PVP 23

Code: 23BS1203

I B.Tech - II Semester – Regular / Supplementary Examinations
JUNE 2026

ENGINEERING PHYSICS
(Common for EEE, ECE, CSE)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Distinguish between Spontaneous and Stimulated emission.	L4	CO4
1.b)	Discuss the structure of an optical fiber.	L3	CO2
1.c)	Explain the term “Coordination number”.	L4	CO5
1.d)	What is packing fraction?	L2	CO1
1.e)	Define Displacement vector (D).	L2	CO1
1.f)	What is Magnetic permeability?	L3	CO3
1.g)	Interpret Heisenberg’s Uncertainty Principle. Why can’t we measure both simultaneously with absolute precision?	L4	CO5
1.h)	Write the physical interpretation of wave function ‘Ψ’ .	L3	CO3
1.i)	Why is a semiconductor act as an insulator at 0 K?	L4	CO4
1.j)	What are intrinsic and extrinsic semiconductors?	L3	CO2

PART – B

			BL	CO	Max. Marks
UNIT-I					
2	a)	Choose any four applications of LASERS in various fields.	L3	CO2	4 M
	b)	Explain the construction of He-Ne Laser, and its lasing action with the help of energy level diagram.	L4	CO4	6 M
OR					
3	a)	Classify the different types of optical fibers.	L4	CO4	4 M
	b)	Interpret the expressions for the Acceptance Angle and Numerical Aperture of an optical fiber.	L3	CO2	6 M
UNIT-II					
4	a)	Discuss Crystal lattice, Bravia's lattice and primitive cell.	L3	CO3	3 M
	b)	Sketch the crystal systems with neat diagram.	L3	CO3	7 M
OR					
5	a)	Explain Bragg's law.	L4	CO5	4 M
	b)	Analyze Laue's method to determine crystal structure.	L4	CO5	6 M
UNIT-III					
6	a)	Illustrate various types of polarization mechanisms in dielectrics.	L3	CO3	4 M

	b)	Discuss Frequency dependence of polarization mechanisms.	L3	CO3	6 M
OR					
7	a)	Explain Hysteresis curve in magnetism.	L4	CO5	4 M
	b)	Analyze domain concept for Ferro magnetism & Domain walls, what are anti ferro and ferri magnetic materials.	L4	CO5	6 M
UNIT-IV					
8	a)	Elaborate De-Broglie's hypothesis of matter waves.	L3	CO3	2 M
	b)	Estimate the energy eigen values of a Particle in a one-dimensional infinite potential well using Schrodinger's wave equation.	L3	CO3	8 M
OR					
9	a)	Compare and contrast classical free electron theory with quantum free electron theory.	L4	CO5	4 M
	b)	Explain the Fermi-Dirac distribution function and its significance in understanding electron occupancy at different energy levels and temperatures.	L4	CO5	6 M
UNIT-V					
10	a)	Explain the formation of energy bands in solids. Based on this, provide a detailed classification of crystalline solids into conductors, semiconductors, and insulators with neat energy band diagrams.	L4	CO4	6 M

	b)	Discuss the dependence of Fermi energy on carrier concentration and temperature.	L4	CO4	4 M
OR					
11	a)	What is the Hall Effect? Obtain an expression for the Hall Coefficient, and the Hall Voltage.	L3	CO2	6 M
	b)	List the major applications of the Hall effect.	L3	CO2	4 M

ENGINEERING PHYSICS (23BS1203)

Scheme of Valuation

PART- A

1.a)

Any TWO distinguishes ---- 2M

1.b)

Diagram ---- 1M

Parts ---- 1M

1.c)

Coordination Number definition ---- 2M

1.d)

Packing Fraction Definition ---- 1M

Formula ---- 1M

1.e)

Definition ---- 1M

Formula ---- 1M

1.f)

Definition ---- 1M

Formula ---- 1M

1.g)

Definition ---- 1 M

Formula including reason ---- 1M

1.h)

Any TWO Physical Interpretations ---- 2M

1. i)

Explanation ---- 2M

1.j)

Intrinsic Semiconductor ---- 1M

Extrinsic Semiconductor ---- 1M

PART-B

2.a)

