



Chapter # 16

Basic Electronics

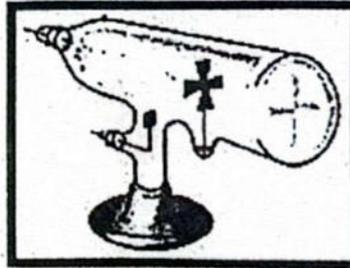


Q1. Define electronics.

Ans: Electronics:

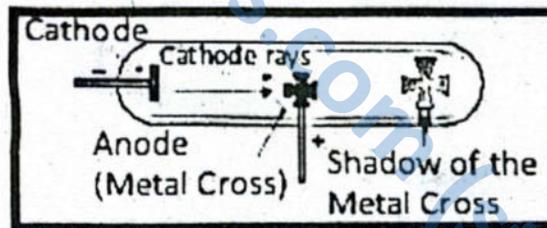
Electronics is that branch of applied physics which deals with behaviour of electrons using different devices for various useful purposes.

For Your Information



In a cathode-rays tube, a greenish glow is formed on the inner surface of the glass opposite the cathode, which itself is glowing orange here. The shadow cast by the cross at the centre of the tube gives evidence that rays of some kind are passing through the tube.

Physics Insight



When an opaque object like a metal cross is placed in the path of cathode rays in a cathode-ray tube, a shadow of the metal cross is formed at the end opposite to the cathode. This is an evidence that rays of some kind are passing straight through the tube.

Q2. What do you understand by cathode rays?

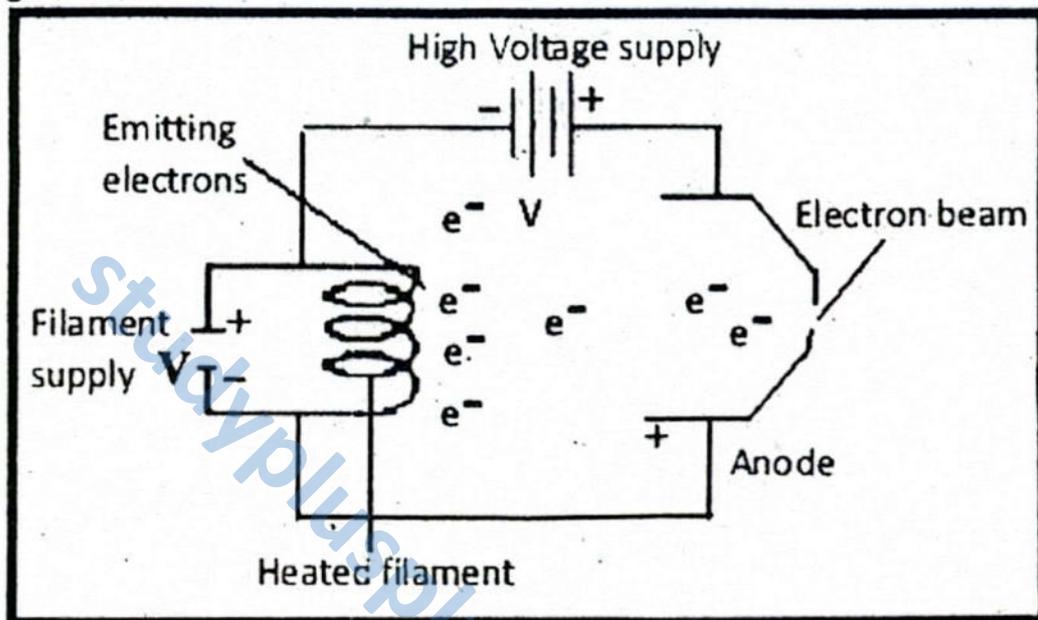
Ans: Cathode Rays:

In 1850's physicists started to examine the passage of electricity through a vacuum by putting two electrodes in a sealed vacuum tube. Some kind of rays was emitted from the cathode or the negative electrode. These rays were called cathode rays. J.J. Thomson in 1897 observed the deflection of cathode rays by both electric and magnetic fields. From these deflection experiments, he concluded the cathode rays must carry a negative charge. These negatively charged particles were given the name electrons.

Q3. How electron gun is used to investigate the properties of electron beam?

Ans: Investigating the Properties of Electrons:

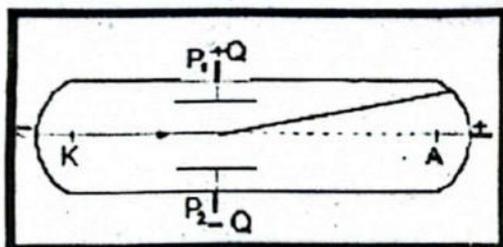
Electron gun is used to investigate the properties of electron beam. The electrons are produced by thermionic emission from a tungsten filament heated by 6 V supply. A high positive potential (several thousands) is applied to a cylindrical anode (+). The electrons are accelerated to a high speed and pass through the hole of the anode in the form of a fine beam of electrons. The whole set up is fitted in an evacuated glass bulb.



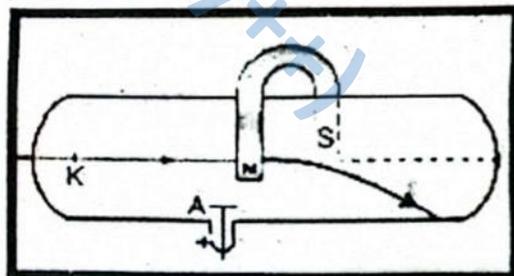
Electron gun

Deflection of electrons by electric field:

We can set up electric field by applying a potential difference across two parallel metal plates placed horizontally separated with some distance. When an electron beam passes between the two plates, it can be seen that the electrons are deflected towards the positive plate. The reason for this is that electrons are attracted by the positive charges and repelled by the negative charges due to force $F = qE$, where q is the electron charge and E is the electric field due to plates. The degree of deflection of electrons from their original direction is proportional to the strength of the electric field applied.



