Chapter = 17

Introductory Electronics

Q1.Define Electronics. Also name its field.

Electronics is the branch of physics and electrical engineering that deals with the emission, behaviors, and effects of electrons and with electronic devices.

Fields of Electronics: Electronics may have two fields:

(1) Analogue
(2) Digital

Q2.What are the Advantages of digital information over analogue information

Advantages of digital information over analogue information

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.

Q3.What are the Advantages of digital electronic devices over analogue electronic devices

Advantages of digital electronic devices over analogue electronic devices

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.

Q4.Give Example of advantages of digital electronic devices over analogue electronic devices

Example

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

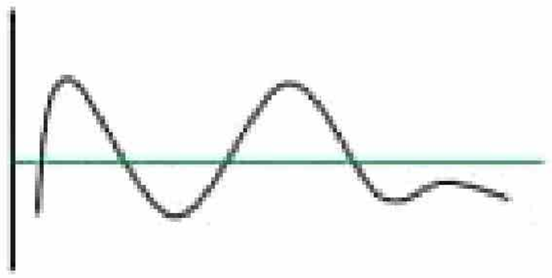
(i) Higher accuracy.
(ii) Higher resolution.

(iii) Greater speed.
(iv) No parallax errors.
(v) Reduced human error.
(vi) Compatibility with other digital equipment.

Q5.Define Analogue electronics and Digital electronics

Analogue electronics

Analogue electronics deals with circuits which have continuously varying signals.



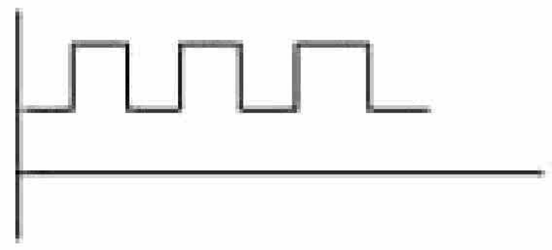
Analog signal

Example

radio, television, oscillator etc.

Digital electronics

Digital electronics deals with circuits which have discrete signals.



Digital signal

Example

Computers, calculators, MP3 players etc.

Q6.Difference between analogue and digital electronics:

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 cannot 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 does not have noise.

7.	Analogue devices have high precession.	Digital devices have very high precession.
8.	Examples of analogue devices include ordinary air thermometer, the barometer, speedometer, vehicles, the mechanical watches etc.	Examples of digital devices include computers, calculators, watches, MP3 players, DVD's, laptops, sensors, biometric machines, chip in ID cards etc.

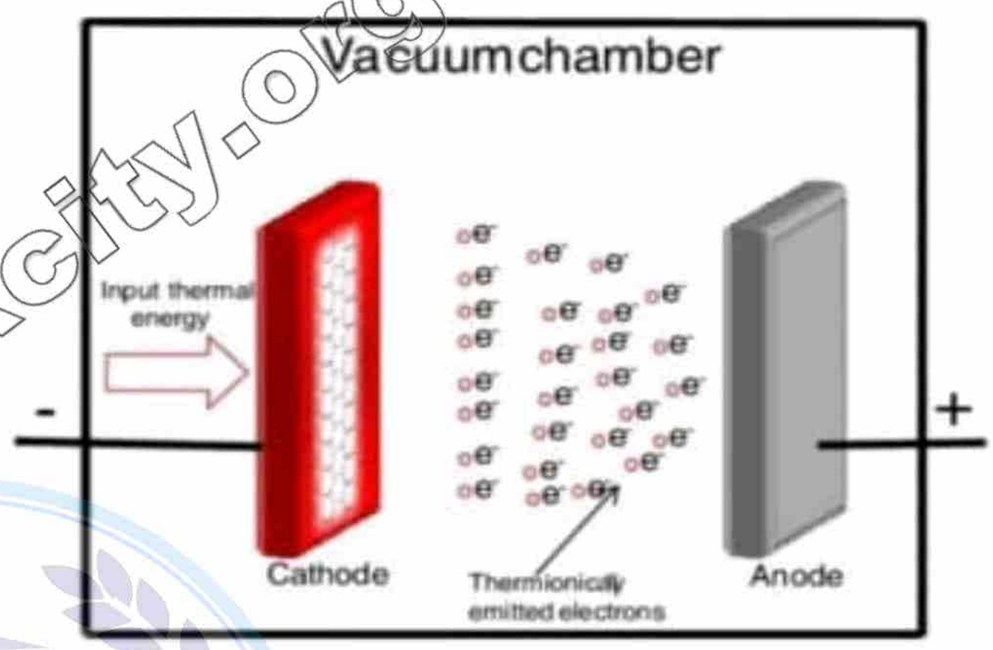
Q7.What is Thermionic emission? Also describe it with an example.

