# Unit - 17
# Introductory Electronics

**Students Learning Outcomes (SLOs)**

**After learning this unit students should be able to**

- Identify by quoting examples that the modern world is the world of digital electronics.
- Identify that the computers are the forefront of electronic technology.
- Realize that electronics is shifting from low-tech electrical appliances to high-tech electronic appliances.
- Differentiate between analogue and digital electronics.
- Explain the process of thermionic emission emitted from a filament.
- Describe the simple construction and use of an electron gun as a source of electron beam.
- Describe the effect of electric field on an electron beam.
- Describe the effect of magnetic field on an electron beam.
- Describe the basic principle of CRO and make a list of its uses.
- State the basic operations of digital electronics.
- Identify and draw the symbols for the logic gates (NOT, OR, AND, NOR and NAND).
- State the action of logic gates in truth table form.
- Describe the simple uses of logic gates.

Electronics controls electron motion using various electronic devices. Electronic devices manage electron flow for information processing and system control. Both the world and technology are changing very quickly. Every day, a new device develops to make our lives easier. Electronic devices are so important that we can't picture a day without them. Everything from a telephone to a washing machine. If we Look around us, and every corner has an electric device. The reason we are getting so used to it is simple, it is easier and it takes no time to get the work done.

Laptop

Camera

Loud speakers

Projector

**Fig: 17.1.**
**Some electronic devices**

Please recall that, the following questions may arise in your mind time to time that:

- What is the difference between analogue and digital electronics?
- Why digital electronics based devices are more rapidly growing than analogue based devices?
- Why computer process the data at extremely high speed?
- Have you ever think why the electrons are emitted from a filament?
- How electron beams are formed?
- Why electron beams are deflected by both electric and magnetic fields?
- Why electronic devices are better than electrical devices?

After studying this unit you will be able to find the answers of such questions and develop the clear concepts.

## 17.1 INTRODUCTION TO ELECTRONICS

In 1897 electron was identified. Vacuum tube was invented in the same period of time. Vacuum tube can amplify and rectify small electrical signals. The invention of vacuum tube opens up a new field of technology called "ELECTRONICS". Electronics comprises the physics, engineering and technology. Electronics also has applications that deal with the emission, flow and control of electrons in vacuum and matter using different devices.

The progress in the field of science and technology depends upon the ability to measure, calculate and finally estimate the unknown. There are three ways in which this could be done.

1. Mechanical (Measurement of gas pressure by pressure gauge.)
2. Electrical (Measurement of current with electrical ammeter.)
3. Electronics (Measurement of potential difference by cathode-ray oscilloscope.

Among above three ways the electronics is far better. Since, in electronics we get higher sensitivity, faster

response and greater flexibility in indicating, recording and controlling the measured quantity.

Electronics may have two fields:

(1) Analogue

(2) Digital

## Modern World Is The World Of Digital Electronics:

Digital electronic technology is a revolution in the field of information. Data of any sort can be instantly and accurately retrieved from any part of the world. Internet is just the start of this global sharing of information.

The conversion of signals from analogue to digital has been the key to this digital revolution, their processing and transmission in digital form and their conversion back into analogue form.

It is now possible to perform many tasks digitally which were used to be carried out using analogue electronics. Digital information has several advantages over analogue information. Some of these advantages are:

(i) Easy storage.

(ii) Easy transmission.

(iii) Large amplification.

(iv) Less noisy signal (clear signal).

(v) Negligible power or line losses.

Digital electronics devices have many advantages over analogue electronic devices. Some of these advantages are:

(i) They have greater speed.

(ii) They are very sensitive.

(iii) Their displays are easily readable.

(iv) They are very accurate.

(v) They have better resolution.

(vi) They can monitor remote signals.

(vii) Their sizes are small.

For example: A digital voltmeter (DVM) has following advantages over electrical voltmeter.

(i) Higher accuracy.

Fig: 17.2.
Analogue devices

Fig: 17.3.
Digital devices

**Do You Know!**

Digital Cameras are fast, reliable and easy to use. They provide quality pictures with better resolutions. These pictures can be edited as per our requirements.

**Do You Know!**

Now electronic sensors can digitally measure the continuously varying quantities such as temperature, pressure or positions and some other quantities.

**Do You Know!**

A 1960 Newmark analogue computer, made up of five units. This computer was used to solve differential equations and is currently housed at the Cambridge Museum of Technology.

(ii) Higher resolution.
(iii) Greater speed.
(iv) No parallax errors.
(v) Reduced human error.
(vi) Compatibility with other digital equipments.

Above reasons made the modern world, the world of digital electronics.

The digital electronics, based devices are used all over the world in every field of life. E.g. mobile phones, LED, LCD, laptops, watches, calculators, cathode-ray oscilloscopes, digital balances, sensors, alarms, digital versatile discs (DVD's), amplifiers, in telecommunication, MP3 player.

## 17.2 "COMPUTERS" THE FOREFRONT OF ELECTRONIC TECHNOLOGY:

Electronic technology is improving day-by-day. Electronic devices are proving more efficient, accurate, fast, less costly, flexible, portable and smaller in size with time. There are advancements in electronic technology in every field but computers can be regarded as the fore front (i.e. the most prominent part of electronic technology). Because computers are the most simple and accurate electronic machines that can receive data from many input devices, process this data and produce the results in desired format. They can also store data. The powerful flexible computers available now a day have revolutionized modern life in many different ways. Computers are the basic need of the everyday life. Computers are used almost everywhere for various purposes.

For example: Computers are used in industries, offices, research organizations, educational institutes, shopping malls, business, home, hospitals etc, for designing, storing data, solving research problems, study, graphics, billing, keeping trade records, communication, playing games and much more.