Deflection of Cathode Rays by an electric field

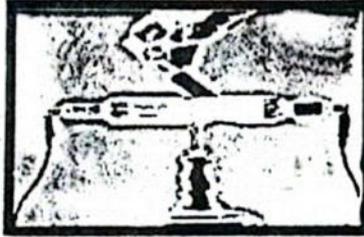


Deflection of Cathode Rays by a magnetic field

Deflection of electrons by magnetic field:

Now we apply magnetic field at right angle to the beam of electrons by using a horse shoe magnet. We will notice that the spot of the electrons beam on screen is getting deflected from its original direction.

Do You Know?



A cathode ray will deflect as shown when it is under the influence of an external magnetic field.

Now change the direction of the horse shoe magnet. We will see that spot on the fluorescent screen is getting deflected in the opposite direction.

Q4. What is the function of filament?

Ans: The filament, a tiny tungsten which is heated by current, gives off electrons due to heat generated by an electric current.

Q5. What is the function of grid?

Ans: The grid controls the brightness. When the grid is made negative it pushes back some electrons so that fewer of them reach the screen.

Q6. What is the function of anode?

Ans: The anode accelerate electrons toward the screen.

Q7. What is the function of the electron-gun?

Ans: The electron gun makes a narrow beam of electrons. Its cathode gives off electrons and the anode accelerate them.

Q8. What is the function of X-plates?

Ans: The X-plates are used to move the electrons beam across the x-axis of the screen.

Q9. What is the function of Y-plates?

Ans: The Y-plates are used to move the electrons beam up and down the screen along the y-axis of the screen. When an AC signal is placed at the Y-plates, they move the beam up and down resulting in a moving spot on the screen. So, by these plates we can draw the variations of an electrical signal with respect to time.

Q10. What is the function of fluorescent screen?

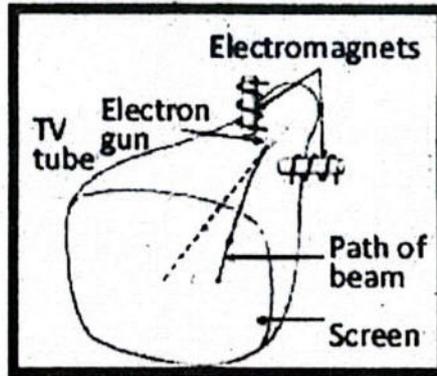
Ans: The screen is coated in a fluorescent material. It shows a bright spot where the electron beams strikes it. The screen also is divided into 1 cm squares. Each square is called a division. The horizontal divisions represent units of time set by the time base and the vertical divisions represent the gain in units of volts set by the gain-control of the oscilloscope.

Point to Ponder

When a magnet is brought near to the screen of a television tube, picture on the screen is distorted. Do you know why?

Ans: A magnet distorts the picture as it distorts the path of electrons flowing from the electron gun towards the screen inside the television. As electrons are negatively charged particles, their motion is distorted by a magnet. Therefore the picture on the screen is distorted.

Do You Know?



Electromagnets are used to deflect electrons to desired positions on the screen of a television tube.

Do You Know?

Cathode Rays:

The beam of electrons was called a cathode ray because the electron had not yet been discovered. The old terminology survives in electronic engineering where a cathode-ray tube is any tube constructed along Thomson's lines whether in a computer monitor, a television, or an oscilloscope.

Do You Know?

The glow in the tube is due to circular motion of electron in the magnetic field. The glow comes from the light emitted from the excitations of the gas atoms in the tube.

Q11. Name any five devices based upon analogue physical quantities?

Ans: Analogue physical quantities involve electric fan, refrigerators, iron, lamp, Loudspeaker and radio receivers.

Q12. Name any five devices based upon digital physical quantities?

Ans: The devices based upon digital physical electronics are computer, TV, security system, mobile phone, digital camera radar system, naval system, medical equipments etc.

Q13. What do you understand by analogue to digital converter (ADC)?

Ans: Analogue to Digital Converter (ADC):

In our daily life, the quantities that we perceive by our senses are usually analogue quantities, which cannot be processed by digital circuits. To overcome this problem, a special circuit has been designed which converts in binary form the analogue signal into a digital one in the form of digits in binary form. This circuit is known as analogue to digital converter (ADC). This binary output is then processed by a computer which also gives output in digital form.

Q14. What do you understand by digital to analogue converter (DAC)?

Ans: Digital to Analogue Converter (DAC):

The output of the computer is again converted into an analogue form by a circuit known as digital to analogue converter (DAC). As the output of DAC is an

analogue signal, it can be readily sensed by us. Thus, electronic systems used at present consist of both analogue and digital type circuits.

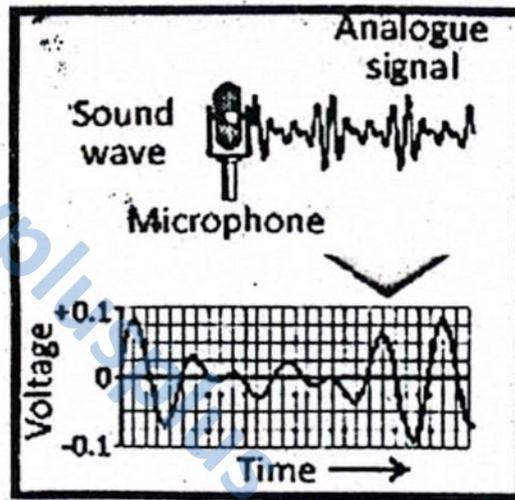
Q15. Explain the public address system is an analogue system.

Ans: Public Address System:

The public address system is an analogue system in which the microphone converts sound into a continuously varying electric potential. This potential is an analogue signal which is fed into an amplifier. Amplifier is an analogue circuit which amplifies the signal without changing its shape to such an extent that it can operate a loudspeaker. In this way loud sound is produced by the speaker.

Radios, televisions and telephones are a few common devices that process analogue signals.

Do You Know?



Microphone creates an analogue signal, shown by the voltage versus time graph.

For Your Information

Digital technology has entered every part of our lives. Digital TV gives excellent view and allows us to be interactive. Digital cameras are fast replacing traditional film equipment. We can download an image into a PC and crop, enhance, airbrush and edit the picture. Smart ID cards are being developed. A single card can be a passport, national insurance card and driving license all in one. The card could also hold biometric data like an eye retina scan and voice scan for unique identification and security. All of this data would be held digitally in the tiny chip.

