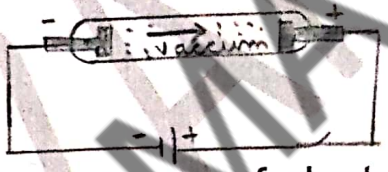
CHAPTER 16

BASIC ELECTRONICS

Electronics is that branch of applied physics which deals with the control of motion of electrons using different devices.

16.1 THERMIONIC EMISSION:

Definition: - The process of emission of electrons from hot metal surface is called thermionic emission.



Background: -

1) In 1850s, physicists started to examine the passage of electricity through vacuum by putting two electrodes in a sealed vacuum tube.
2) They discovered that some kinds of rays were emitted by cathode or the negative electrode.
3) These rays were called cathode rays.
4) JJ Thomson in 1897 observed the deflection of cathode rays by both electric and magnetic fields.
5) From the deflection experiments, he concluded that cathode rays must carry a negative charge.
6) These negatively charged particles were given the name electrons.

Explanation: -

1) metals contain a large number of free electrons.
2) At room temperature electrons cannot escape from the metal surface due to attraction forces of atomic nucleus.
3) If the metal is heated to a high temperature, some of the free electrons may gain sufficient energy to escape the metal surface.

V_S I_P

4) The process of emission of electrons from hot metal surface is called thermionic emission.

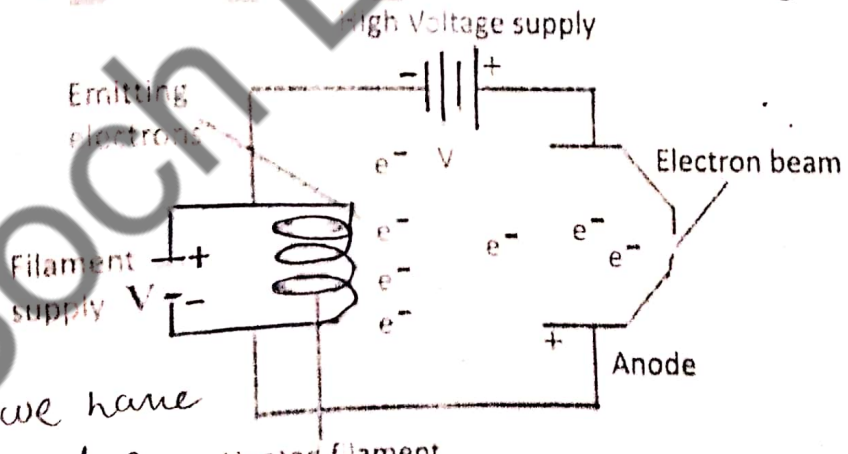
Practical Example: -

1) Thermionic emission can usually be produced by electrically heating a fine tungsten filament.
2) Typical values of the voltage and current used for this purpose are 6v and 0.3 A respectively.

16.2 INVESTING THE PROPERTIES OF ELECTRONS:

Electron Gun: -

1) An electron gun is used to investigate the properties of electron beam.
2) The electrons are produced by thermionic emission from a tungsten filament heated by 6v supply.
3) A high positive potential is applied to cylindrical anode
4) The electrons are accelerated to a high speed and pass through the hole of anode in the form of fine beam of electrons.
5) The whole set up is fitted in an evacuated glass bulb.



ELECTRON GUN

Construction:
1. Tungsten filament
2. 6V power supply
3. High +ive potential
4. cylindrical anode
5. Glass tube (evacuated).

why we have provided 2 potentials?
1) The 1st V is applied to emit e⁻
2) to accelerate the e⁻ in one direction

How much force is acting on charged particle? can be calculated by F = qE.

Deflection Of Electrons By Electric Field: -

1) We can set up an electric field by applying a potential difference across two parallel metal plate separated by some distance.
2) When an electron beam passes between the two plates, it can be seen that the electrons are deflected towards negative plate.
3) The reason for this is that electrons are attracted by the positive charges and are repelled by the negative charges due to the force

$F = qE$

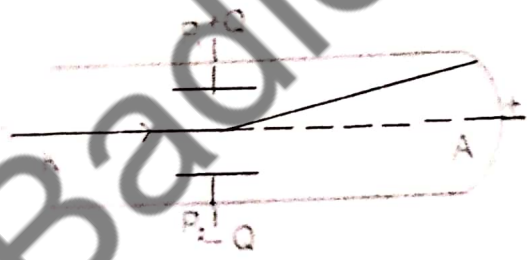
WHERE,

q = electron charge

E = electric field due to plates

4) The degree of deflection of electrons from there original direction is directly proportional to the strength of the electric field applied.