In 1980's a mainframe computer occupies a room is now may be a desktop, a laptop or a tablet computer. So, with the passage of time the speed of computer increased and its size is reduced. Computer with internet is now becomes the most powerful tool of communication which transfers required data within seconds from one part of the world to other. Thus computer is the forefront of electronic technology which is making the world into a global village. With the growing advancement in electronic technology, one day it might be possible to dispense keyboard of a computer altogether and instead just talk to computer.

## 17.3 ADVANCEMENT FROM LOW-TECH ELECTRICAL TO HIGH-TECH ELECTRIC APPLIANCES:

High-tech is abbreviated from High technology. A high technology is the most advanced technology available. The Low-tech is abbreviated from Low technology. A low technology is opposite of high technology. The low technology refers to simple, often traditional or not advanced technology.

Fig: 17.4.
A low-tech (analogue) computer

The use of digital electronics (technology) enters into new era. This shifts the world from low-tech electrical appliances to high-tech electronic appliances. This happens due to the following reasons that the digital appliances are more efficient, accurate. They are flexible, compact and easy to use. These appliances have negligible power losses. They consume less energy.

There are many examples in our daily life like:

- The field of data storage is improved a lot. The images recorded in digital camera can be transferred to computer where they can be edited easily.
- The record of a person such as ID card, passport, driving license, insurance card, health card and biometric data (voice scan or eye-retina scan) can all be stored on a single tiny chip.

Fig: 17.5.
A high-tech (digital) computer

The way of communication has changed drastically. For example, the telephone signals which were transmitted electrically through copper wires are now transmitted digitally (as light) through optical fibers.
Digital television gives excellent picture and sound.

Equipments used in film industry for recording were camera, sound recorder, audio visual recording tape etc. These recording equipments are now replaced by digital cameras. Digital camera can perform all these operations with better resolution and accuracy.

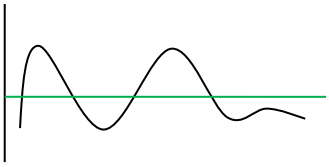


Fig: 17.6.
Analog signal

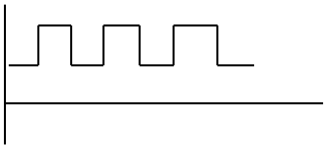


Fig: 17.7.
Digital signal

Fig: 17.8.
Different analogue and digital devices

## 17.4 DIFFERENCE BETWEEN ANALOGUE AND DIGITAL ELECTRONICS:

Electronics can be divided into two categories:

1. Analogue electronics.
2. Digital electronics.

First we understand the differences between analogue and digital electronics by their signals and examples from daily life, then we will differentiate them by their properties:

Analogue electronics deals with circuits which have continuously varying signals. For example; radio, television, oscillator etc.

An analogue signal is shown below:

The term “digital” derived from a Latin word “Digitus” means for fingers. This is because fingers are usually used for discrete counting.

Thus digital electronics deals with circuits which have discrete signals. For example computers, calculators, MP3 players etc.

A digital signal is shown below:

The differences between analogue and digital electronics can be summarized in the table below:

| S. No. | Analogue Electronics | Digital Electronics |
|---|---|---|
| 1. | Measures continuously varying quantities. | Measures discrete as well as continuously varying quantities. |
| 2. | Analogue signals are in the form of a wave. | Digital signals are in the form of 0's and 1's. These two levels can be joined to form a square wave. |
| 3. | Data can not be stored closely (compactly). | Data can be stored more closely (compactly) like in CD's. |
| 4. | Analogue signals are very much affected by noise (the unwanted voltage fluctuations). | Digital signals are almost not affected by noise (the unwanted voltage fluctuations). |
| 5. | Analogue data can be transmitted less efficiently and reliably. | Digital data can be transmitted more efficiently and reliably. |
| 6. | Amplified analogue signal does have noise. | Amplified digital signal almost do not have noise. |
| 7. | Analogue devices have high precession. | Digital devices have very high precession. |
| 8. | Examples of analogue devices includes ordinary air thermometer, the barometer, the speedometer, vehicles, the mechanical watches etc. | Examples of digital devices includes computers, calculators, watches, MP3 players, DVD's, laptops, sensors, biometric machines, chip in ID cards etc. |

**Weblinks**

Encourage students to visit below link for Digital vs Analog Why does it matter?

https://www.youtube.com/watch?v=ZWdT-6Ld71Q&ab_channel=BasicsExplained%2CH3Vtux

**Weblinks**

Encourage students to visit below link for Difference between Analog and Digital Signals

https://www.youtube.com/watch?v=WxJKXGugfh8&ab_channel=AddOhms

Both analogue and digital electronics are used in many devices. Compact disc (CD) player is an example of it. The basic principle of a CD player is shown in the following simplified block diagram:

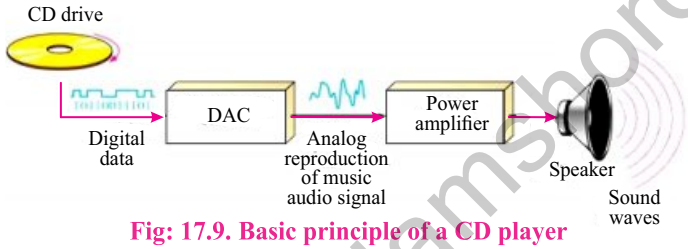



Fig: 17.9. Basic principle of a CD player

Music stored on a compact disc in digital form. An optical system picks up this data and transfers it to the digital-to-analogue converter (DAC). The DAC changes this digital data into an analogue signal (The original music). This analogue signal is amplified by a linear amplifier and sent to speaker for us to listen. The reverse process to the above process was used when the music was originally recorded on the CD, using an analogue to digital converter (ADC). A diagram of an analogue to digital convertor (ADC) is shown in figure 17.10.

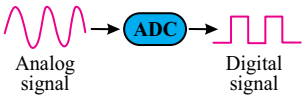



Fig: 17.10.
Diagram of Analog to digital converter

**Self Assessment Questions:**

Q1: Write the names of any three analogue devices.
Q2: Define the term "High-tech"?
Q3: Write the names of any three digital devices.