Do You Know?

TV and telephone signals once travelled as analogue signals. Electrical signals in copper wires would interfere with each other and give poor quality sound and vision. Today, everything is going digital. The big advantage of digital is quality. There is no interference or loss of strength in digital signal travelling in an optical fibre.

Q16. Differentiate between digital and analog electronics.

Ans: Difference between digital and analog electronics:

	Analog	Digital
Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
Waves	Denoted by sine waves	Denoted by square waves
Representation	Uses continuous range of values to represent information	Uses discrete or discontinuous values to represent information
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs, and other digital electronic devices.
Technology	Analog technology records waveforms as they are.	Samples analog waveforms into a limited set of numbers and records them.
Data transmissions	Subjected to deterioration by noise during transmission and write/read cycle.	Can be noise-immune without deterioration during transmission and write/read cycle.
Response to Noise	More likely to get affected reducing accuracy	Less affected since noise response are analog in nature
Flexibility	Analog hardware is not flexible.	Digital hardware is flexible in implementation.
Uses	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Applications	Thermometer	PCs, PDAs
Bandwidth	Analog signal processing can be done in real time and consumes less bandwidth.	There is no guarantee that digital signal processing can be done in real time and consumes more bandwidth to carry out the same information.
Memory	Stored in the form of wave signal	Stored in the form of binary bit
Power	Analog instrument draws large power	Digital instrument draws only negligible power
Cost	Low cost and portable	Cost is high and not easily portable
Impedance	Low	High order of 100 mega ohm
Errors	Analog instruments usually have a scale which is cramped at lower end and give considerable observational errors.	Digital instruments are free from observational errors like parallax and approximation errors.

The algebra used to describe logic operations by symbols is called Boolean Algebra. Like ordinary algebra, English alphabets (A, B, C etc.) are used to represent the Boolean variables. However, Boolean variable can have only two values; 0 and 1. Digital circuits perform the binary arithmetic operations with binary digits 1 and 0. These operations are called logic function or logical operations.

Table 16.1

S	Lamp
Open	OFF
Closed	ON

Q17. What is Boolean algebra?

Ans: Boolean Algebra:

George Boole invented a special algebra called Boolean algebra also known algebra of logics. It is a branch of mathematics which deals the relationships of logic variables.

Boolean algebra handles variables that represent types of logic propositions: 'true' and 'false'.

Q18. What is Boolean constant?

Ans: Boolean constants:

In Boolean algebra a set of constants has only two elements 0 or 1. Thus a Boolean constant is either 0 if not 1 or is 1 if not 0.

Note: The potential of the output is either 'HIGH' (5 - 6V) or 'LOW (0 V)'.

Q19. What are logical operators?

Ans: Logical operators:

In Boolean algebra there are three basic operators NOT, AND and OR.

Q20. What is Boolean Expression?

Ans: Boolean expression:

An expression is a logical statement which is either true or false. These statements are represented by variables operated by logical operators.

Q21. What is truth table?

Ans: Truth table:

A truth table is a table that shows the result of a Boolean expression for all the possible combinations of the values given to the variables used.

Truth table is a table listing all possible combinations of input states and the corresponding output states.

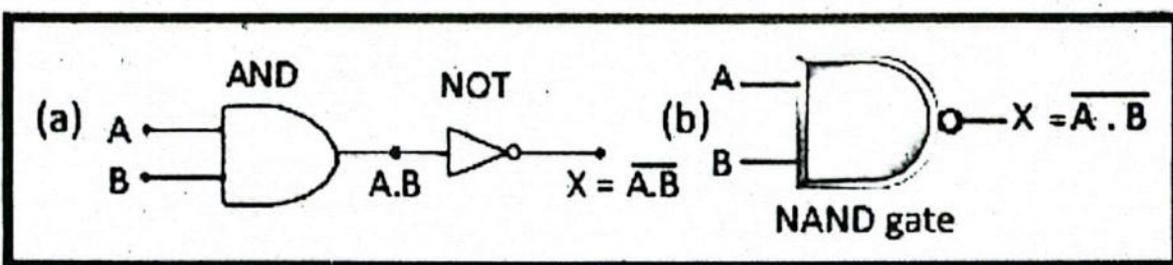
Q22. Describe NAND gate and draw its symbol and truth table?

Ans: NAND gate:

The combination of And gate with NOT gate is called NAND gate.

In NAND gate the output of AND gate is inverted. The bubble in this figure shows that the output of AND gate is inverted.

Symbol of NAND Gate:



Truth table for NAND Gate:

A	B	A . B	Out put = X = $\overline{A . B}$
0	0	0 . 0 = 0	$\overline{0} = 1$
0	1	0 . 1 = 0	$\overline{0} = 1$
1	0	1 . 0 = 0	$\overline{0} = 1$
1	1	1 . 1 = 1	$\overline{1} = 0$

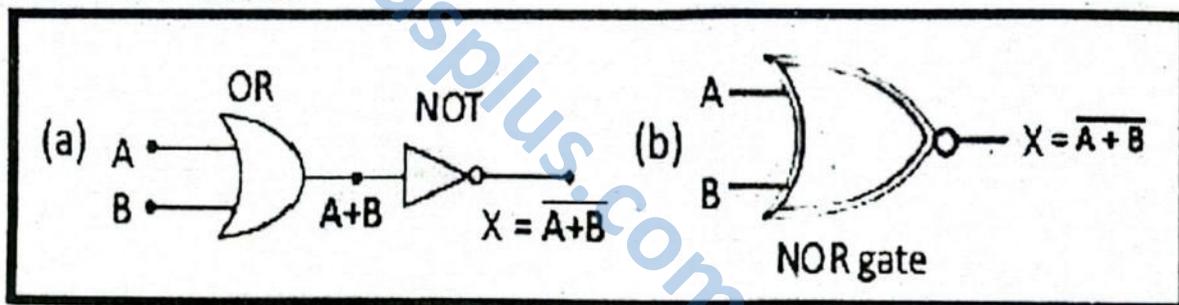
Note: The output is not high only if the input X and input Y are high.

Q23. Describe NOR gate and draw its symbol and truth table?

