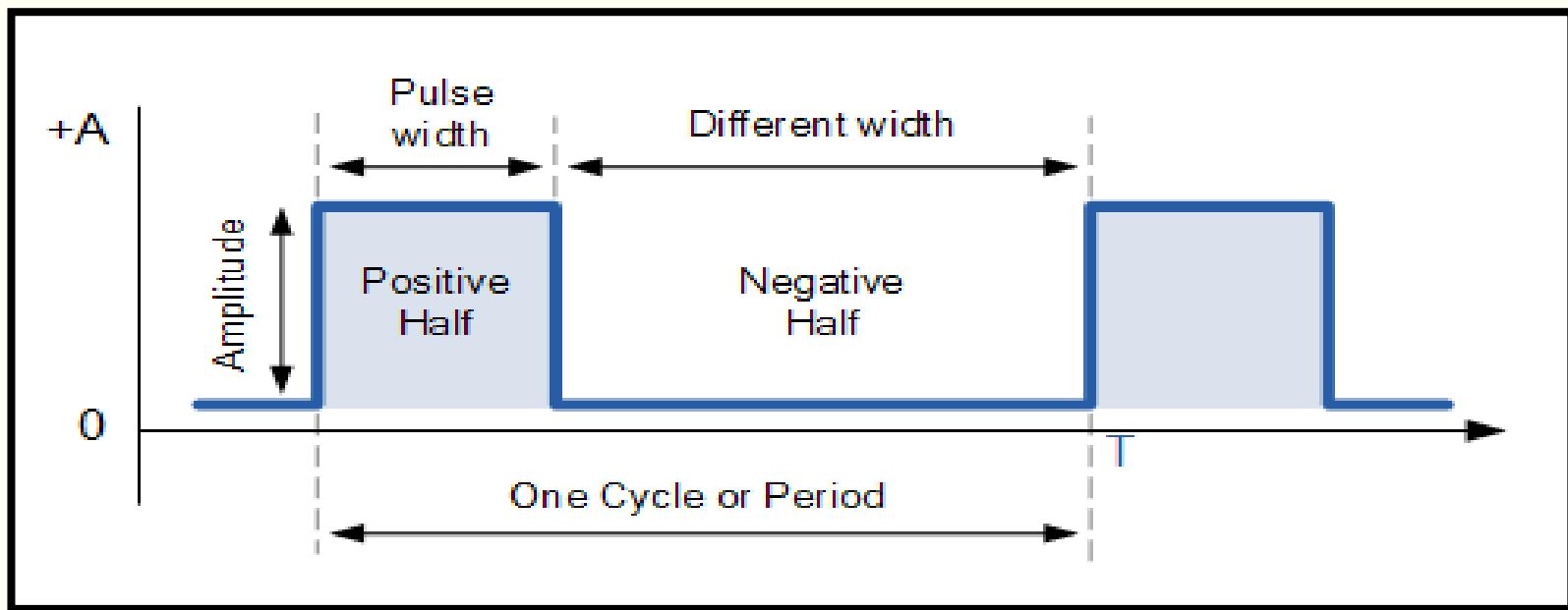
- **A SQUARE WAVEFORM:** Square-wave Waveforms are used extensively in electronic and micro electronic circuits for clock and timing control signals as they are symmetrical waveforms of equal and square duration representing each half of a cycle and nearly all digital logic circuits use square wave waveforms on their input and output gates.
- Unlike sine waves which have a smooth rise and fall waveform with rounded corners at their positive and negative peaks, square waves on the other hand have very steep almost vertical up and down sides with a flat top and bottom producing a waveform which matches its description.