Any FOUR application ---- 4M

2.b)

Construction of He-Ne laser ---- 2M

Lasing Action Explanation ---- 2M

Energy level diagram ---- 2M

3.a)

Classification ---- 2M

Explanation ---- 2M

3.b)

Acceptance angle definition ---- 1M

Derivation ---- 2M

Numerical Aperture definition ---- 1M

Derivation ---- 2M

4.a)

Crystal lattice definition ---- 1M

Bravia's Lattice definition ---- 1M

Primitive Cell (Unit Cell) Definition ---- 1M

4.b)

Seven crystal systems a,b,c & angle relations ---- 3M

Seven crystal systems diagrams ---- 4M

5.a)

Bragg's law definition ---- 1M

Diagram ---- 1M

Explanation & derivation ---- 2M

5.b)

Laue method diagram ---- 2M

Explanation ---- 1M

Derivation ---- 2M

Final formulae ----1M

6.a)

Electronic polarization ---- 2M

Ionic polarization ---- 1M

Orientational polarization ---- 1M

6.b)

Frequency dependence Graph ---- 3M

Explanation ---- 3M

7.a)

Hysteresis curve diagram ---- 2M

Explanation ---- 2M

7.b)

Domain concept explanation ----2M

Domain walls diagram ---- 2M

Anti ferro magnetic material definition ---- 1M

Ferri magnetic material definition ---- 1M

8.a)

Debroglie hypothesis of matter waves definition ---- 1M

Formulae ---- 1M

8.b)

One-dimensional potential box diagram ---- 1M

Explanation ---- 2M

Derivation ---- 2M

Eigen value formula ---- 1M

Energy level diagram ---- 2M

9.a)

Any TWO comparisons ---- 2M

Any TWO contrasts ---- 2M

9.b)

Fermi- Dirac distribution function formula ---- 1M

Explanation ---- 2M

Graphs ---- 2M

Temperature dependence ---- 1M

10.a)

Formation of Energy bands in solids ---- 2M

Classifications & Explanation ---- 2M

Diagrams ---- 2M

10.b)

Fermi energy definition ---- 1M

Formula ---- 1M

Intrinsic semiconductor fermi energy variation ---- 1M

Extrinsic Semiconductor fermi Energy variation ---- 1M

11.a)

Hall effect definition ---- 1M

Derivation of Hall coefficient & Hall Voltage ---- 3M

Diagram ---- 2M

11.b)

Any FOUR application ----4M

	PART-A
Q.NO	
1.a)	**Distinguish between Spontaneous and Stimulated emission.**

Ans

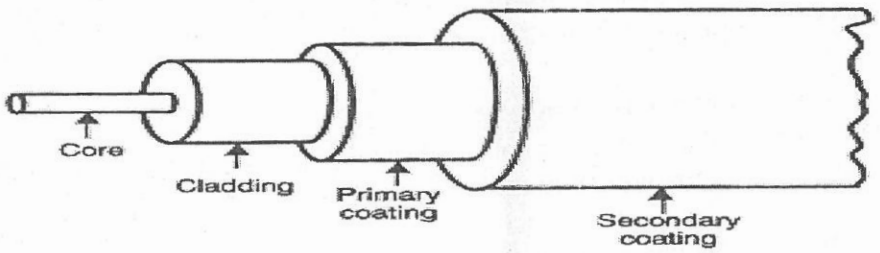
S.No	Spontaneous Emission	Stimulated Emission
1.	Emission of light photon takes place immediately without external agency during the transition of atoms.	Emission light photon by inducement of a photon with same energy of Difference between the energy levels.
2.	No incident photon is required	Incident photon is required
3.	single photon is emitted	Double photon energy emitted.
4.	Incoherent radiation & less intensity.	Coherent radiation and high intensity.

1.b) Discuss the structure of an optical fiber

Ans

Structure of an optical fiber:-

An optical fiber is a flexible thin and transparent plastic or glass in which light is transmitted by multiple total internal reflections. The Structure of an optical fiber is as shown in below fig. It consists of core, cladding and buffer coating (protecting material)



1.c) Explain the term "Coordination number".

Ans It is the number of nearest equidistant neighbours that an atom has in a unitcell. Its value depends upon the type of crystal structure.
For example the co-ordination number for simple cubic is 6.