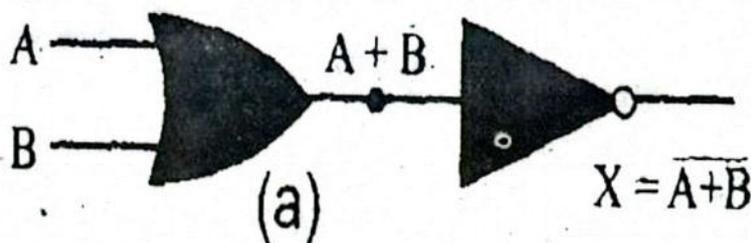
Ans: NOR Gate:

The combination of OR gate with NOT gate is called NOR gate. In NOR gate the output of OR gate is inverted.

Symbol of NOR Gate:



A	B	A + B	Out put = X = $\overline{A + B}$
0	0	0 + 0 = 0	$\overline{0} = 1$
0	1	0 + 1 = 1	$\overline{1} = 0$
1	0	1 + 0 = 1	$\overline{1} = 0$
1	1	1 + 1 = 1	$\overline{1} = 0$



In NOR gate the output of OR gate is coupled with a NOT gate. This NOT gate inverts the output $A + B$ of the OR gate, i.e., the output of the NOR gate is $\overline{A + B}$ which is expressed by the following equation $X = \overline{A + B}$

Note: The output is not high if either input X or input Y are high.

For Your Information

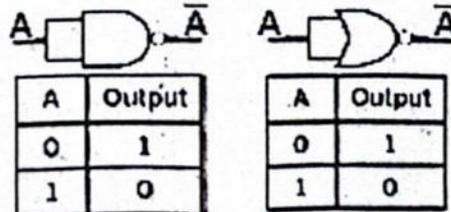
$$X = \overline{\overline{A}} = A$$

$$X = \overline{\overline{A+B}} = A+B$$

$$X = \overline{\overline{A \cdot B}} = A \cdot B$$

Here double line indicates double NOT operation.

For Your Information



Formation of NOT gate from NAND and NOR gates with the resultant truth tables.

Quick Quiz

Assume you have an OR gate with two inputs, A and B. Determine the output, C, for the following cases:

(a) $A = 1, B = 0$

(b) $A = 0, B = 1$

If either input is one, what is the output?

Ans: The value of output of OR gate will be '1' when one of its inputs is at '1'. The output will be '0', when both inputs are at '0'.

In both given cases (a) and (b) the value of output will be 1.

$1 + 0 = 1$ and $0 + 1 = 1$ also $1 + 1 = 1$

If either input is one then output is one.

Q24. Write down the uses of logic gates?

Ans: Uses of Logic Gates:

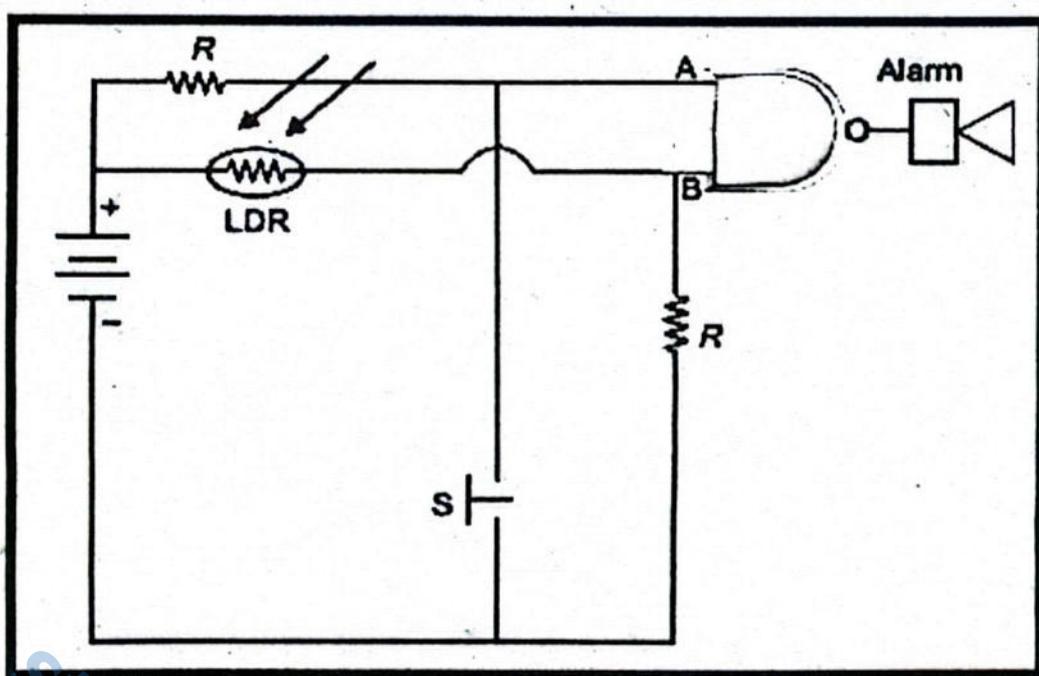
We can use logic gates in electronic circuits to do useful tasks.

i. Light depending resistors (LDRs):

These circuits usually use light depending resistors (LDRs) to keep inputs LOW. An LDR can act as a switch that is closed when illuminated by light and open in the dark.

ii. House Safety Alarm:

We can use single NAND gate to make burglar alarm. This can be done by using NAND gate, an LDR, a push-button switch S and an alarm. Connect LDR between NAND gate input B and the positive terminal of the battery. The LDR will cause a HIGH level input (1) at B when in light because of its low resistance. The LDR will cause a low level input (0) at B when light is interrupted and causes high resistance in LDR. A LOW level signal is also caused at A when burglar steps on switch S. So this burglar alarm sounds when either burglar interrupts light falling on LDR or steps on switch S.



Burglar Alarm Schematic Circuit

For Your Information

Most of today's technologies fall under the classification of digital electronics. Digital electronics devices store and process bits electronically. A *bit* represents data using 1's and 0's. Eight bits is a *byte* – the standard grouping in digital electronics. *Digitization* is the process of transforming information into 1's and 0's.