Thermionic emission

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

Demonstration of thermionic emission

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



Model for thermionic emission

Experiment

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.

What are Cathode rays? Also list its properties.

Cathode rays

The beam of fast-moving electrons is called cathode rays.

Properties or characteristics of cathode rays

- 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.

Q8.Define an electron gun. Also describe its construction and working.

Electron gun

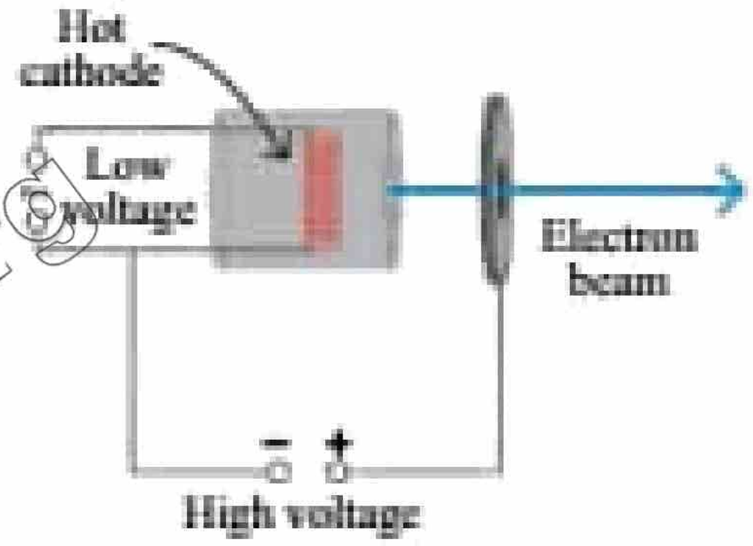
An electron gun makes the electrons to travel in straight lines like a beam called "Cathode rays".

An electron gun as a source of electron beam

Construction: It consists of cathode which is connected to negative terminal, anode which is connected to positive terminal, filament and sealed glass tube.

Working

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.