1.d) What is packing fraction?

Ans It is the ratio of the volume occupied by the atoms in the unit cell to volume of unit cell.

1.e) Define Displacement Vector (D)

Ans The number of electric lines of force passing normally through a surface per unit cross sectional area is called electric flux density or electric displacement.

$D \propto E$ (or) $D = \varepsilon E = \varepsilon_0 \varepsilon_r E$

It is independent of the dielectric medium. Units: Coulomb/meter^2

1.f) What is Magnetic permeability?

Ans It is defined as the ratio of magnetic induction in the sample to the applied field

	intensity. In a medium this relation can be written as B = $\mu H \Rightarrow$ $\boxed{\mu = \frac{B}{H}}$
1.g)	**Interpret Heisenberg's Uncertainty Principle. Why can't we measure both simultaneously with absolute precision?**
Ans	It is impossible to determine precisely and simultaneously the values of both the members of a pair of physical variables which describe the motion of an atomic system. Such pair of variables is called canonically conjugate variables. For example they are momentum and position Let Δx as the error in determining its position and Δp is the error in determining its momentum at the same instant, these quantities are related as $\Delta x \ \Delta p \geq \frac{\hbar}{2} \geq \frac{h}{4\pi}$ Similarly $\Delta E \ \Delta t \geq \frac{\hbar}{2} \geq \frac{h}{4\pi}$
1.h)	**Write the physical interpretation of wave function 'Ψ'**
Ans	The Wave function Ψ gives the information about the particle. Since it is a complex function, it does not have any direct physical meaning. Born suggested that the probability associated with the wave function is related to finding the particle there at the time. But Ψ alone cannot be equal to this probability. The value of probability lies between two limits they are zero, corresponding to certainty of its absence and one corresponds to certainty of its presence. The amplitude of wave may be positive or negative. But the negative probability is meaningless. By analogy the intensity of monochromatic radiation is square of the amplitude. Therefore the square of absolute magnitude of the wave function Ψ is interpreted as $\lvert\Psi^2\rvert$ as the probability density. Since it is a real value it has physical meaning.
1.i)	**Why is a semiconductor act as an insulator at 0 K?**
Ans	At 0K Temperature the semiconductor act as an Insulator because there is no free electrons are available at 0K temperature due to not breaking of covalent bonds of semiconductors.
1.j)	**What are Intrinsic and Extrinsic semiconductors?**
Ans	**Types of Semiconductors** Semiconductors can be classified as: 1. Intrinsic Semiconductor. 2. Extrinsic Semiconductor. **Intrinsic (or) pure Semiconductor:** A pure semiconducting material without any impurity iscalled intrinsic semiconductors. IV group elements are the intrinsic (or) pure semiconductors. For eg: Si, Ge. **Extrinsic Semiconductors (Or) Impure Semiconductors:** The semiconductor in which impurities are added is called extrinsic semiconductor. Depending upon the doping concentration these semiconductors divided into two types • P-type Extrinsic semiconductor • N-type Extrinsic semiconductor
	PART – B
	UNIT-I
2 a)	**Choose any four applications of LASERS in various fields?**
Ans	1. Lasers are used in microwave communications due to their narrow

bandwidth.

2. Lasers are used in CD-ROMs during recording and reading the data.
3. Lasers are used to blast holes in diamonds and hard steel.
4. Lasers are used in the field of 3D photography called holography.
5. A laser beam can be bounced off a target such as enemy air plane or ship, to determine its distance and speed.
6. Laser beams have been used in the eye surgery for the detachment of retinas.

2 b) Explain the construction of He-Ne Laser, and its lasing action with the help of energy level diagram.