## 17.5 THERMIONIC EMISSION

As we know that the metals are good conductors of electricity because they have free electrons. These electrons can easily move through the metal. If energy is supplied to these electrons they may leave the surface of metal.

The ordinary bulbs have tungsten filament. If, this tungsten filament is heated to a temperature of about two thousand degree centigrade (2000°C). Then, some of the electrons in the tungsten gain enough energy to escape from its surface. This effect is called "thermionic emission". Thus:

Thermionic emission is the emission of electrons from a hot metal surface.

Fig: 17.11.
An ordinary bulb

**Do You Know!**

Thermionic emission is like evaporation of molecules from a liquid surface.

### Demonstration of thermionic emission:

The thermionic emission effect is demonstrated below by an experiment. The figure 17.10. shows this experiment.

The vacuum tube shown in above figure is called a thermionic diode. This vacuum tube consists of two electrodes called the anode and the cathode.

The anode is positively charged so attracts negative charges (electrons).

The cathode is negatively charged so repels negative charges (electrons).

The cathode shown is made up of tungsten filament. Normally the gap between cathode and anode cannot be crossed by the electrons when the filament is switched OFF. As the filament is switched ON, the electrons escape from the hot tungsten surface. These electrons are attracted across to the anode. Hence thermionic emission occurs.
Note that if air is in the tube instead of having vacuum in it, thermionic emission still occurs.

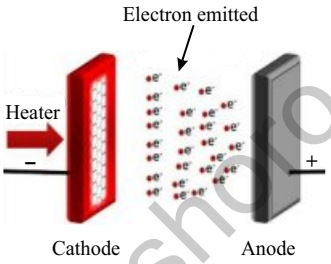



**Fig: 17.12.**
**Model for thermionic emission**

**Self Assessment Questions:**

Q1: What is meant by thermionic emission?
Q2: What particles are released by thermionic emission?
Q3: Why cathode must be heated?

**Do You Know!**

An electron microscope gives a three dimensional image of a very minute object by using narrow beam of electrons rather than light.

## 17.6 ELECTRON GUN AND CATHODE RAYS

The beam of fast moving electrons is called cathode rays. The filament of a bulb does not produce continuous flow of electrons. Since electrons are much smaller than the gas particles in the bulb. Therefore when electrons collide with gas particles they lose energy. As a result electrons do not travel very far continuously.

An electron gun made the electrons to travel in straight lines like a beam called “Cathode rays”. These invisible rays were coming to found from the cathode. This leads to discovery of electron. These rays have following characteristics:

They transfer negative charge (electrons).
They transfer energy.
They transfer mass.
They transfer momentum.

Their charge to mass ratio (e/m) is much larger than Hydrogen ion.

Their properties are independent of the choice of gas in the tube and also the metal used as cathode.

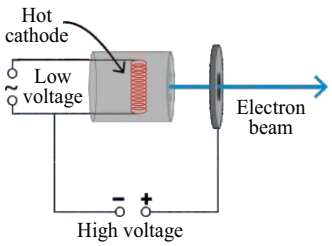



**Fig: 17.13.**
**An electron gun**

### An electron gun as a source of electron beam:

The production of an electron beam by electron gun is shown in figure 17.13.

The above figure shows that an electron gun is used to produce a continuous flow of electrons. The electrons are emitted from the hot filament. The cathode is a metal plate warmed by the filament. The cathode is held at a negative potential compared with the anode. The anode is held at high positive potential. The difference of potential between cathode and anode is about thousands of volts. The electrons emitted from the hot filament are then accelerated by this large potential difference between cathode and anode. This produces fast moving electrons. As the electrons are negatively charged therefore they are repelled by cathode and attracted towards anode. So the electrons are not slowed down by colliding with air molecules. Hence a beam of fast moving electrons is produced. The electron gun is placed inside a sealed glass tube called vacuum tube because most of the air is removed from the tube. The fast moving e beams produced by electron gun are used in TV monitors, cathode ray oscilloscopes, electron microscopes and in some other devices.

**Do You Know!**

Modern color TVS have three electron guns. Each gun produces separate beam for each of the three primary colors produced on the screen.

**Self Assessment Questions:**

Q1: Who made the electrons to travel in straight lines like a beam?

Q2: Define cathode rays.

Q3: Which one is held at high positive potential the cathode or the anode?

## 17.7 DEFLECTION OF ELECTRON BY ELECTRIC FIELD

Electrons can be deflected by electric fields. The diagram given 17.14. shows the deflection of an electron passing through a uniform electric field at 90° to the direction of motion of electron.

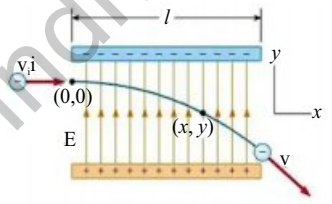



**Fig: 17.14.**
**Deflection of electron passing through uniform electric field**

This field is generated by parallel charged plates. The two plates are oppositely charged. Force acting on electron is constant and towards the positive plate as a result electron follows a curved path towards the positive plate.

**Effect of electric field on an electron beam:**

The beam of electron produced by the electron gun can be directed to a specific target. This could be done efficiently by:

(i) Keeping the gun itself remains fixed.

(ii) The beam of electrons to be deflected after it has been produced.

This could be done by deflecting the beam of electrons by an electric field. This field is provided by two oppositely charged metal plates. The deflection pattern of an electron beam is same to that of a single electron as discussed earlier. The effects of deflection of electron beam by an electric field are:

(i) The beam bends and changes direction.

(ii) The beam follows a parabolic (curved) path in the electric field.

(iii) The beam of electron changes direction millions of times each second.

(iv) The energy and speed of electron beam increases.