Summary

- Electronics is that branch of applied physics which deals with behaviour of electrons using different devices for various useful purposes.
- The process of emission of electrons from the surface of hot metal is called thermionic emission.
- *Cathode rays* are electrons which are emitted from the hot surface of cathode and travel towards anode by applying potential difference.
- Beam of electrons emitted from cathode surface can be deflected by electric and magnetic fields, e
- The cathode-ray oscilloscope is an instrument which can be used to display the magnitudes of rapidly changing electric current or potential. It consists of the following three parts: the electron gun, the deflecting plate and a fluorescent screen.
- Those quantities which change continuously with time are known as analogue quantities. And the quantities which change in non discrete steps are called digital quantities.
- Electronic devices have become integral part of our daily lives. Television,

computers, cell phone, audio and video cassette recorders and players, radio, hi-fi sound system have made our lives more comfortable and pleasant.

- The branch of electronics which processes the data being provided in the form of analogue quantities is called analogue electronics.
- The branch of electronics which processes the data being provided in the form of digital is known as digital electronics. Logic gates are the circuits which implement the various logic operations. These are digital circuits which have one or more input signals but only one output signal.
- There are three basic logic gates: AND gate, OR gate and NOT gate. While NAND gate, NOR gate are combinations of these basic gates.
- The AND gate is a logic gate that gives an output of '1' only when all of its inputs are '1'. The OR gate is a logic gate that gives an output of '0' only when all of its inputs are '0'. The NOT gate is a logic gate that gives an output that is opposite the state of its input.
- The truth tables are tables which give the values of the inputs and outputs of the basic types of logic gates or combination of such gates.

Multiple Choice Questions (MCQs)

Choose the correct answer from the following choices:

i. The process by which electrons are emitted by a hot metal surface is known as.

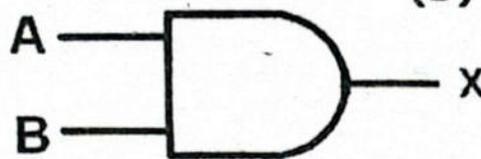
- (A) boiling (B) evaporation
(C) conduction (D) thermionic emission

ii. The particles emitted from a hot cathode surface are

- (A) positive ions (B) negative ions
(C) protons (D) electrons

iii. The logical operation performed by this gate is

- (A) AND (B) NOR
(C) NAND (D) OR



iv. AND gate can be formed by using two

- (A) NOT gates (B) OR gates
(C) NOR gates (D) NAND gates

v. The output of a two-input NOR gate is 1 when:

- (A) A is 1 and B is 0 (B) A is 0 and B is 1
(C) both A and B are 0 (D) both A and B are 1

vi. If $X = A \cdot B$, then X is 1 when:

- (A) A and B are 1 (B) A or B is 0
(C) A is 0 and B is 1 (D) A is 1 and B is 0

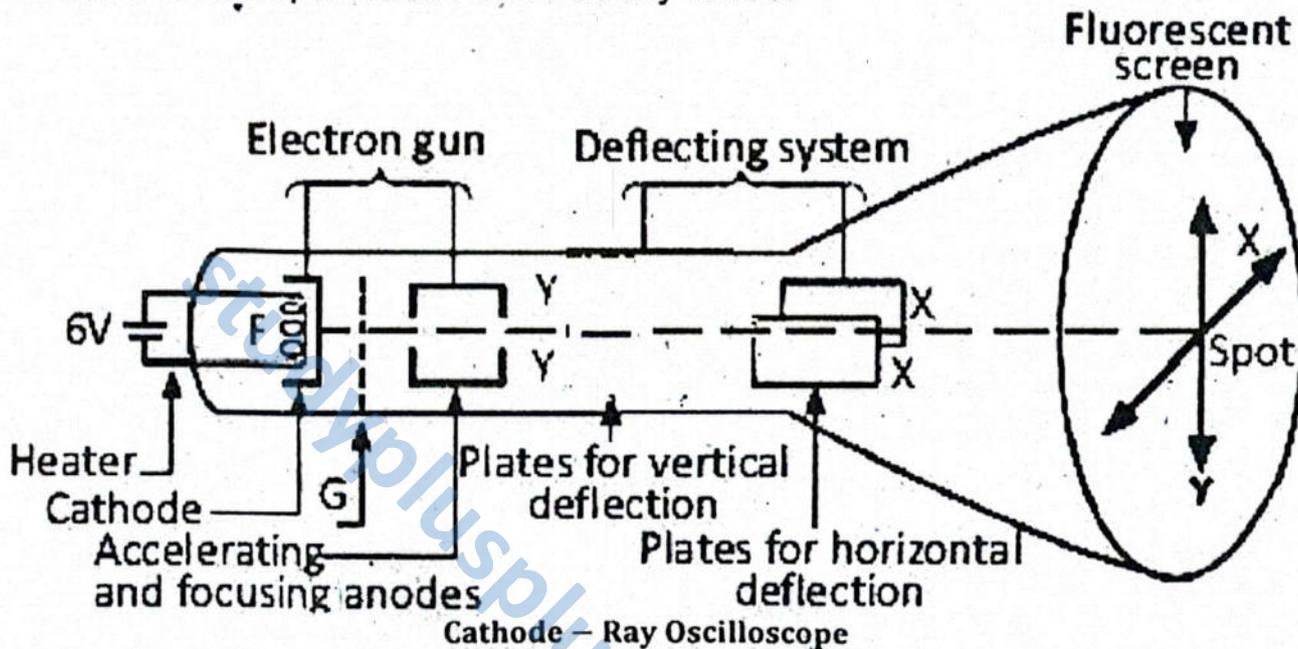
16.2. Explain the working of different parts of oscilloscope.

Ans: Cathode-Ray Oscilloscope (C.R.O):

The cathode-ray oscilloscope is an instrument which is used display the magnitudes of changing electric currents or potentials.

Cathode-Ray Tube:

The information is displayed on the screen of a "cathode-ray tube". This screen appears as a circular or rectangular window usually with a centimeter graph superimposed on it. For example, the picture tube in our TV set and the display terminal of most computers are cathode-ray tubes.