Ans

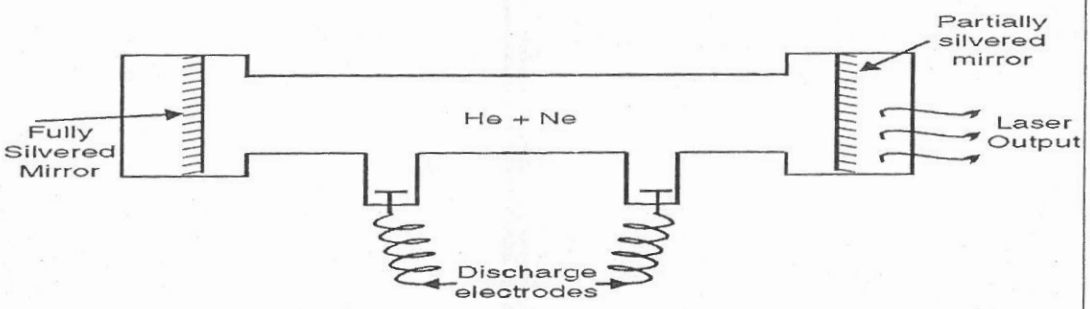
He-Ne gas laser:- It was invented by the scientist Ali Javan in 1961. He-Ne laser is a gaseous state laser system and is used to produce a continuous laser. This laser is highly directional, monochromatic, coherent and stable. But the output power is moderate when it is compared with the solid state laser. It is very useful in making holograms and interferometric experiments.

Source of energy –R.F oscillator

Active medium-He-Ne gas mixture

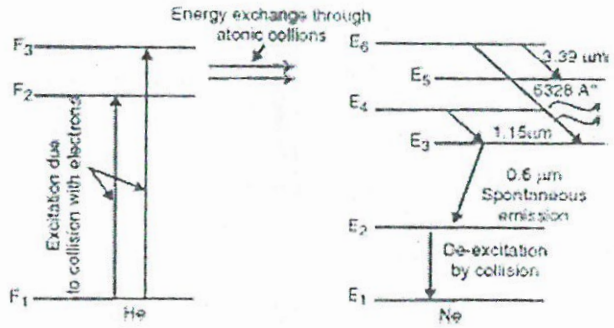
Optical cavity-Arrangement of reflector

Construction:- .The schematic diagram of He- Ne laser is shown in below fig. It consists of a long narrow quartz discharge tube filled with helium and neon mixture in the ratio of 10:1. The He atoms are at a pressure of 1mm of Hg and the neon atoms are at pressure of 0.1mm of Hg. That is the pressure of He & Ne atoms are in the ratio of 10:1. The laser action takes place in the energy levels of Ne atom. Helium atoms help to achieve population inversion by imparting their energy to the Ne atoms. The electrodes are placed close to the discharge tube and a source of high frequency alternating current is connected to the electrodes. The He-Ne gas mixture forms the lasing medium. The mixture is enclosed between a set of parallel mirrors forming a resonating cavity. One of the mirrors is completely reflecting and the other partially reflecting in order to amplify the output laser beam.



Working:- The working principal of He- Ne laser is shown in the below energy level diagram. In He there are three active energy levels namely He_1 ,He_2 & He_3 where as in Neon atom there are six energy levels namely Ne_1, Ne_2, Ne_3, Ne_4, Ne_5 & Ne_6. When an electric discharge tube passes through the gas, the electrons which are accelerated down the tube, collide with the helium and neon atoms. He atoms are excited very efficiently by electron impact into the higher energy level He_2 and

	He_3,but the neon atoms remain in the ground state. The He_2 and He_3 levels are meta stable states of helium. The atoms are stay longer time in these states. The life time of He_2 and He_3 levels are 10^{-4}sec and $5x10^{-6}$sec respectively. Now these helium atoms in the meta stable states are inelastically collide with the neon atoms which are in the ground state and excite the neon atoms to their meta stable states Ne_4 and Ne_6, while the helium atoms return to their ground state. The energy level of Ne_4 and Ne_6 coincides with He_2 and He_3 respectively. Therefore the states Ne_4 and Ne_6 of neon atoms act as meta stable states. So the neon atoms stay longer time in these states. As the energy exchange continues, the population inversion will be achieved in the meta stable states Ne_4 and Ne_6.



The various possible transitions are:

i)Some of the neon atoms are de-excite from Ne_6 to Ne_5. In this transition the electromagnetic radiation of wavelength of 3.39μm will be emitted.

ii)The other neon atoms de-excite from Ne_6 to Ne_3. During this transition a photon of wavelength 6328A° is emitted. This is the important and major wavelength in this laser. This photon causes laser emission.