(v) The beam continues to move in a straight line after passing through the electric field.

The deflection of electron beam by electric field is shown in figure 17.15.

**Self Assessment Questions:**

Q1: How many times the beam of electron changes direction when it passes through an electric field?

Q2: What happens to the energy and speed of an electron beam when it passes through an electric field?

Q3: Describe the path of an electron in an electric field?

**Do You Know!**

The motion of an electron in an electric field is like the motion of a projectile in a gravitational field.

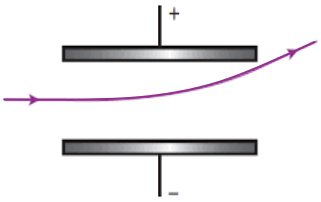



**Fig: 17.15.**
**Deflection of electron beam**

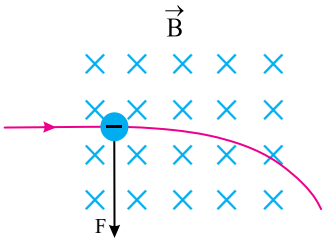



Fig: 17.16.
Deflection of electron passing through uniform magnetic field

## 17.8 DEFLECTION OF ELECTRON BY MAGNETIC FIELD

Electrons can be deflected by magnetic fields. The diagram given 17.16. shows the deflection of an electron passing through a uniform magnetic field acting at 90° to the direction of motion of electron.

This field is generated by passing a current through a pair of plates (coils). In the above figure the field is shown by "×" sign. This means that the field lines are perpendicular to the page and are directed into the page. This produces a force that acts at right angles to the direction of motion of electron. If the field direction is reversed, the force direction also reversed. The direction of the force can be found by Fleming's left hand rule (Note that conventional current direction is opposite to that of electron flow). The electron changes direction and bends. Because the force acts at right angles to the direction of motion of electron, the electron will move in a circular path.

**Effect of magnetic field on an electron beam:**

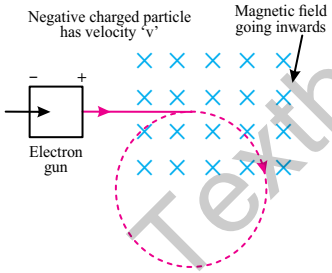



Fig: 17.17.
Effect of magnetic field

The path of a beam of electrons which enters in a magnetic field acting perpendicular to the direction of motion is shown in figure 17.17.

The effects of deflection of electron beam by a magnetic field are:

(i) The beam bends and changes direction.
(ii) The beam follows a circular path in the magnetic field.
(iii) The energy of electron beam does not change in the magnetic field.
(iv) The speed of electron beam does not change in a magnetic field.

**Self Assessment Questions:**

Q1: Describe the path of an electron in a magnetic field?
Q2: Which rule is used to find the direction of the force in a magnetic field?
Q3: What happens to the speed of an electron beam as it passes through a magnetic field?

## 17.9 CATHODE-RAY OSCILLOSCOPE (CRO)

A Cathode-ray oscilloscope (CRO) is generally referred to as oscilloscope or scope. It can display and also measure many electrical quantities like ac/dc voltages, frequency etc. It is called a cathode ray oscilloscope because it traces a required wave-form with a beam of electrons called cathode rays. A cathode-ray oscilloscope (CRO) is used to observe the voltage waveforms of a transformer. A cathode-ray oscilloscope is used to display traces showing how a voltage varies with time. For example, the varying voltage produced by a microphone when it detects sound waves.

### Basic principle of Cathode-ray oscilloscope (CRO)

A cathode ray oscilloscope consists of different components. The main component of a cathode-ray oscilloscope (CRO) is a cathode-ray tube. A cathode-ray tube is shown in figure 17.19.

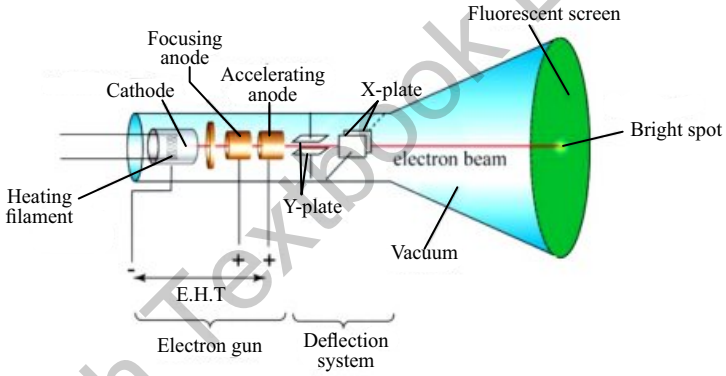



Fig: 17.19 Diagram of CRO

### Working:

- The electron gun emits a beam of electrons (i.e. cathode-ray) which is produced by the cathode.
- When this electron beam strikes the fluorescent screen a bright spot is created on the screen. This is due to the reason that the fluorescent screen is coated with a fluorescent salt such as zinc sulfide, a chemical that glows when electrons strike it.

**Do You Know!**

Fleming's left hand rule

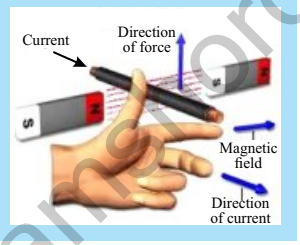
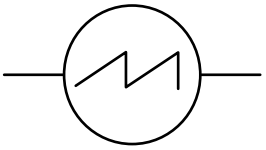



Fig: 17.18. Oscilloscope



The symbol of CRO

**Do You Know!**

Before LED and LCD, televisions were inverted, they contained cathode-ray tubes and hence they were assembled in lage boxes.