# DIFFERENT TYPES OF SIGNALS WAVEFORM

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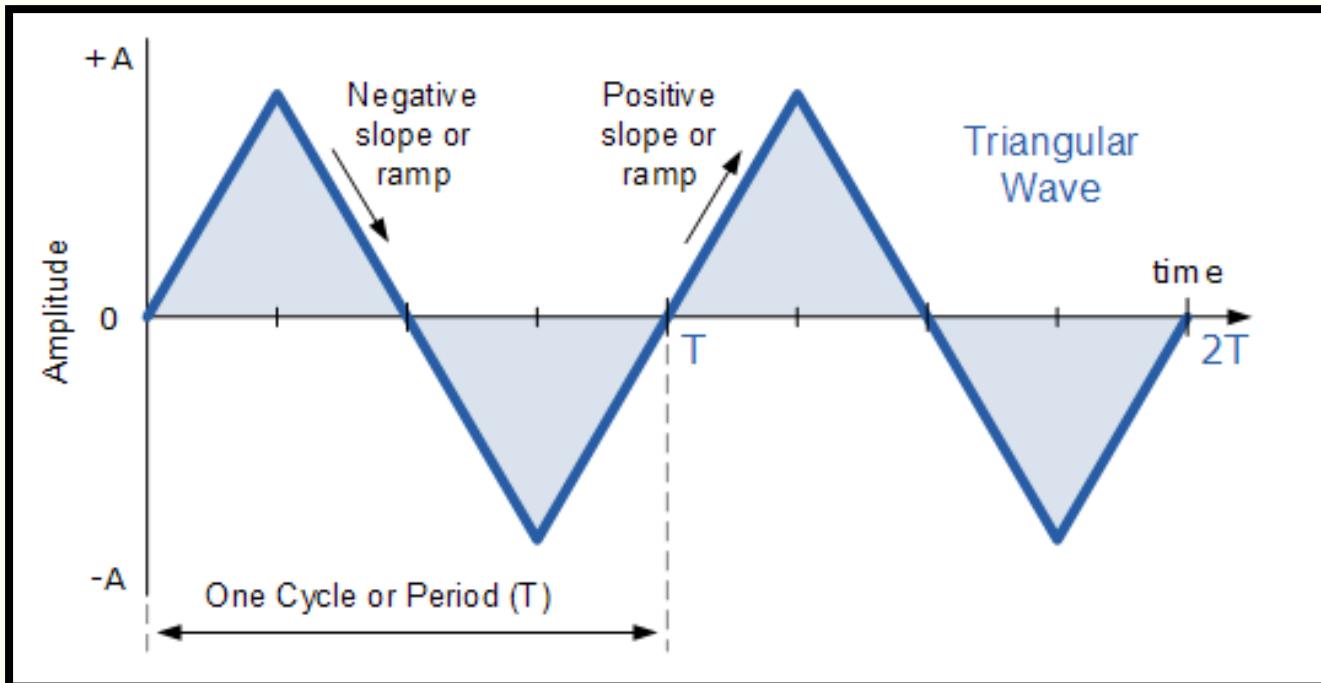
- **A RECTANGULAR WAVEFORM:** Rectangular Waveforms can be used to regulate the amount of power being applied to a load such as a lamp or motor by varying the duty cycle of the waveform. The higher the duty cycle, the greater the average amount of power being applied to the load and the lower the duty cycle, the less the average amount of power being applied to the load and an excellent example of this is in the use of “Pulse Width Modulation” speed controllers.