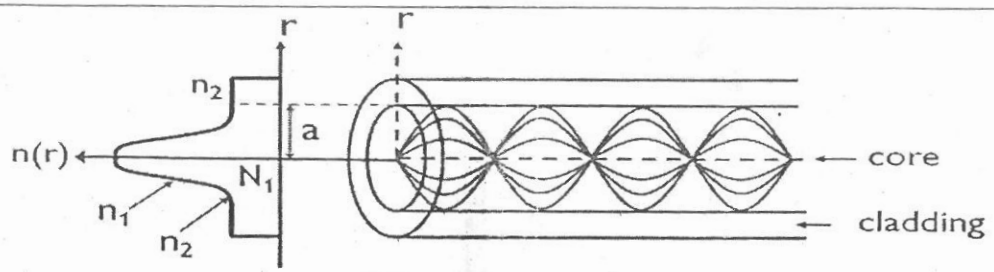
iii)The neon atoms in the Ne_4 state are de-excited to Ne_3, then an electromagnetic radiation of wavelength 1.15μm is emitted.

iv)The neon atoms in Ne_3 state de-excite spontaneously to Ne_2 state by emitting an electromagnetic radiation of wavelength 6000A°.

v)The neon atoms in the state Ne_2 de-excite to the Ne_1 by making collisions with the wall of the discharge tube.

Here the wavelength of laser output is 6328A°.

	OR
3 a)	**Classify the different types of optical fibers.**
Ans	Optical fibers can be classified based on either the modes they support or the refractive index profile of the fiber. Another classification is based on the material of the Optical fiber either glass or plastic. **Single mode and Multi mode Optical fibers:** We have seen that the light launched at one end of the fiber within the acceptance cone alone propagates through the fiber by total internal reflection. But



Ray Transmission in Multimode Graded Index Fiber

Circuit Globe

It has maximum refractive index at its center, which gradually falls with increase of radius and at the core- cladding interface matches with the refractive index of the cladding.

Transmission of signal in graded index fiber:

Let us consider a signal pulse travelling through graded index fiber in two different paths 1 and 2. The pulse 1, travelling along the axis of the fiber, through travels along shorter route it travels through a medium of higher refractive index. The other pulse 2, travelling away from the axis undergo refraction and bend as shown in fig.

3 b) Interpret the expressions for the Acceptance Angle and Numerical Aperture of an optical fiber.

Ans

Acceptance angle:

Consider a ray of light traveling along a medium of refractive index n_o, incident at air-core interface of the optical fiber and making an angle Θ_i with the axis of fiber. It is refracted into the core of refractive index n_1 with angle of refraction Θ_r. This ray makes an angle φ with the normal at the core-cladding interface and is totally reflected into the core as shown in below fig.(a). If φ greater than the critical angle Θ_c, the ray undergoes total internal reflection at the interface, since $n_1 > n_2$. As long as φ is greater than the critical angle Θ_c the light will stay within the fiber.

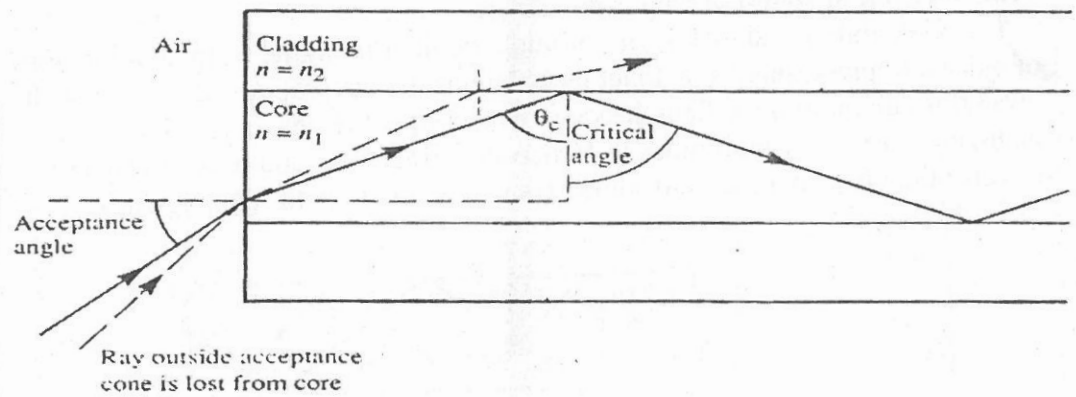


Fig.(a)