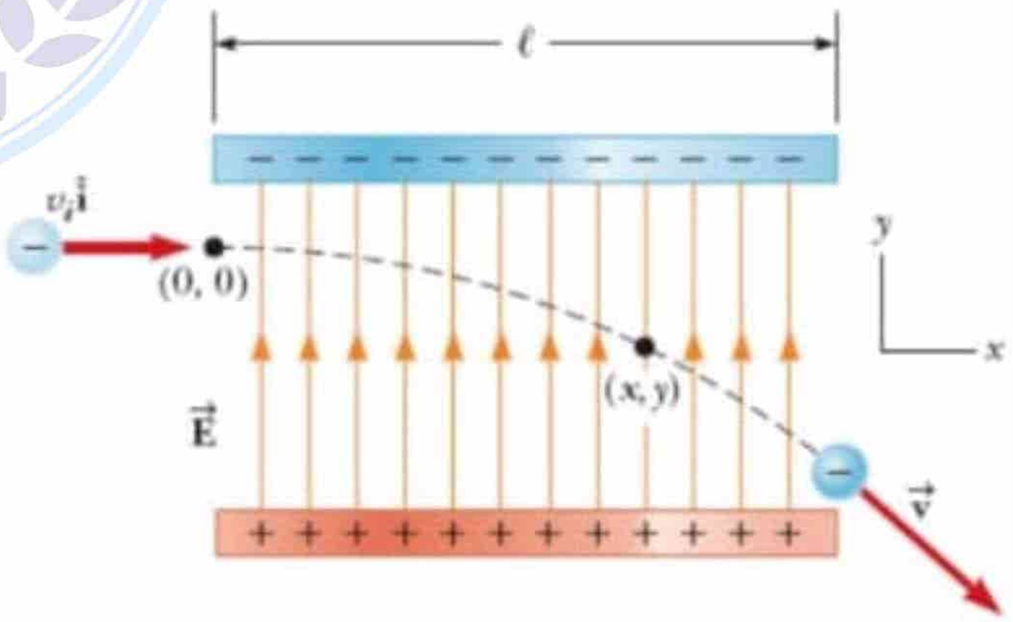
An electron gun

Q9.Explain Deflection of an electron by electric field

Demonstration

The diagram given below shows the deflection of an electron passing through a uniform electric field at 90° to the direction of motion of electron.

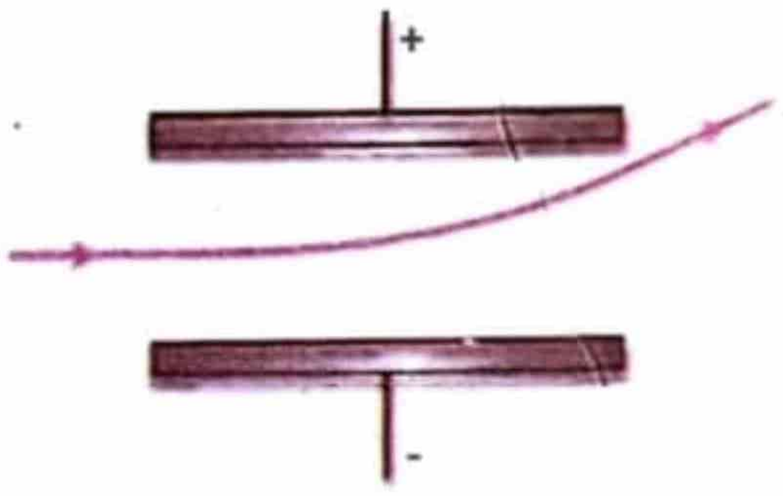
This field is generated by parallel charged plates. The two plates are oppositely charged. Force acting on electron is constant and towards the positive plate as a result electron follows a curved path towards the positive plate. Deflection of an electron passing through uniform electric field



Q10. Describe the Effect of electric field on an electron beam

Effect of electric field on an electron beam

The deflection pattern of an electron beam is same to that of a single electron.



Deflection of electron beam

The effects of electric field on an electron beam are:

(i) The beam bends and changes direction.

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

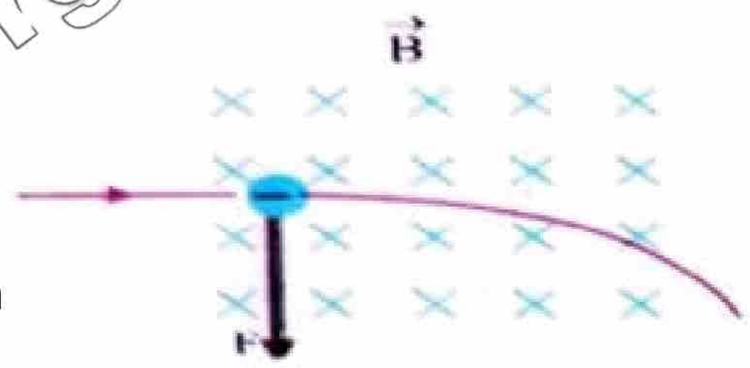
(iii) The beam of electron changes direction millions of times each second.

(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.

Q11. Explain the Deflection of an electron by magnetic field

Demonstration

The diagram given below 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 sing shown by "x" 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 downwards 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.