# DIFFERENT TYPES OF SIGNALS WAVEFORM

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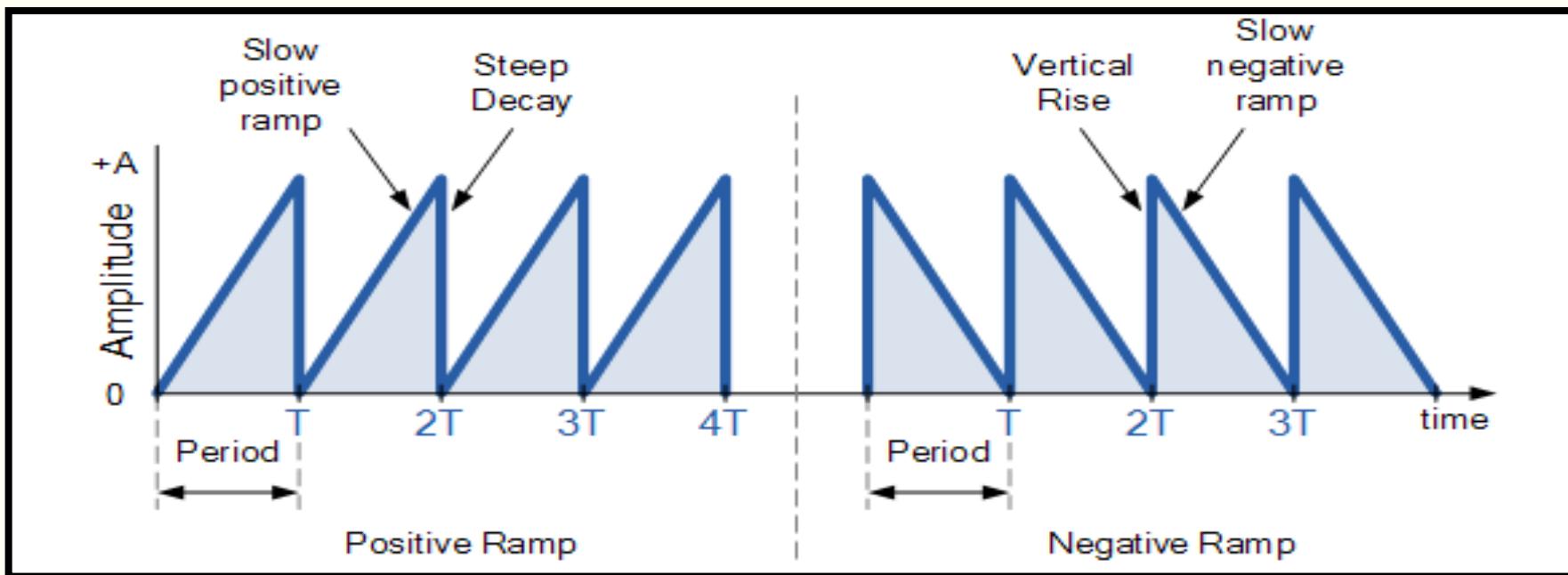
- **A TRIANGULAR WAVEFORM:** Triangular Waveforms are generally bi-directional non-sinusoidal waveforms that oscillate between a positive and a negative peak value. Although called a triangular waveform, the triangular wave is actually more of a symmetrical linear ramp waveform because it is simply a slow rising and falling voltage signal at a constant frequency or rate. The rate at which the voltage changes between each ramp direction is equal during both halves of the cycle as shown below.



# DIFFERENT TYPES OF SIGNALS WAVEFORM

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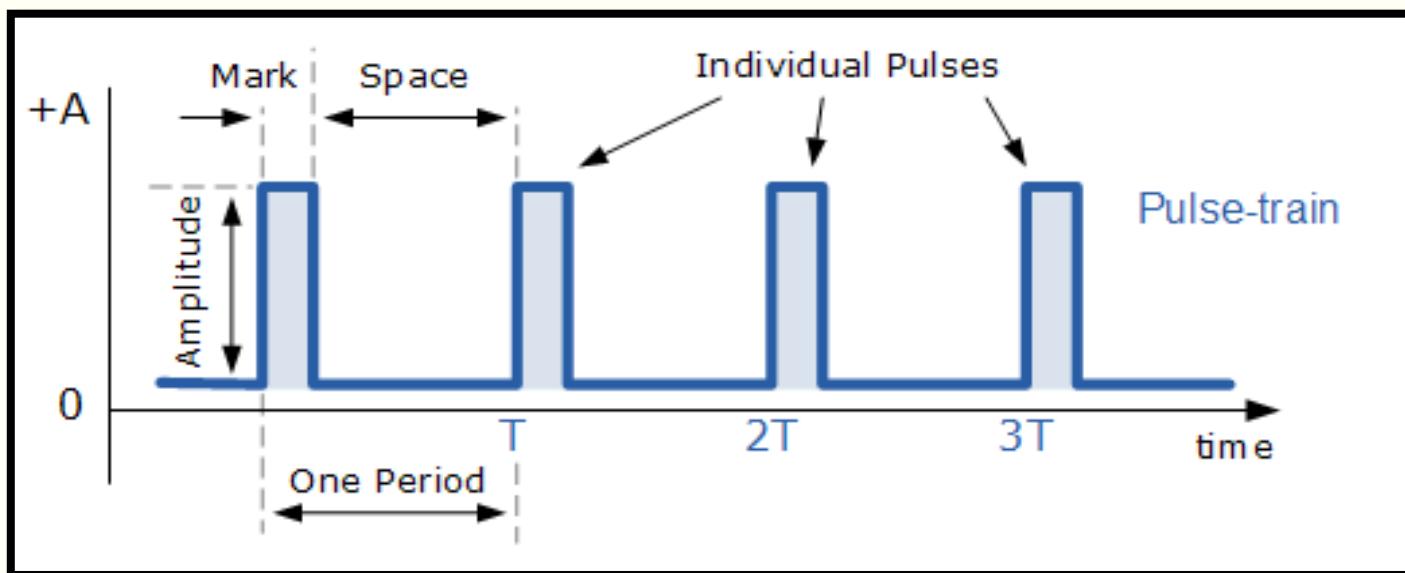
- **A SAWTOOTH WAVEFORM:** Saw tooth Waveforms are another type of periodic waveform. As its name suggests, the shape of the waveform resembles the teeth of a saw blade. Saw-toothed waveforms can have a mirror image of themselves, by having either a slow-rising but extremely steep decay, or an extremely steep almost vertical rise and a slow-decay as shown below.