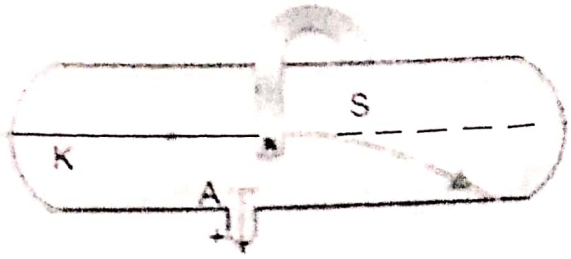
Deflection of beam $\propto$ strength of the EF



Deflection of cathode rays by electric field lines

Deflection Of Electrons By Magnetic Field: -

1) Apply magnetic field at the right angle to the beam of electrons by using a horseshoe magnet.
2) It is noticed that the spot of the electrons beam on the screen is getting deflected from its original path.
3) Now change the direction of the horseshoe magnet. The spot on the fluorescent screen gets deflected in the opposite direction.



Deflection of cathode rays by magnetic field lines

16.3 CATHODE RAY OSCILLOSCOPE (C.R.O)

Statement: -

"It is fast electron graph plotting device"

OR

"It is used to display the magnitude of changing of current (ΔI) or changing of potential(ΔV)."

Construction: -

Cathode ray oscilloscope consists of

(i) An electron gun
(ii) Deflecting plates
(iii) A fluorescent screen

ELECTRON GUN: -

The working of electron gun can be explained on the basis of its components

(i) **Electron source: -** Electron source is an electrically heated cathode (negative electrode). It ejects electrons.

(ii) **Grid: -** It also an electrode and have negative potential. It controls number of electrons. Due to its negative potential electrons will be repelled and fewer electrons reach anode and escape. No. of electrons $\propto$ brightness
The negative potential of the grid can be used to control brightness of beam.

(iii) **Anode:** - It is positive potential electrode. Electrons are **accelerated** and **focused** due to anode.

DEFLECTING PLATES: -

The system of deflecting plates consists of "two sets of plates".

(i) X-X plates (horizontal deflecting plates) deflects beam of e- vertically

(ii) Y-Y plates (vertical deflecting plates) deflects beam of e- horizontally.

When electron beam passes through a pair of horizontal plate, a ΔV (potential difference) is applied between these plates and spot of the beam along y-axis as well as along x-axis.

FLUORESCENT SCREEN: -

Fluorescent screen consists of a thin layer of phosphor, it gives light when the bombardment of fast-moving electrons takes place over it. Screen appears as circular or rectangular window with a cm(centimeters) graph super imposed on it

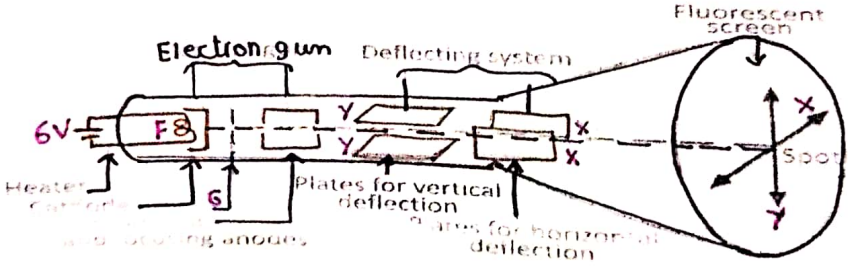
Uses: -

(i) It is used to display wave forms.

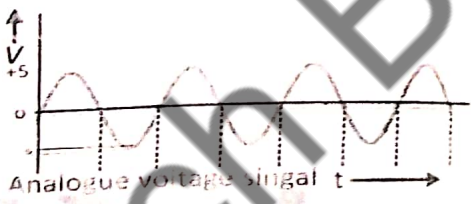
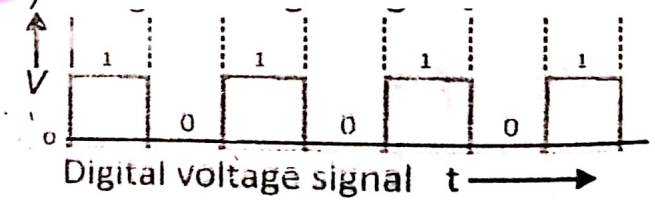
(ii) We can measure voltages, range-finding(radar) & echo-sounding (depth of sea beds).