Components of Cathode-Ray Oscilloscope (C.R.O):

The cathode - ray oscilloscope (C.R.O) consists of the following components:

- i. The electron gun
- ii. The deflecting plates
- iii. A fluorescent screen

i. The Electron Gun:

The cathode-ray oscilloscope consists of an "electron gun" for producing a beam of fast-moving electrons called cathode rays. The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons. Electron gun also has an electrode called grid G for controlling the flow of electrons in the beam.

The grid is connected to a negative potential. The more negative this potential, the more electrons will be repelled from the grid and hence fewer electrons will reach the anode and the screen. The number of electrons reaching the screen determines the brightness on the screen light. Hence the negative potential of the grid can be used as a brightness control. The anode is connected to positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

ii. The Deflecting Plates:

After leaving the electron gun, the electron beam passes between a pair of horizontal plates. A potential difference applied between these plates deflects the beam in a vertical plane. This pair of plates provides the Y-axis or vertical

movement of the spot on the screen. A pair of vertical plates provides the X-axis or horizontal movement of the spot on the screen.

iii. The Fluorescent Screen:

The screen of a cathode-ray tube consists of a thin layer of phosphor, which is a material that gives light as a result of bombardment by fast moving electrons.

16.3. Name some uses of oscilloscope.

Ans: Uses of Cathode-Ray Oscilloscope (C.R.O):

The CRO is used in many fields of science; displaying waveforms, measuring voltages, range-finding (as in radar), echo-sounding (to find the depth of sea-beds). The CRO is also used to display heart beats.

16.4. Considering an oscilloscope explain:

- (i) **How the filament is heated?**
- (ii) **Why the filament is heated?**
- (iii) **Why the anode potential is positive with respect to the cathode potential?**
- (iv) **Why a large potential is applied between anode and cathode?**
- (v) **Why the tube is evacuated?**

Ans:

(i) How the filament is heated?

The filament is connected to a 6 volt external battery (usually). When it is heated, a large number of electrons are free to move.

(ii) Why the filament is heated?

Filament when heated will release electrons from its surface.

(iii) Why the anode potential is positive with respect to the cathode potential?

When the cathode (negatively charged electrode) is connected to the anode (positively charged electrode). by an extra high tension (EHT) voltage supply, a narrow beam of fast electrons will move to the anode. That is why the anode potential is positive with respect to the cathode potential.

(iv) Why a large potential is applied between anode and cathode?

Due to large potential a narrow beam of fast electrons will move towards the anode.

(v) Why the tube is evacuated?

Tube is evacuated so that electrons (cathode rays) can move and conduct electricity easily. High pressure will cause hindrance for the movement of electron cathode rays.

16.5. What is electron gun? Describe the process of thermionic emission.

Ans: The Electron Gun:

The electron gun makes a narrow beam of electrons. Its cathode gives off electrons and the anode accelerate them.

The cathode-ray oscilloscope consists of an "electron gun" for producing a beam of fast moving electrons called cathode rays. The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons. Electron gun also has an electrode called grid G for controlling the flow of electrons in the beam.

The grid is connected to a negative potential. The more negative this potential, the more electrons will be repelled from the grid and hence fewer electrons will reach the anode and the screen. The number of electrons reaching the screen determines the brightness on the screen light. Hence the negative potential of the grid can be used as a brightness control. The anode is connected to positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

Thermionic Emission:

The process of emission of electrons from the hot metal surfaces is called thermion emission.

Metals contain a large number of free electrons. At room temperature electrons cannot escape the metal surface due to attractive forces of the atomic nucleus. If the metal is heated to a high temperature, some of the electrons may gain sufficient energy to escape metal surface,

Thermionic emission can also be produced by produced heating a fine tungsten filament. Typical the voltage and current used are 6 V and 0.3 A respectively.

16.6. What do you understand by digital and analogue quantities?

Ans: Digital Quantities:

The quantities which change in non discrete steps are called digital quantities.

Examples:

Modern telephone system, radar system, naval and other systems of military importance, devices to control the operation of industrial machines, medical equipments and many household appliances are using digital technology.

Analogue Quantities:

The quantities which change continuously with time are known as analogue quantities.

Examples:

Temperature, time, pressure, current, voltage and distance etc., are analogue quantities.

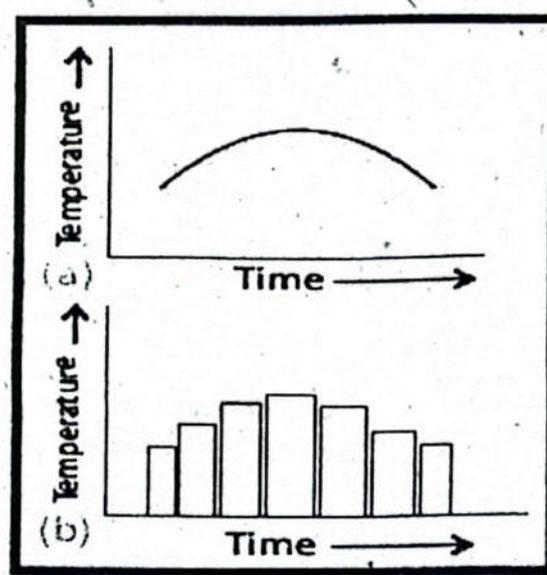
16.7. Differentiate between analogue electronics and digital electronics. Write down names of five analogue and five digital devices that are commonly used everyday life.

Ans: Analogue Electronics:

The branch of electronics consisting of circuits which process analogue quantities is called analogue electronics.

Devices:

Analogue physical quantities involve electric fan, refrigerators, iron, lamp, Loudspeaker and radio receivers.