# DIFFERENT TYPES OF SIGNALS WAVEFORM

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- **A PULSE WAVEFORM:** A Pulse Waveform or “Pulse-train” as they are more commonly called, is a type of non-sinusoidal waveform that is similar to the Rectangular waveform we looked at earlier. The difference being that the exact shape of the pulse is determined by the “Mark-to-Space” ratio of the period and for a pulse or trigger waveform the Mark portion of the wave is very short with a rapid rise and decay shape as shown below.



# ROOT MEAN SQUARE (R.M.S VALUE OF A.C QUANTITY)

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- **RMS VALUE OF A.C** : We have seen that the value of the alternating quantity changes instantaneously. Its effective value is represented by RMS value. For this heating effect of electric current is taken in to account.
- Let us assume that certain value of alternating current flows through a resistor for some period and as a result certain amount of heat is generated. Now we pass direct current through the same value of the resistor for the same time period to produce the same amount of heat. Then this value of direct current is known as effective value or RMS value of the alternating current.
- **Thus RMS value of the alternating current is defined as that value of the direct current which is required to be passed through a resistor to produce the same amount of heat produced by the alternating current when passed for the same period through the same value of resistor.**
- **$I_{RMS} = 0.707 I_m$**

# AVERAGE VALUE OF A.C QUANTITY

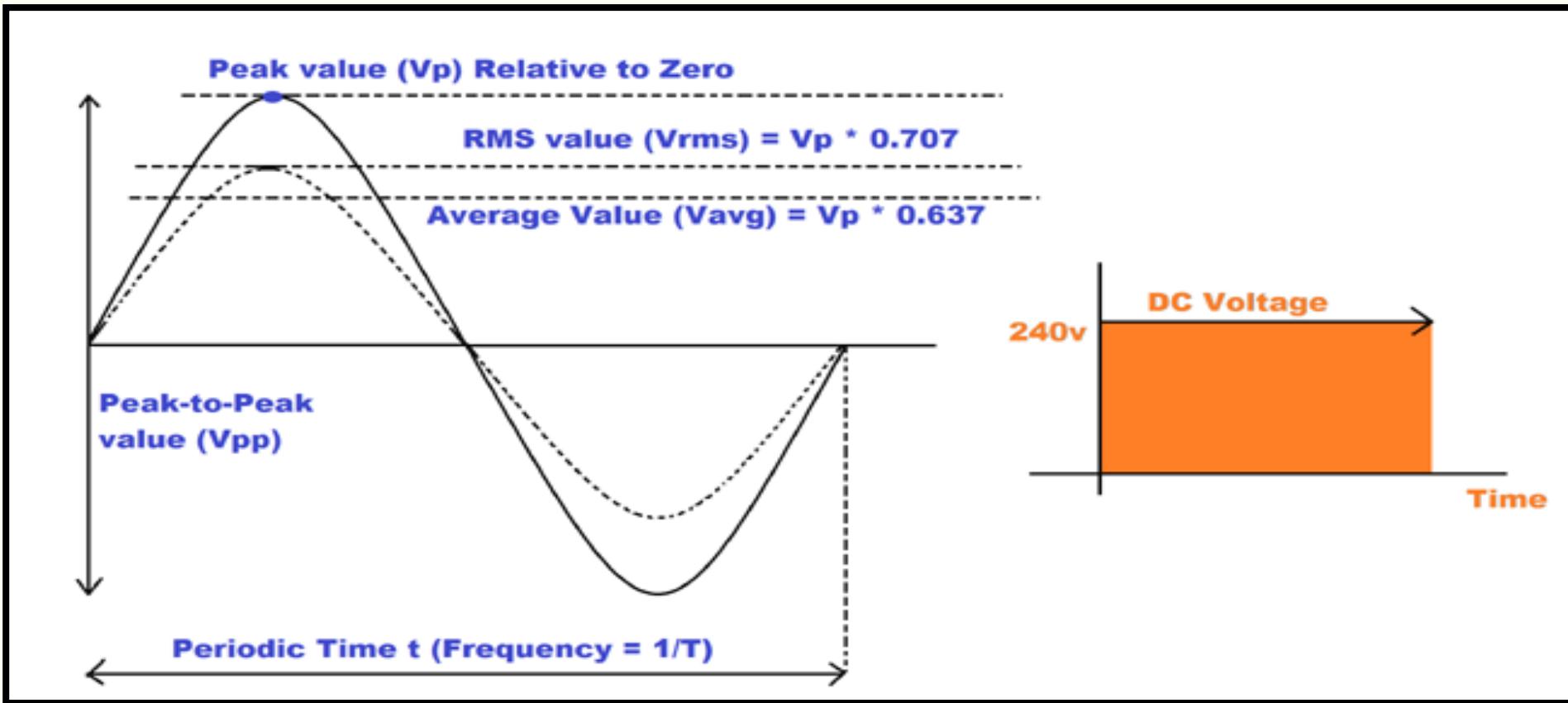
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- **AVERAGE VALUE OF A.C:** Average value is found by considering the charge transfer. **Average value of electric current is defined as that value of direct current which transfer the same amount of charge in a circuit which is transmitted by an alternating current flowing through the same circuit for the same period.**
- The average value is fund by taking the area under the curve and dividing it by the base. Now for alternating waveform the sum of areas becomes zero, as there are two loops of equal area in positive and negative direction. So the average value is found by taking the area of one loop and dividing it by the corresponding base.
- **$I_{avg} = 0.637 I_m$**