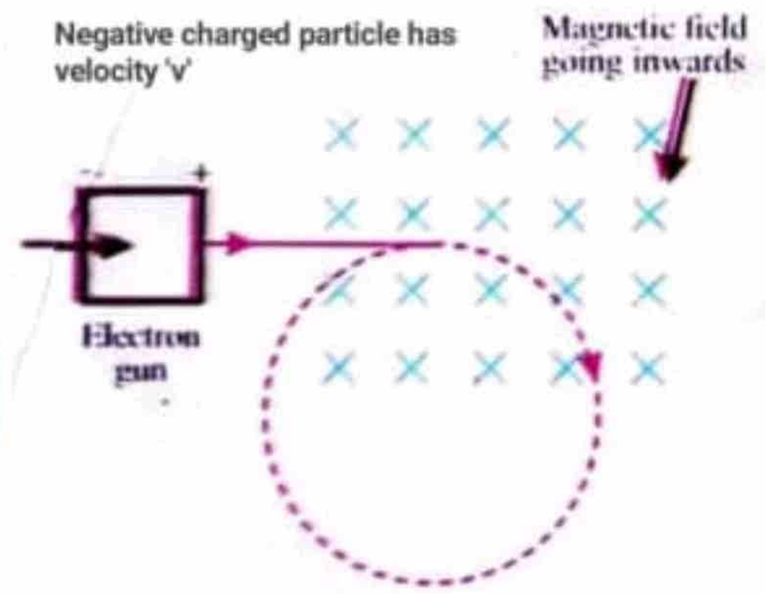


Fig: 17.17.
Effect of magnetic field

Q12. What are the Effect of magnetic field on an electron beam:

Effect of magnetic field on an electron beam

(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 magnetic field.

Q13. What is Cathode-ray Oscilloscope? give its construction and working.

Cathode-ray Oscilloscope (CRO): A Cathode-ray oscilloscope (CRO) is generally referred to as oscilloscope or scope.

Construction: 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 below.

Working:

- The electron gun emits a beam of electrons (ie. cathode-ray) which is produced by the cathode.
- When this electron beam strikes the fluorescent screen, a bright spot is created on the screen.
- 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.

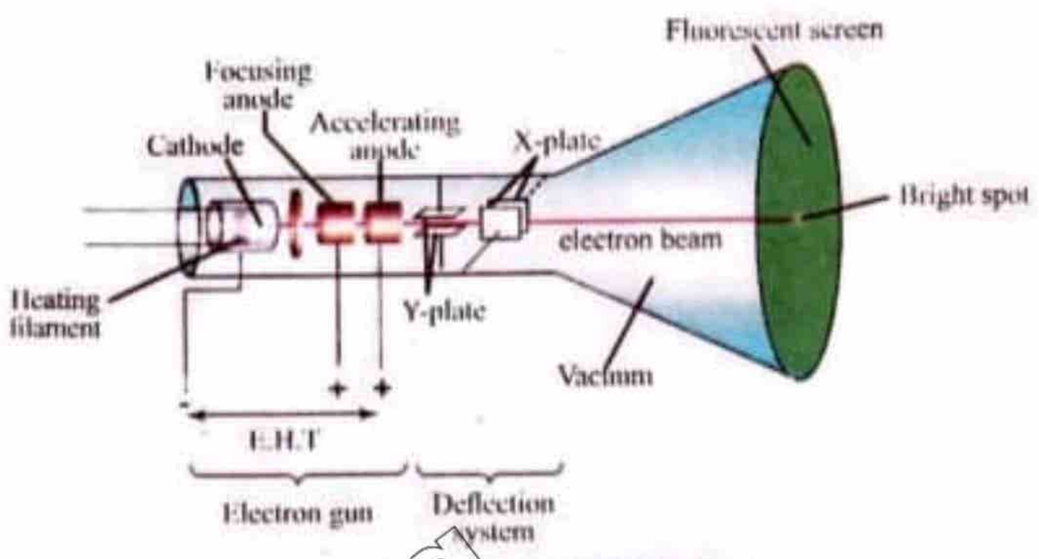


Diagram of CRO

- 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.
- 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.