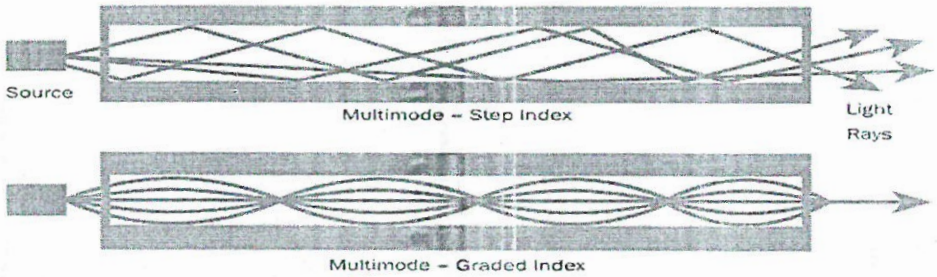
According to Snell's law at the air-core interface

$$n_o \sin \Theta_i = n_1 \sin \Theta_r$$

$$\sin \Theta_i = n_1 / n_o \sin \Theta_r \text{----------(1)}$$

If Θ_i is increased beyond a limit, φ will decrease below the critical angle Θ_c and the ray escapes from the side walls of the fiber. The largest value of Θ_i occurs

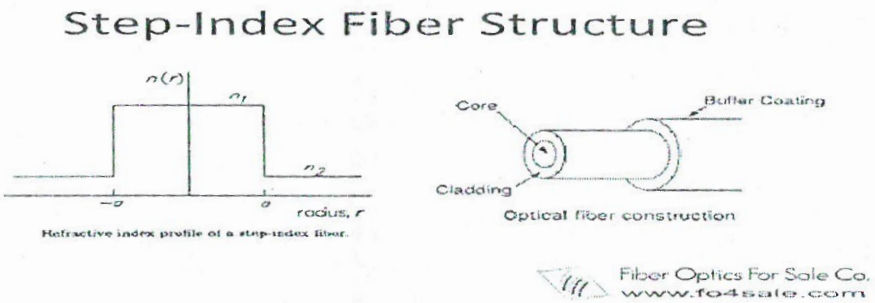
not all the light within the acceptance cone propagates but only specified directions are allowed which satisify conditions for constructive interference. The rays travelling in these specified directions called **modes** as shown in fig.



The number of modes that the fiber supports depends on the dimension of the fiber. If the thickness of the fiber is so small that it supports only one mode then the fiber is called **single mode fiber or mono mode fiber**. Instead if it supports more than one mode then it is called **Multimode fiber.** The single mode fiber has very small core diameter of the order of 2 to 8 μm. The core diameter of the multimode fiber is of the order of 50 μm.

Step Index fiber:

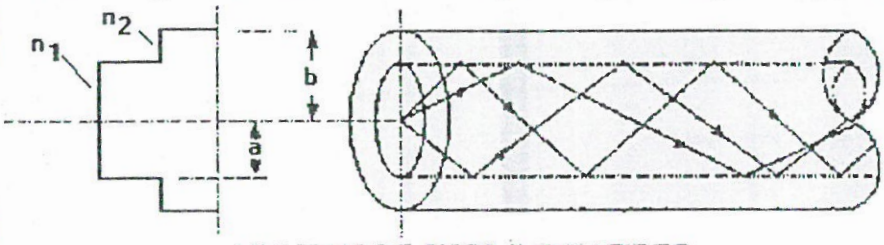
In these fibers the entire core has uniform refractive index n_1 slightly greater than the refractive index of the cladding n_2 as shown in below fig.



Since the index profile is in the form of a step, these fibers are called step index fibers.