# R.M.S AND AVERAGE VALUE OF A.C QUANTITY

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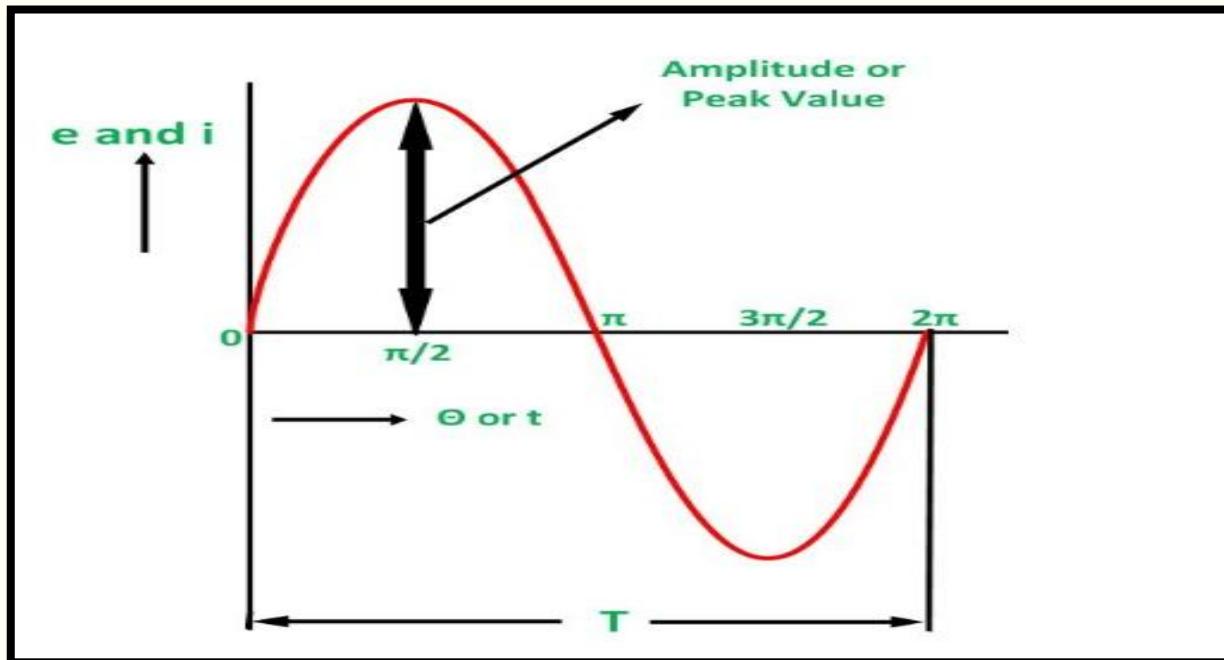
R.M.S and Average Value of A.C

# PEAK VALUE OF A.C QUANTITY

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- **Maximum value or Amplitude or Peak Value:** Maximum value of alternating quantity (emf, current or flux) is called maximum value or peak value or amplitude. In a cycle it occurs twice. One is positive maximum and the other is negative maximum. These two values are equal in magnitude.



Maximum value or Amplitude or Peak Value

# DEPENDENT AND INDEPENDENT SOURCES

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- **Independent Source:** The element for which both voltage and current don't depends on the voltage or current elsewhere in circuit.
- The strength of voltage or current is not changed by any variation in the connected network the source is said to be either independent voltage or independent current source. In this, the value of voltage or current is fixed and is not adjustable.
- **Dependent Source:** The element for which either the voltage or current depends on the voltage or current elsewhere in circuit.
- There four types of dependent sources in electronics.
  1. Voltage Controlled Voltage Source (VCVS)
  2. Voltage Controlled Current Source (VCCS)
  3. Current Controlled Voltage Source (CCVS)
  4. Current Controlled Current Source (CCCS)