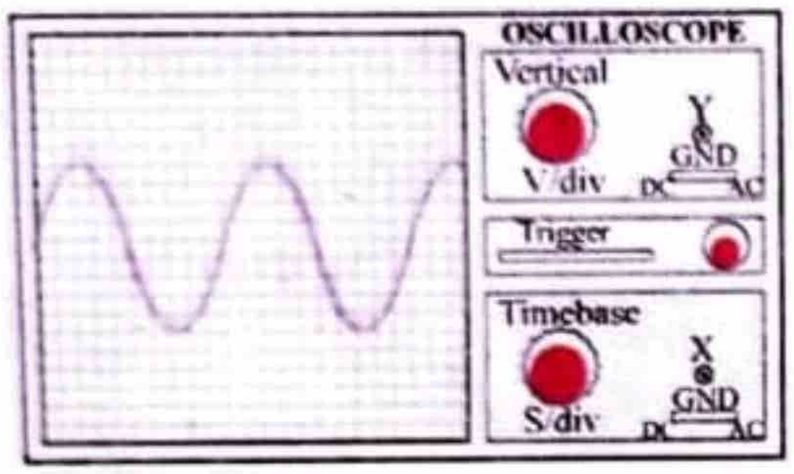
Q14. What are the Important controls oscilloscope?

Important controls oscilloscope

The figure below 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



Front panel of CRO

- 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 the cathode-ray tube. An amplifier circuit amplifies the voltage across the Y-plates in the cathode-ray oscilloscope.
- 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 the 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.

Q15. Give the Uses of the CRO

Uses of the CRO

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

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.

Q16. What do you know about the Basic operations of digital electronics?

Basic operations of digital electronics

Digital electronics-based devices use 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 intermediate state is possible (allowed).

Example: A block diagram of a security alarm which operates through two switches is shown in figure below.

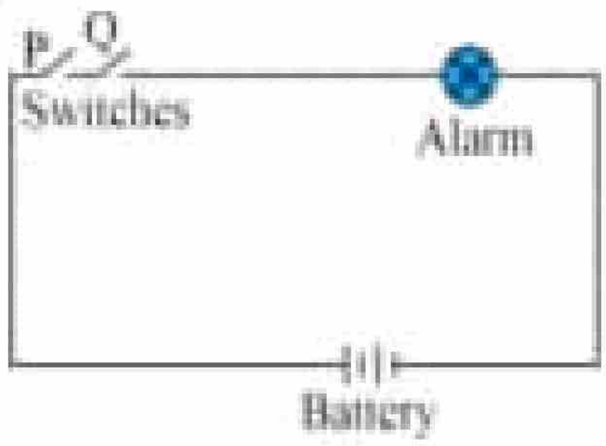


Diagram of security alarm

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

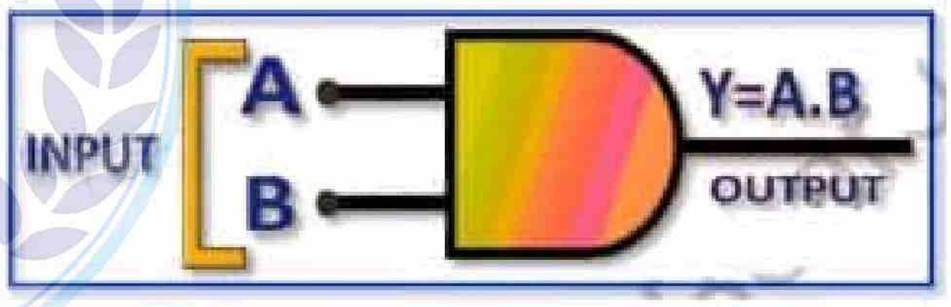
The above table represents the logic behind the working of the alarm. In digital electronics, this logic is implemented by "LOGIC GATES".

Q17. Discus with example different gate.

Logic Gates: The logic gate is the basic unit of digital logic circuits.

Examples: 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 using two input variables

Operation: AND gate operates on logical multiplication rules.

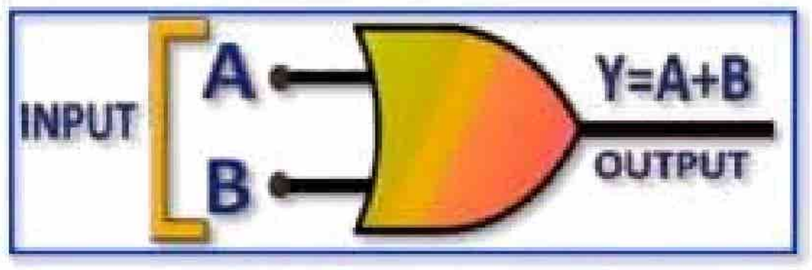
Representation: AND operation using variables A and B is represented "A.B". here (.) dot is a logical multiplication sign.