- The electron gun consists of a grid which is connected to (-ve) potential. It repels the electrons and therefore controls the number of electrons reaching to anode and screen. Thus it controls the brightness of the spot on the screen.
- The anode at (+ve) potential and is used to accelerate the electrons and to focus them into a fine beam.
- The deflecting system consists of X- plates and Y-plates to move the spot on the screen. If it moves fast enough it appears as a line.
- Y-plates cause deflection in vertical direction (up and down) when voltage is applied across them. The vertical deflection of the electron beam can be changed by varying the voltage across the Y- plates.
- X-plates cause deflection in horizontal direction (left and right) when voltage is applied across them. The horizontal deflection of the electron beam can be changed by varying the voltage across the X- plates.

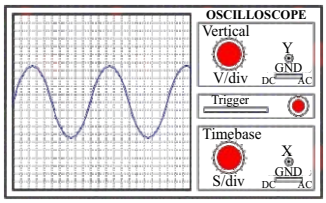



**Fig: 17.20.**
**Front panel of CRO**

The figure 17.20. shows the front panel of a CRO with the understanding of the important terminals to be used.

The following are the four important controls on an oscilloscope.

1. X-shift
2. Y-shift
3. Time base
4. Y-gain

- X-shift control moves the trace from the left or right of the screen to the centre of the screen.
- Y-shift control moves the trace from the top or bottom of the screen to the centre of the screen. The vertical deflection of the electron beam can be changed by varying the voltage across the Y- plates.
- Vertical deflection (Y-gain) of the electron beam can be amplified by using this control. This is done by varying the voltage applied across the Y-plates of cathode-ray tube. An amplifier circuit amplifies the voltage across the Y-plates in the cathode-ray oscilloscope.

**Weblinks**

Encourage students to visit below link for Cathode ray oscilloscope

https://www.youtube.com/watch?v=9scohkuTG88&ab_channel=myhometuition

- Time base: Horizontal (X) speed of the electron beam on the screen can be adjusted by using this control. This is done by varying the voltage applied across the X-plates of cathode-ray tube. The frequency of the time base is varied by an internal circuit in the cathode-ray oscilloscope which applies an alternating voltage across the X-plates. The time-base actually applies a saw tooth voltage to the X-plates is shown in figure 17.21.

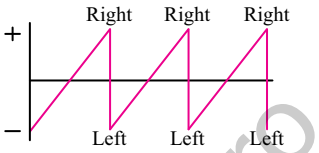



Fig: 17.21.

**Uses of the CRO:**

The voltage to be measured is connected to the Y-input of the oscilloscope. Two things to be remember.

1. Y-axis is used to measure the voltage.
2. X-axis is used to measure the time.

So, the display on a cathode-ray oscilloscope screen is a graph of voltage against time. Some of the important uses of cathode-ray oscilloscope are given below:

1. Measuring voltage
2. Displaying voltage waveforms
3. Measuring short intervals of time

**Self Assessment Questions:**

Q1: Which axis is used to measure the voltage?
Q2: What is the function of X-shift?
Q3: Which is the main component of a cathode-ray oscilloscope?

**Weblinks**

Encourage students to visit below link for How to use CRO to measure Amplitude and Frequency

https://www.youtube.com/watch?v=kh-oIlf4e3Y&ab_channel=TechnicalKnowledgeinElectr

## 17.10 ANALOGUE AND DIGITAL ELECTRONICS

Analogue electronics deals with the continuously varying quantities. Analogue electronics possesses the data being provided in the form of continuously varying quantities (continuous signals).

Digital electronics deals with the discretely varying quantities. Digital electronics possesses the data being provided in the form of digits (discrete signals).

**Basic operations of digital electronics:**

Digital electronics based devices uses discrete signals. A digital signal represents two opposite states. These signals either represents a (ON, OFF, HIGH, LOW, OPEN, CLOSE, UPPER, LOWER, PLUS, MINUS, TRUE, FALSE, MAX, MIN) states of a system. There is no

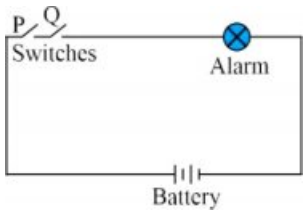



**Fig: 17.22.**
**Diagram of security alarm**

intermediate state is possible (allowed). For example, a block diagram of a security alarm which operates through two switches is shown in figure 17.22.

It can be seen clearly from the above diagram that:

- If either switch "P" or "Q" is OFF, the alarm will remain OFF (quite).
- If both switches "P" and "Q" are ON, the alarm will be ON (ringing).

This example could be demonstrated by the following table:

| Switch "p" | Switch "q" | Alarm status |
|---|---|---|
| OFF | OFF | Quite |
| ON | OFF | Quite |
| OFF | ON | Quite |
| ON | ON | Ringing |

The above table represents the logic behind the working of the alarm. In digital electronics, this logic is implemented by **"LOGIC GATES"**.

**Do You Know!**

A digital MP3 player is on example of a device that uses digital electronics.

**Self Assessment Questions:**

Q1: Which types of signals are used by digital electronics based devices?
Q2: Which component implements the logic?
Q3: A digital signal has how many states?

## 17.11 LOGIC GATES

The logic gate is the basic unit of digital logic circuits, there are mainly three basic gates AND, OR, and NOT and these logical gates perform AND, OR, and NOT operations in the digital system.

### AND Gate:

An AND gate is a digital circuit that has two or more inputs and a single output. AND gate operates on logical multiplication rules. AND operation using variables A and B is represented "A.B", here (.) dot is a

logical multiplication sign. Boolean Expression of AND gate: Y=A.B

| Truth table of AND operation using two input variables | | |
|---|---|---|
| A | B | Y = A . B |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

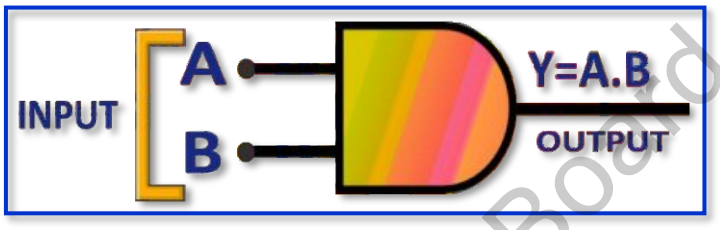



Fig: 17.23 AND Gate using two input variables

Truth Table of AND gate using three input variables A, B, C, and output is Y. If any input is 0, then output Y becomes 0. If all inputs are 1 then output Y becomes 1.