An analogue signal

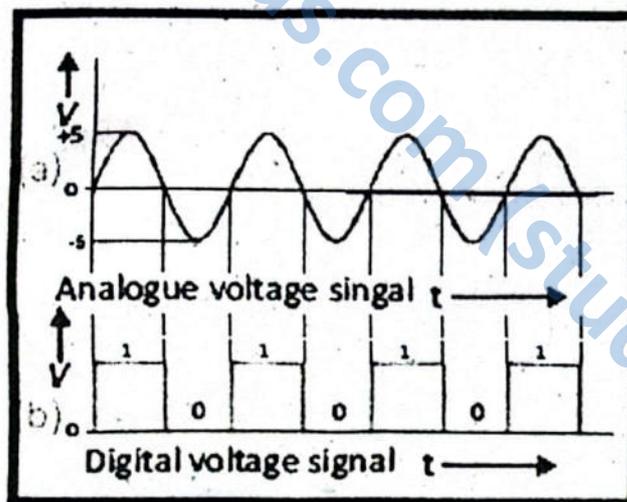
Digital Electronics:

The branch of electronics which deals with digital quantities is called digital electronics.

Digital quantities are expressed in the form of digits or numbers. Digital electronics uses only two digits 0 (zero) and 1 (one) and the whole data are provided in binary form due to which processing of data becomes easy.

Devices:

The devices based upon digital physical electronics are computer, TV, security system, mobile phone, digital camera radar system, naval system, medical equipments etc.



16.8. State and explain for each case whether the information given by the following devices is in analogue or a digital form.

- a moving-coil voltmeter measuring the e.m.f of a cell.
- a microphone generating an electric current.
- a central heating thermostat controlling the water pump.
- automatic traffic lights controlling the flow of traffic.

Ans:

a. a moving-coil voltmeter measuring the e.m.f of a cell.

It is analog device which measure the value of emf a cell. The deflection of the moving-coil is continuous variation with time. It is analogue signal.

b. a microphone generating an electric current.

The current in the microphone varies according to the variation in sound pressure. Since this variation is continuous, hence current from microphone is an analogue quantity.

c. a central heating thermostat controlling the water pump.

The thermostat depends upon the atmospheric temperature which varies continuously with time. It is an analogue signal. So the thermostat controlling is an analogue device.

d. automatic traffic lights controlling the flow of traffic.

The digital circuit used in traffic control light system makes them ON (1) or OFF (0). Hence, automatic traffic lights is a digital system.

16.9. Write down some benefits of using digital electronics over analogue electronics.

Ans: Digital information has certain properties that distinguish it from analog communication methods. These include

- **Synchronization** – digital communication uses specific synchronization (Organization) sequences for determining synchronization.
- **Language** – digital communications requires a language which should be possessed by both sender and receiver and should specify meaning of symbol sequences.
- **Errors** – disturbances in analog communication causes errors in actual intended communication but disturbances in digital communication does not cause errors enabling error free communication. Errors should be able to substitute, insert or delete symbols to be expressed.
- **Copying** – analog communication copies are quality wise not as good as their originals while due to error free digital communication, copies can be made indefinitely.
- **Granularity** – for a continuously variable analog value to be represented in digital form there occur quantization error which is difference in actual analog value and digital representation and this property of digital communication is known as granularity.

16.10. What are the three universal Logic Gates? Give their symbols and truth tables.

Ans: Three universal Logic Gates:

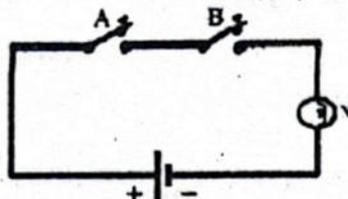
i. AND OPERATION:

AND operation is physical realization of the logical Multiplication. It is the implement of AND gate.

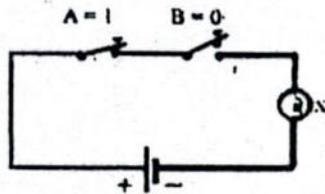
Explanation:

In order to understand AND operation, we consider input variables A and B as two switches. If we connect two switches A and B in **series combination** There are four possible states of these two switches which are given below:

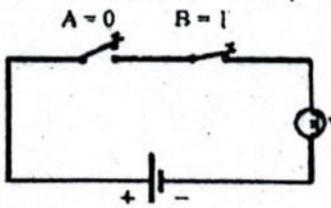
i. Both A and B are open i.e., $A = 0, B = 0$



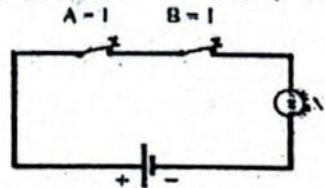
ii. The switch A is closed and B is open i.e., $A = 1, B = 0$



iii. The switch A is open and B is closed i.e., $A = 0, B = 1$



iv. Both switches A and B are closed i.e., $A = 1, B = 1$



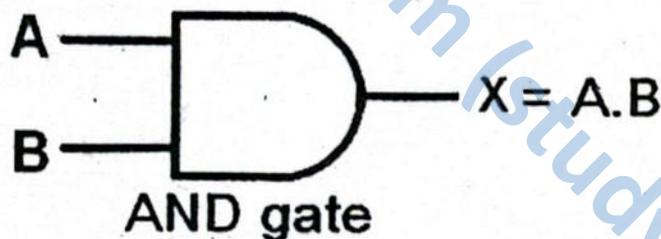
The four possible states of the switches A and B are given in table.

A	B	$X = A \cdot B$
0	0	$0 \cdot 0 = 0$
1	0	$1 \cdot 0 = 0$
0	1	$0 \cdot 1 = 0$
1	1	$1 \cdot 1 = 1$

AND Gate:

AND Gate is physical realization of the logical multiplication. It is the implement of AND operation.

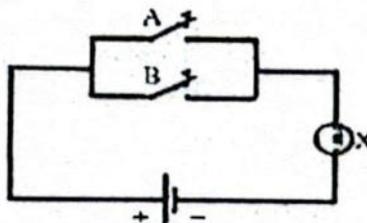
Symbol of AND Gate:



Note: The output is high only if input X and input Y are high.