Boolean Expression: Y=A.B

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.

Operation: An OR gate operates on logical Addition rules.



OR Gate using two input variables

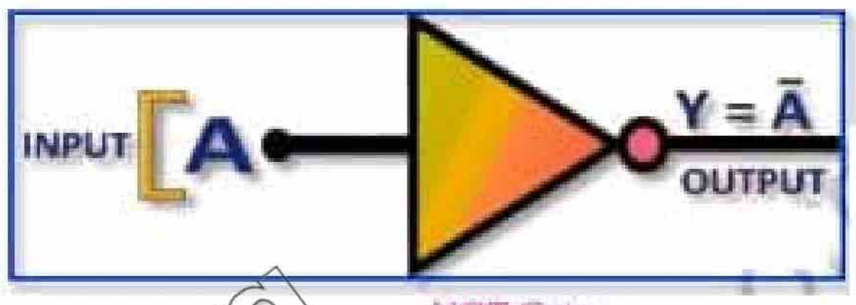
Representation: The logical OR is represented with symbol "+"

Boolean Expression: Y = A + B

NOT Gate

A NOT gate is a digital circuit that has a single input and a single output. It is also known as INVERTER.

Operation: The NOT operates complement or invert of any input.



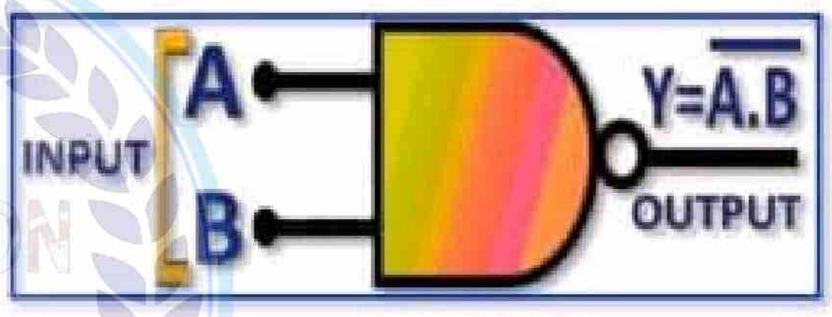
NOT Gate

Representation

It is symbolized by the complement sign (') on the right side of the top of the input variable or bar (-) sign on top of the variable.

Boolean Expression: Y = A' or Y = Ā

NAND Gate: A NAND Gate could be constructed by connecting a NOT Gate at the output terminal of the AND Gate.



NAND Gate

Boolean Expression

$$Y = (A.B)' \; or \; Y = \overline{AB}$$

NOR Gate: A NOR Gate could be constructed by connecting a NOT Gate at the output terminal of the OR Gate.

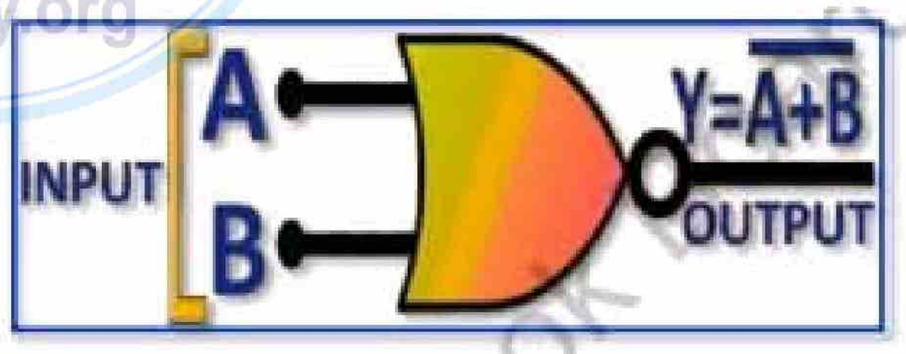


Fig: 17.29 NOR Gate

Boolean Expression

$$Y = (A + b)' \; or \; Y = \overline{A + B}$$

Q18. Describe the Truth table of AND operation using two input variables:

Truth Table of AND gate using two input variables A, B and output is Y. If any input is 0, then output Y becomes 0.