Boolean expression of AND gate is Y=A.B.C

| Truth table of AND operation using three input variables | | | |
|---|---|---|---|
| A | B | C | Y = A.B.C |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

**Do You Know!**

The truth table is the table that represents the input and output circuit involving two or more variables. The logic circuit's output depends on the logical signals (0 & 1)present at the inputs.

**Weblinks**

Encourage students to visit below link for The AND gate

https://www.youtube.com/watch?v=oRiWUZRUyKo&ab_channel=EarthPen

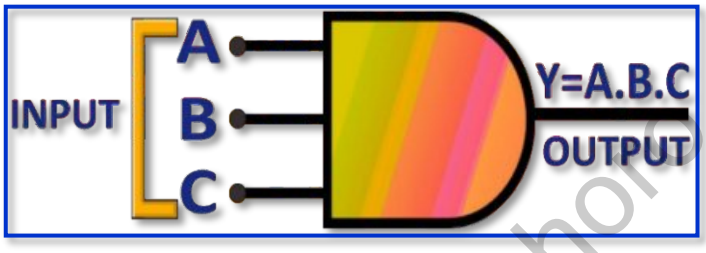



Fig: 17.24 AND Gate using three input variables

## OR Gate:

An OR gate is a digital circuit that has two or more inputs and produces a single output. which is the logical OR of all those inputs. The logical OR is represented with the symbol "+". An OR gate operates on logical Addition rules.

Boolean Expression of OR gate: Y=A+B

**Weblinks**

Encourage students to visit below link for OR gate operations

https://www.youtube.com/watch?v=XLSsEKl-g7A&ab_channel=Physics4students

| Truth table of OR gate operation using two input variables | | |
|---|---|---|
| **A** | **B** | **Y = A + B** |
| **0** | **0** | **0** |
| **0** | **1** | **1** |
| **1** | **0** | **1** |
| **1** | **1** | **1** |

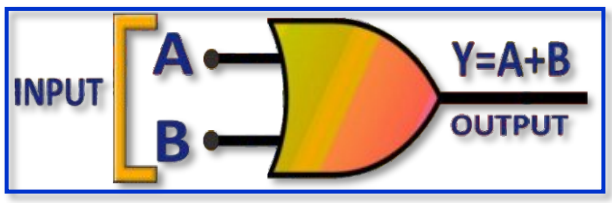



Fig: 17.25 OR Gate using two input variables

Truth Table of OR gate using three input variables A, B, C and output is Y. If any input is 1 then output Y becomes 1 and if all inputs are 0 then ouput Y becomes 0.

Boolean expression of OR gate is Y=A+B+C

| Truth table of OR operation using three input variables | | | |
|---|---|---|---|
| A | B | C | Y = A+B+C |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

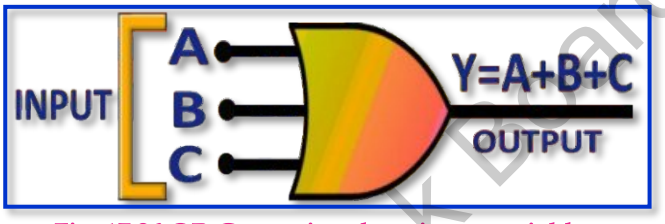



Fig: 17.26 OR Gate using three input variables

**Do You Know!**

A logical statement that results in form of a digital value, either be True or False, is called a Boolean expression.

## NOT Gate:

A NOT gate is a digital circuit that has a single input and a single output. It is also known as INVERTER. The NOT operates complement or invert of any input, it symbolized by complement sign (') Right side on top of the input variable or bar (-) sign on top of the variable.

Boolean expression is NOT gate: Y = A' **or** Y = $\overline{A}$

Truth table of NOT gate is A is input and Y = $\overline{A}$ is output.

| Truth table of NOT gate operation using two input variables | |
|---|---|
| A | Y = $\overline{A}$ |
| 0 | 1 |
| 1 | 0 |

**Weblinks**

Encourage students to visit below link for NOT gate

https://www.youtube.com/watch?v=C_NNbYNy-cw&ab_channel=EarthPen

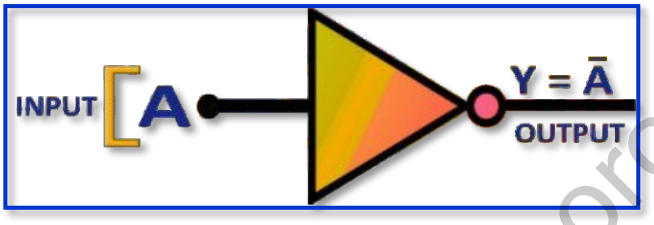



Fig: 17.27 NOT Gate

## NAND Gate:

A NAND Gate could construct by connecting a NOT Gate at the output terminal of the AND Gate. Boolean expression of NAND gate is Y= (A.B)' **or** $Y = \overline{AB}$.

The Truth table of the NAND gate shows A, B are the inputs and Y is the output. When both inputs are "1", the output, Y is "0". If any one of the inputs is "0", then the output Y is "1".