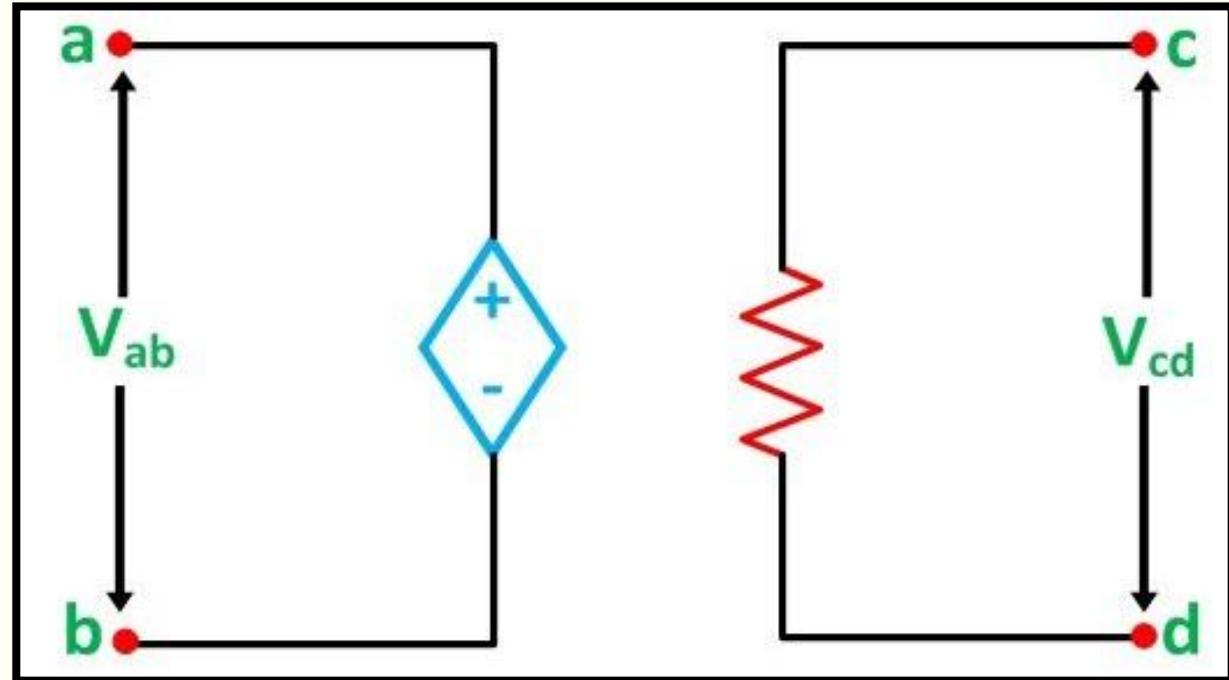
# DEPENDENT AND INDEPENDENT SOURCES

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- **Voltage Controlled Voltage Source (VCVS):**
- In voltage-controlled voltage source, the voltage source is dependent on any element of the circuit.
- As per the diagram, the voltage across the source terminal  $V_{ab}$  is dependent on the voltage across the terminal  $V_{cd}$ .