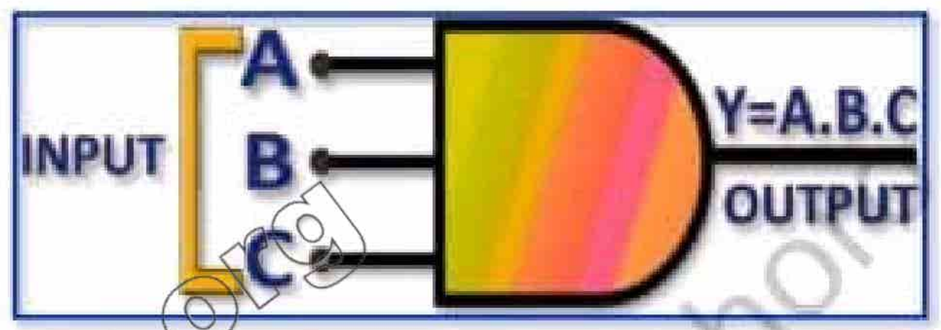
If all inputs are 1 then output Y becomes 1.

Boolean expression of AND gate is Y=A.B

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

Q19. Describe the Truth table of AND operation using three 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.



AND Gate using three input variables

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

Q20. **Describe the Truth table of OR gate operation using two input variables:** Truth Table of OR gate using two input variables A, B and output is Y, If any input is 1 then output Y becomes 1 and if all inputs are 0 then output Y becomes 0.

Boolean expression of OR gate is Y = A + B

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

Q21. **Describe the Truth table of OR operation using three 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 output 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

Q22. Describe the Truth table of NOT gate operation using two input variables

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

Truth table of NOT gate operation using two input variable	
A	Y = $\bar{A}$
0	1
1	0

Q23. Describe the Truth table of NAND operation using two input variables

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".

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

Q24. Describe the Truth table of NOR operation using two input variables

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".

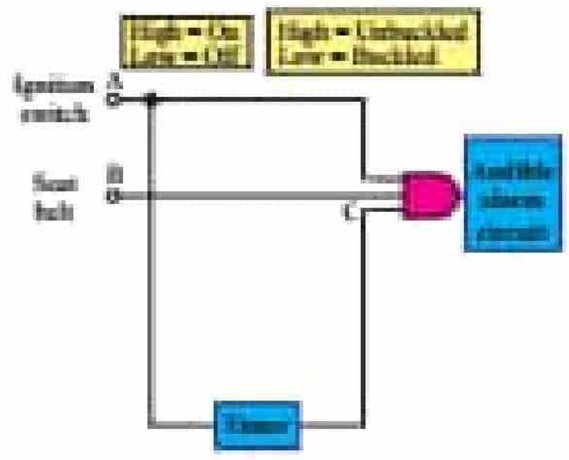
Truth table of NOR operation using two input variables

A	B	Y = $\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

Q25. What are the uses of Use of Logic Gates

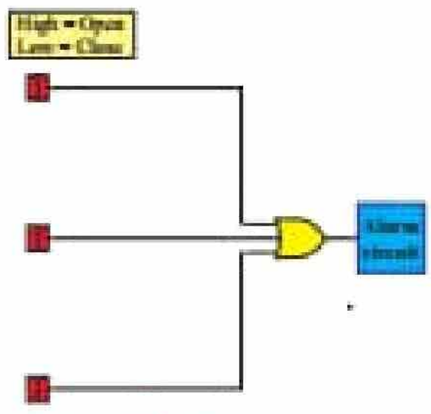
Use of Logic Gates

A seat belt alarm system: In Figure below, 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.



A simple seat belt alarm circuit using an AND 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.



A simplified intrusion detection system using an OR gate.

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) AxB (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) AxB (d) None of these.

10. The cathode ray carry

(a) positive charge (b) neutral

(c) negative charge (d) positrons Ans:

1.Electrons	2.Electron gun	3.Electron	4.Reversed	5.Thermionic emission
6. 0	7.A.B	8.All of these	9.A+B	10. negative charge