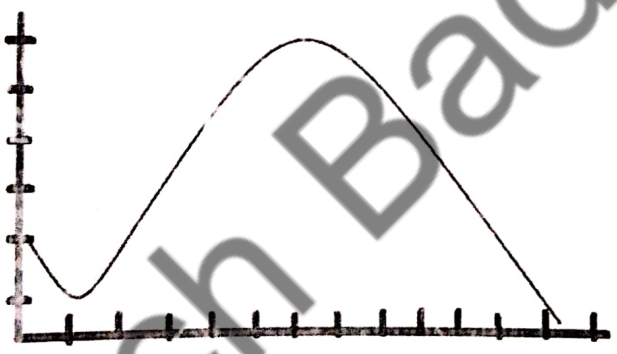
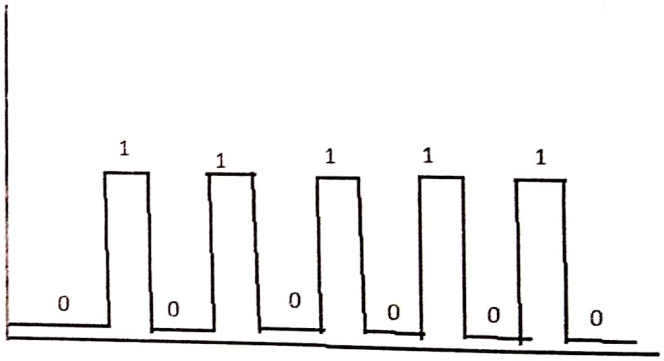
(iii) CRO is used to display heart beats.

(iv) Picture tube in TV sets and display terminals of most computers are cathode ray tubes.



16.4 ANALOGUE AND DIGITAL ELECTRONICS

ANALOGUE QUANTITIES	DIGITAL QUANTITIES
1)The quantity that has continues values is called as the analogue quantity.	1)The quantity that has discrete set of values is called digital quantity.
2)For graphical representation mostly the are represented by curves.	2)It is represented by 0 & 1.
3)Data obtained by analogue quantities cannot be processed easily.	3)Data obtained by digital quantities can be processed easily.
4)EXAMPLES: time, temperature, distance, pressure and sound.	4)Modern telephone system and household appliances use digital technology. Temperature after every hour
5)They cannot easily transmit.	5)They can easily transmit.
6)They cannot be stored and reproduced easily.	6)They can be stored and reproduced easily.
7) 	7) 

ANALOGUE ELECTRONICS	DIGITAL ELECTRONICS
1)The branch of electronics consisting of circuits which process analogue quantities is called analogue electronics.	1)The branch of electronics which deals with the digital quantities is called digital electronics.
2)They cannot be processed easily.	2)They can be processed easily.
3)They are based on continues charge.	3)They show non-continuous/ discrete change.
4)They cannot easily transmit.	4)They cannot easily transmit.
5)EXAMPLES: time, temperature, distance, pressure and sound. Amplifier, Radio, T.V, Television	5)EXAMPLES: Modern telephone system and household appliances use digital technology. Computer
6)There signals are affected by external field.	6) There signals are not affected by external field.
7)GRAPHICAL REPRESENTATION: 	7)GRAPHICAL REPRESENTATION: 

ADC : Analogue to Digital converter
DAC : Digital to Analogue converter.

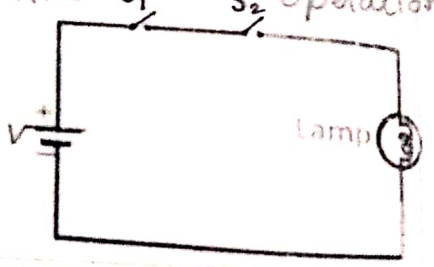
ADC : A circuit which converts analogue signal into digital signal (in the form of digital in binary form.

DAC :

16.5 BASIC OPERATIONS OF DIGITAL ELECTRONS- LOGIC GATES

AND GATE

1) The circuit using AND operation



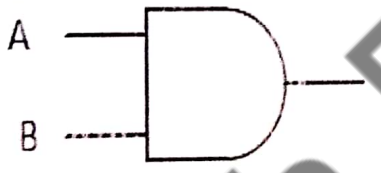
2)Boolean expression for AND Gate:

A.B=X (Symbol (·))

3)TRUTH TABLE:

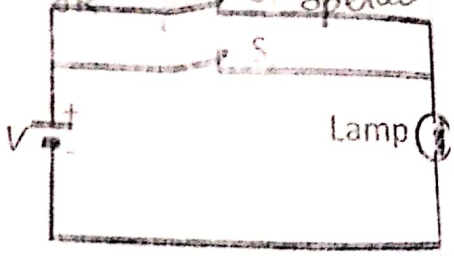
A	B	A.B=X
0	0	0
0	1	0
1	0	0
1	1	1

4)LOGIC GATE:



OR GATE

1) The circuit using OR S operation



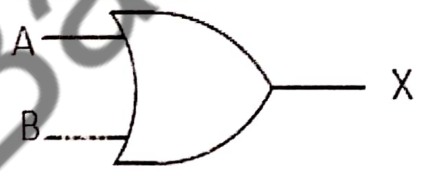
2)Boolean expression for OR Gate: (Symbol (+))

A+B=X

3)TRUTH TABLE:

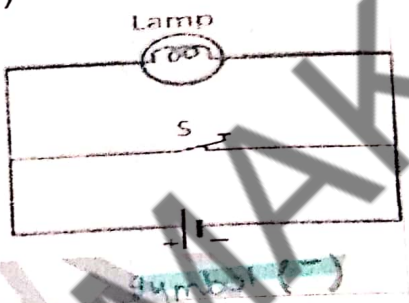
A	B	A+B=X
0	0	0
0	1	1
1	0	1
1	1	1

4)LOGIC GATE:



NOT GATE

1) (inverter)



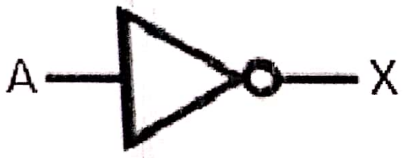
2)Boolean expression for NOT Gate:

$\bar{x} = A$

3)TRUTH TABLE:

A	X
1	0
0	1

4)LOGIC GATE:



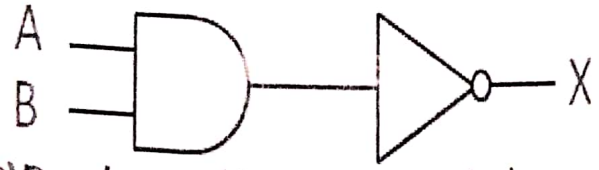
Logic states / Logic variables : The possible combination of input and output.

Binary variable: Such things which can have only 2 possible states.

Arithmetic operations → Logic operations (AND, OR, NOT)

NAND GATE

1)



AND operation followed by NOT operation

2)Boolean expression for NAND Gate:

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

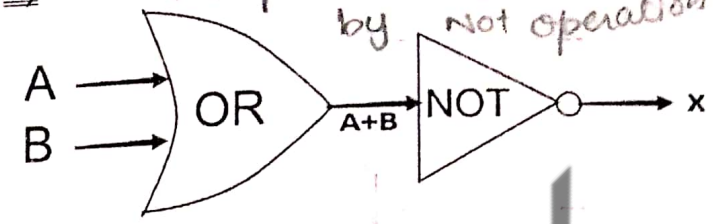
3)LOGIC GATE:

4)TRUTH TABLE:

A	B	A.B	$x = \overline{A.B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

NOR GATE

1) OR operation followed by Not operation



2)Boolean expression for NOR Gate:

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

3)LOGIC GATE:

4)TRUTH TABLE:

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

HOUSE SAFETY ALARM: -

House safety alarm consists of following components

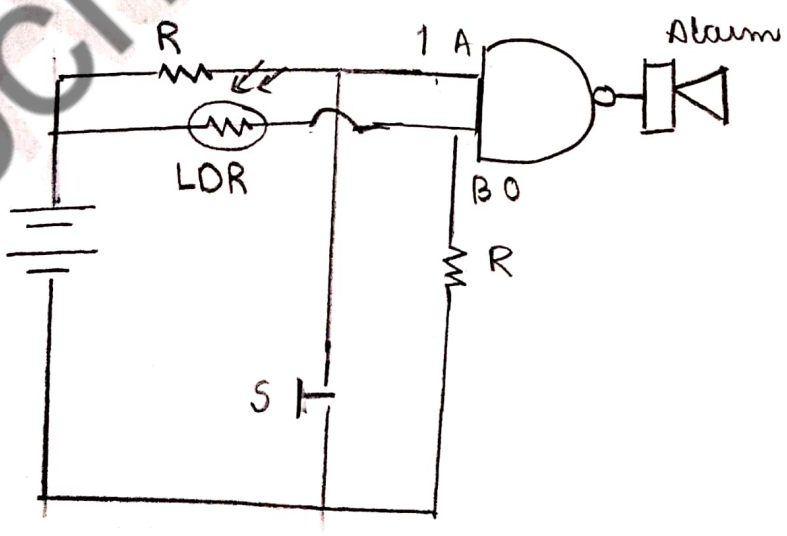
1) LDR (Light dependent resistance, light sensor)
2) NAND gate
3) A sound system (alarm)

LDR
high R
when light interrupt
Low R
when light fall

WORKING: -

A= Input of the NAND gate provided by switch "S"
B= input of the NAND gate provided by LDR
When switch is closed or LDR is absorbing light then input will be 1 which also known as high input. In this state when A & B are 1 alarm will never work.
When LDR causes low level input (0) at B due to interruption of light or high resistance of LDR, alarm will work.
When burglar steps on switch S then alarm sound

Switch "S"	LDR(B)	NAND= $\overline{A.B}$	Alarm
1	1	0	0
1	0	1	1
1	1	1	1
1	0	1	1



A B
1 0
0
1 0

Case - I
when light is interrupted, LDR will cause Low level input '0' at B because of high resistance.

Case - II
Low level signal will cause at A when switch is ON.