**Weblinks**

Encourage students to visit below link for NAND gate operation

https://www.youtube.com/watch?v=EUwjkBJPtuw&ab_channel=Electrical4U

| Truth table of NAND operation using two input variables | | |
|---|---|---|
| **A** | **B** | **$Y = \overline{AB}$** |
| **0** | **0** | **1** |
| **0** | **1** | **1** |
| **1** | **0** | **1** |
| **1** | **1** | **0** |

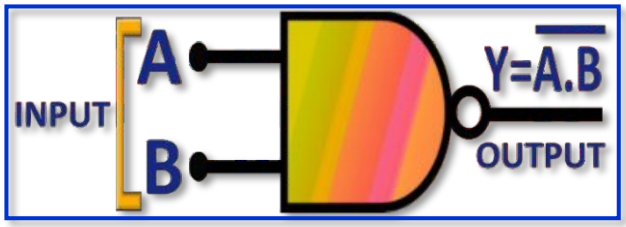



Fig: 17.28 NAND Gate

**Weblinks**

Encourage students to visit below link for NOR gate operation

https://www.youtube.com/watch?v=E3ry_j80AZA&ab_channel=Electrical4U

## NOR Gate:

A NOR Gate could construct by connecting a NOT Gate at the output terminal of the OR Gate. The Boolean expression of NOR gate is Y = (A+B)' **or** $Y = \overline{A + B}$.

The Truth table of the NOR gate shows A, B are the inputs and Y is the output. If both inputs are "0", then the output, Y is "1". If any one of the inputs is "1", then the output Y is "0".

| Truth table of NOR operation using two input variables | | |
|---|---|---|
| A | B | $Y = \overline{A + B}$ |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

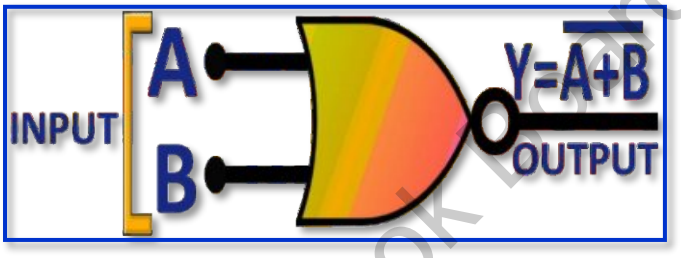



Fig: 17.29 NOR Gate

**Weblinks**

Encourage students to visit below link for Logic gates and its real-world applications

https://www.youtube.com/watch?v=Sb5iU5HDvRc&ab_channel=CognitiveLearners

## USE OF LOGIC GATES:

### A seat belt alarm system:

In Figure 17.30 , an AND gate is used in a simple automobile seat belt alarm system to detect when the ignition switch is on and the seat belt is unbuckled. If the ignition switch is on, a HIGH is produced on input A of the AND gate. If the seat belt is not properly buckled, a HIGH is produced on input B of the AND gate. Also, when the ignition switch is turned on, a timer is started that produces a HIGH on input C for 30 s. If all three conditions exist that is, if the ignition is on and the seat belt is unbuckled and the timer is running—the output of the AND gate is HIGH and an audible alarm is energized to remind the driver.

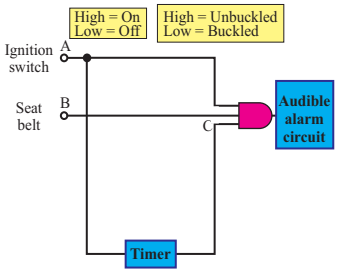



Fig: 17.30
A simple seat belt alarm circuit using an AND gate.

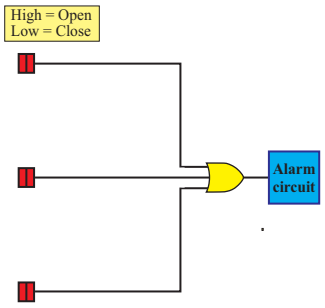



**Fig: 17.31**
**A simplified intrusion detection system using an OR gate.**

## Intrusion detection and alarm system:

A simplified portion of an intrusion detection and alarm system is shown in Figure 17.31. This system could be used for one room in a home a room with two windows and a door. The sensors are magnetic switches that produce a HIGH output when open and a LOW output when closed. As long as the windows and the door are secured, the switches are closed and all three of the OR gate inputs are LOW. When one of the windows or the door is opened, a HIGH is produced on that input to the OR gate and the gate output goes HIGH. It then activates and latches an alarm circuit to warn of the intrusion.

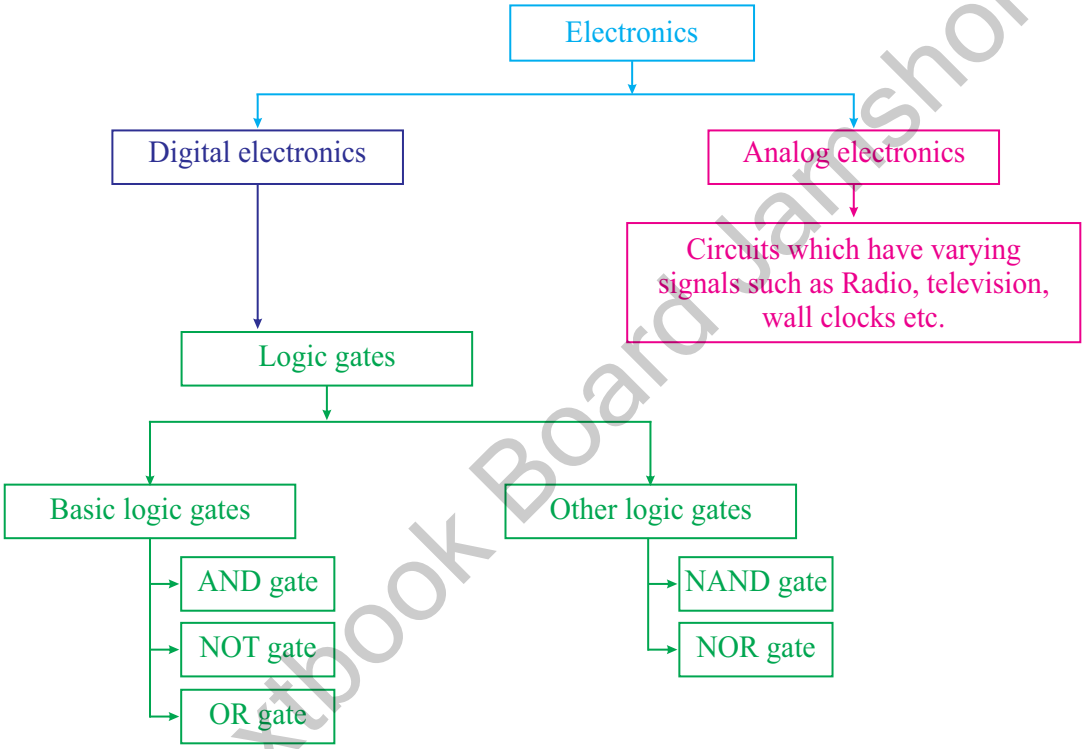
## Self Assessment Questions:

Q1: What is a logic gate?
Q2: Which gate is used to invert the input?
Q3: Write the Boolean expression of an OR gate?

## SUMMARY

- Electronics comprises the physics, engineering and technology.
- Electronics has applications that deal with the emission, flow and control of electrons in vacuum and matter using different devices.
- Analogue are those quantities which change continuously with time.
- Digital are those quantities which change discretely (in steps) with time.
- Analogue electronics possesses the data being provided in the form of continuously varying quantities (continuous signals).
- Digital electronics possesses the data being provided in the form of digits (discrete signals).
- Thermionic emission is the emission of electrons from a hot metal surface.
- An electron gun made the electrons to travel in straight lines like a beam.
- Electrons and their beams can be deflected by electric fields.
- Electrons and their beams can be deflected by magnetic fields.
- The Cathode-ray oscilloscope is an electronic device which can be used to measure voltages, study wave forms and measure short intervals of time.
- Cathode rays are beam of electrons that are produced by thermionic emission in a vacuum tube.
- Cathode rays can be deflected by electric and magnetic fields.
- Logic gates are used to implement the logic.
- There are different types of logic gates, like NOT, OR, AND, NOR and NAND gates.
- A truth table gives all the possible inputs and outputs of a logic circuit.

## CONCEPT MAP

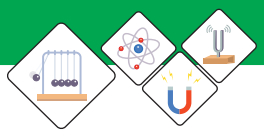


## Section (A) Multiple Choice Questions (MCQs)

1. Metals are good conductors of electricity because they have free:
   (a) Electrons (b) Protons (c) Neutrons (d) Photons
2. The continuous flow of electrons is made possible by a device called:
   (a) Cathode (b) Electron gun (c) Anode (d) Filament
3. The electric field can be detect:
   (a) Photon (b) Neutron (c) Proton (d) Electron
4. If the direction of magnetic field is reversed, the direction of force is:
   (a) Reversed (b) Not reversed (c) May or may not reversed (d) None of these
5. The process of emission of electrons from the hot metal surfaces is called
   (a) Plastic emission (b) Thermionic emission
   (c) Static emission (d) Current emission
6. If input of a NOT gate is "1" then its output is:
   (a) 1 (b) 0 (c) may be 1 or may be 0 (d) None of these
7. The Boolean expression of an AND gate is:
   (a) A . B (b) A + B (c) A × B (d) None of these.
8. Electronics comprises the:
   (a) Physics (b) Engineering (c) Technology (d) All of these
9. The Boolean expression of an OR gate is:
   (a) A . B (b) A + B (c) A × B (d) None of these.
10. The cathode ray carry
    (a) positive charge (b) neutral (c) negative charge (d) positrons

## Section (B) Structured Questions

1. Give an example showing that the world is shifting from low-tech electrical appliances to high-tech electronic appliances
2. (a) Write any three advantages of Digital electronics (devices) over analogue electronics devices.
   (b) Define the role of vacuum tube in electronics.
3. What is the function of a 'DAC'?
4. What makes the cathode give off electrons?
5. (a) Demonstrate the process of thermionic emission by diagram?
   (b) Will the process of thermionic emission still occurs, if air is in the tube instead of having vacuum in it?
6. Why the cathode repel electrons?
7. Write any two properties of cathode rays.



8. (a) Will there be any change in the properties of cathode rays if the gas in the tube is changed?
   (b) Will there be any change in the properties of cathode rays if the metal used as cathode is changed?
   (c) Name any two devices that uses an electron beam?
   (d) Cathode rays lead the discovery of which particle?
9. State and explain the phenomenon of the production of an electron beam by an electron gun?
10. Is there any change occurs in the direction of an electron beam when it passes through an electric field. Explain?
11. How the beam of electron produced by the electron gun can be directed to a specific target?
12. Demonstrate by a diagram the deflection of electron beam by an electric field.
13. (a) What happens to the energy of electron beam when it passes through a magnetic field?
    (b)Is there any change in the speed of electron beam as it passes through a magnetic field.
14. Give any three effects of deflection of electron beam by a magnetic field.
15. Explain the function of following parts of a cathode-ray oscilloscope.
    (a) The fluorescent screen.
    (b) The cathode.
    (c) The anode.
    (d) The Y-plate.
16. Explain how the beam of electrons is produced inside the cathode-ray oscilloscope.
17. Explain what makes the electrons accelerate from the cathode towards the anode?
18. (a) Explain the term "LOGIC" by giving a suitable example?
    (b) Name the component which implements logic in digital electronics.
19. Explain is there any intermediate state possible?
20. (a) Give the symbol of a NAND gate.
    (b) Give the truth table for AND gate.
21. (a) Describe the logic operation of an inverter?
    (b) Produce the truth table for an OR gate?
22. (a) Which two logic gates will give an output of 1 with inputs of 1 and 0 ?
    (b) Give the symbol of a NOR gate?
    (c) Give the truth table of a NOR gate?