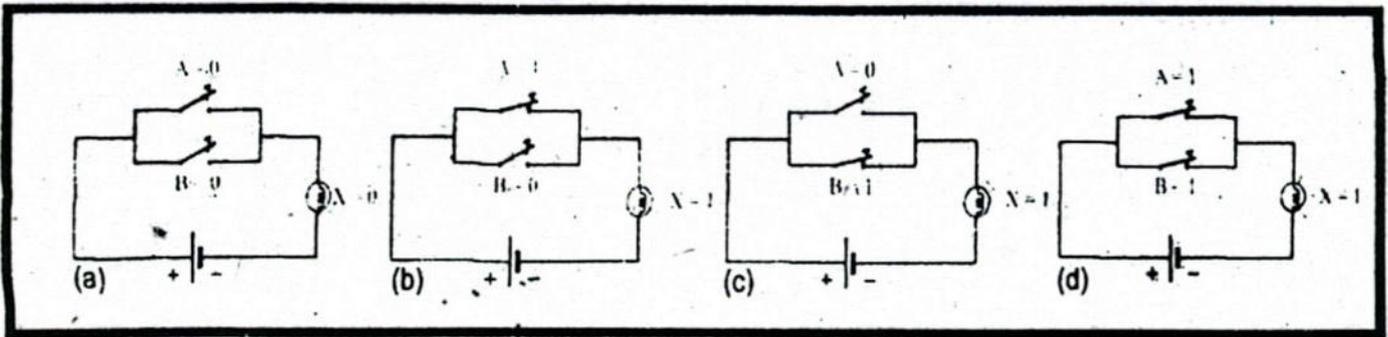
ii. OR operation:

OR operation is physical realization of the logical addition. It is the implement of OR gate.



Explanation:

If we connect two switches A and B in **parallel combination** and make a circuit, the value of the output current X in this circuit will depend upon the state of the switches A and B, i.e., upon the value of the input variables A and B.



OR operation is represented by the plus sign(+). The value of X in the table would be written as

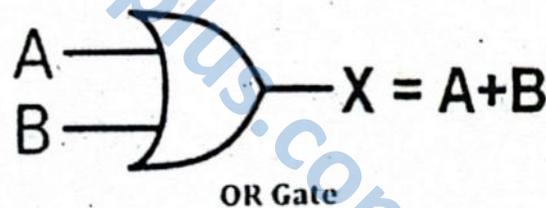
$$X = A + B$$

A	B	X = A + B
0	0	0 + 0 = 0
1	0	1 + 0 = 1
0	1	0 + 1 = 1
1	1	1 + 1 = 1

OR Gate:

OR Gate is physical realization of the logical addition. It is the implement of OR operation.

Symbol of OR gate:



Note:

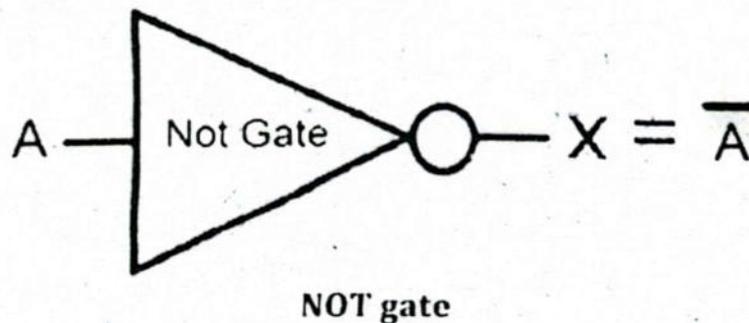
The output is high when either X or Y or both are high..

iii. NOT OPERATION:

NOT operation is physical realization of the complementation operation.

Function of NOT operation:

It is perform the operation of inversion or complementation. That is why it is also known as inverter. It changes a logical level to its opposite level, i.e. it changes 1 to 0 and 0 to 1.



NOT gate:

The electronic circuit which implements NOT operation is known as NOT gate.

Truth table:

A	Output = $X = \bar{A}$
0	$\bar{0} = 1$
1	$\bar{1} = 0$

Note: The output is high if the input is not high. The output is always the opposite of the input. It is an inverter.

Conceptual Questions

16.1. Name two factors which can enhance (increase) thermionic emission.

- Ans:** i) Nature of the metal
ii) Surface area of the metal

By increasing the temperature and surface area of the cathode, rate of thermionic emission can enhance (increase).

16.2. Give three reasons to support the evidence that cathode rays are negatively charged electrons.

- Ans:**
- i) When cathode rays are created then they move towards the anode of the discharge tube which shows that they are negatively charges.
 - ii) When an electric field is applied in the discharge tube then cathode rays experiences an attractive force toward the positive plate of the applied electric field which also shows that they have negative charge.
 - iii) They are deflected in a magnetic field opposite to the direction of positive charge.

16.3. When electrons pass through two parallel plates having opposite charges they are deflected towards the positively charged plate. What important characteristic of the electron can be inferred from this?

Ans: This shows that electrons have negative charge.

16.4. When a moving electron enters the magnetic field, it is deflected from its straight path. Name two factors which can enhance electron deflection.

Ans: Strength of magnetic field and speed of electron enhance electron deflection. If we increase the angle between velocity of electron within range 0° to 90° then it will enhance the deflection of electron because magnetic force is equal to $F = qvB\sin\theta$. If we increase the strength of magnetic field then it will enhance the deflection of electron.

16.5. How can you compare the logic operation $X = A.B$ with usual operation of multiplication.

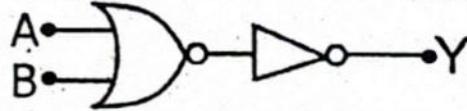
Ans: If we want to compare the logic operation with usual operation of multiplication, we will find same result as in logic operations with same inputs.

but if the inputs changes from 0 and 1 the logic operation will failed to give result.

16.6. NAND gate is the reciprocal of AND gate. Discuss

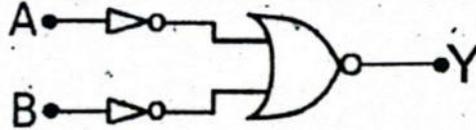
Ans: The combination of AND gate with NOT gate is called NAND gate. In NAND gate the output of AND gate is inverted. Therefore NAND gate is the reciprocal of AND gate.

16.7. Show that the circuit given as below acts as OR gate.



Ans: The given circuit acts as OR gate because in this circuit the output terminal of NOR gate is coupled with NOT operation. In NOR gate the value of OR gate is inverted then followed by NOT operation the value of OR gate is regenerated.

16.8. Show that the circuit given as below acts as AND gate.



Ans: In this circuit two NOT operations are working as inputs terminals of NOR gate. Therefore this circuit will act as AND gate.