$$V_{ab} \propto V_{cd} \quad \text{or}$$

$$V_{ab} = kV_{cd}$$



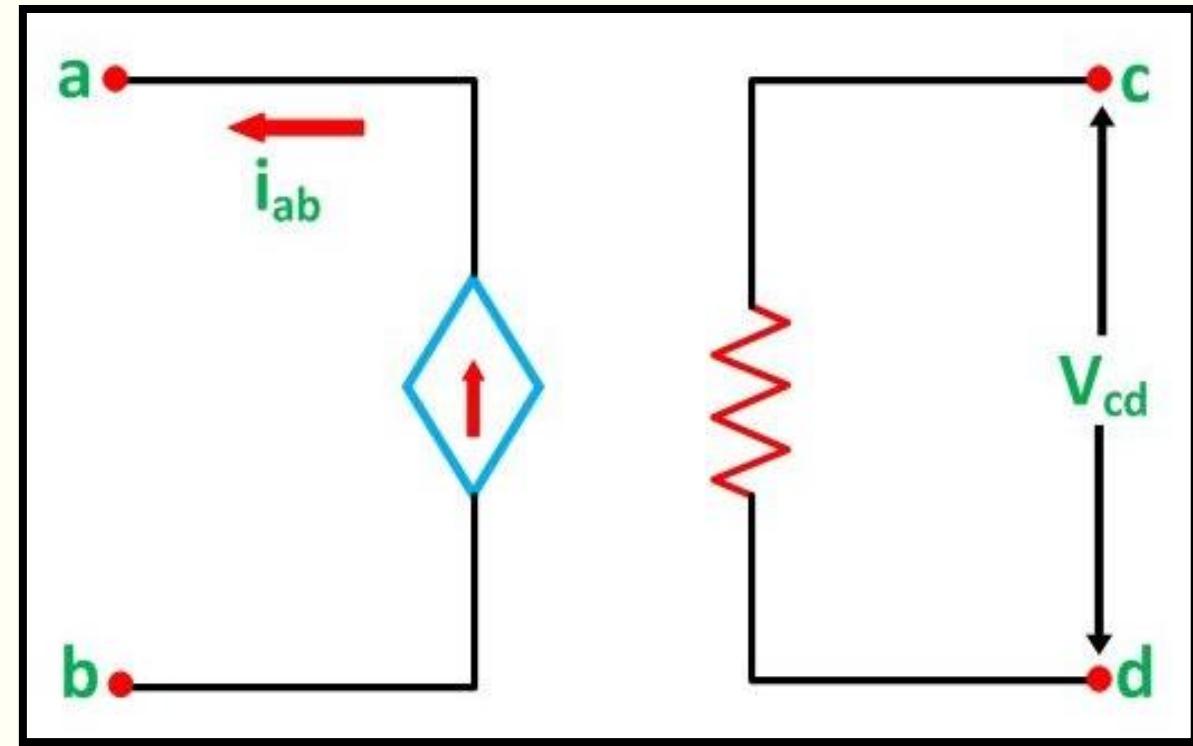
# DEPENDENT AND INDEPENDENT SOURCES

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- **Voltage Controlled Current Source (VCCS):**
- In the voltage controlled current source, the current of the source  $i_{ab}$  depends on the voltage across the terminal cd ( $V_{cd}$ ). Where  $\eta$  is a constant known as trans conductance and its unit is mho.

$$i_{ab} \propto V_{cd}$$

$$i_{ab} = \eta V_{cd}$$



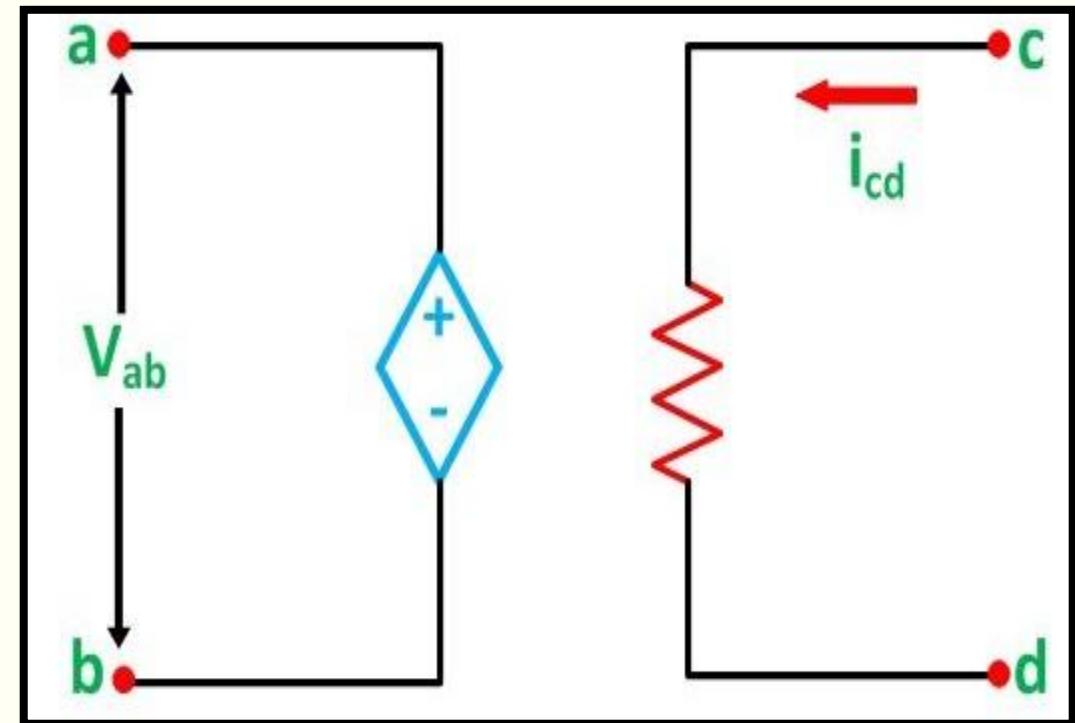
# DEPENDENT AND INDEPENDENT SOURCES

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- **Current Controlled Voltage Source (CCVS):**
- In the current controlled voltage source voltage source of the network depends upon the current of the network.
- Here the voltage of source  $V_{ab}$  depends on the current of the branch  $i_{cd}$ .

$$V_{ab} \propto i_{cd}$$

$$V_{ab} = r i_{cd}$$



# DEPENDENT AND INDEPENDENT SOURCES

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- **Current Controlled Current Source (CCCS):**
- In the Current Controlled Current Source, the current source is dependent on the current of the branch another branch.

$$i_{ab} \propto i_{cd}$$
$$i_{ab} = \beta i_{cd}$$