Transmission of signal in step index fiber:

Generally the signal is sent through the fiber in digital form i.e in the form of pulses. Representing 0s or 1s.let us now consider the propagation of one such pulse through multimode fiber.the same pulsed signal travels in different paths(represented by multimodes). Hence at the receiving end only the ray (1) travels along the fiber axis and some rays taking longer paths (2) (zig-zag)



MULTIMODE STEP-INDEX FIBER

Graded index fiber:

In the graded index multimode fiber, the refractive index of the core varies radically as shown in below fig.

when $\varphi = \Theta c$.

From the fig. Δ^{le} OAB, $\varphi + \Theta_r = 90^\circ$

$$\Theta_r = 90^\circ - \varphi$$

$$\sin \Theta_r = \sin(90^\circ - \varphi) = \cos \varphi \text{----------(2)}$$

Substituting the value of $\sin \Theta_r$ from equation (2) in equ.(1), we get

$$\sin \Theta_i = n_1 / n_o \cos \varphi$$

When $\varphi = \Theta c$,

$$\sin[\Theta_i(max)] = n_1 / n_o \cos \Theta c, \text{----------(3)}$$

But the condition for total internal reflection, $\sin \Theta_c = n_2 / n_1$

$$\cos \Theta c = (1 - \sin \Theta c)^{1/2} = [1 - n_2^2 / n_1^2]^{1/2}$$

$$= [n_1^2 - n_2^2]^{1/2} / n_1 \text{----------(4)}$$

Substituting the value of $\cos \Theta c$ from equ.(4) in equ.(3), we get

$$\sin[\Theta_i(max)] = n_1 / n_o [n_1^2 - n_2^2]^{1/2} / n_1$$

$$= [n_1^2 - n_2^2]^{1/2} / n_o$$

By representing $\Theta_i(max)$ as Θ_a

$$\text{Sin } \Theta_a = [n_1^2 - n_2^2]^{1/2} / n_o \text{----------(5)}$$

For air medium $n_o = 1$

$$\text{Sin } \Theta_a = [n_1^2 - n_2^2]^{1/2}$$

$$\Theta_a = \sin^{-1} [n_1^2 - n_2^2]^{1/2} \text{----------(6)}$$

The angle Θ_a is called the acceptance angle of the fiber. The acceptance angle may be defined as the maximum angle of incidence that light ray makes with the axis of the fiber to get the total internal reflection.

Numerical aperture:-

It is defined as "The light gathering capacity of an optical fiber" and is proportional to acceptance angle. Sometimes it is called the figure of merit for optical fiber. It is a measure of the amount of light that can be accepted by as fiber. Numerically it is equal to sine of acceptance angle.

$$\text{Numerical Aperture(NA)} = \text{Sin } \Theta_a = [n_1^2 - n_2^2]^{1/2} / n_o$$

For air medium $n_o = 1$, then

$$NA = [n_1^2 - n_2^2]^{1/2}$$

Generally n_1 is slightly greater than n_2.

$$NA = [(n_1 + n_2)(n_1 - n_2)]^{1/2}$$

$$= n_1 (2\Delta)^{1/2} \text{----------(1)}$$

Where $n_1 + n_2 \approx 2n_1$ and the Δ is fractional difference between the refractive indices of core and cladding known as a fractional refractive index change. It is expressed as

$$\Delta = n_1 - n_2 / n_1 \text{---------- (2)}$$

The Numerical Aperture depends on the refractive indices of core and cladding materials. Larger numerical aperture implies that a fiber will accept large amount of light from the source. The value of numerical aperture ranges from 0.13 to 0.50.

UNIT-II

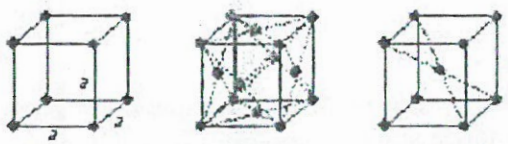
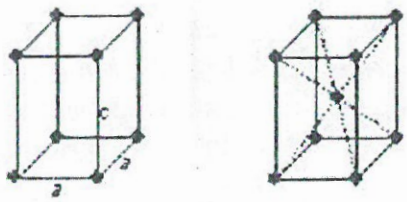
4 a) Discuss Crystal lattice, Bravia's lattice and primitive cell.

Ans

Crystal lattice : A crystal lattice is a regular three-dimensional arrangement of identical points representing the positions of atoms, ions, or molecules in a crystal.

Characteristics:

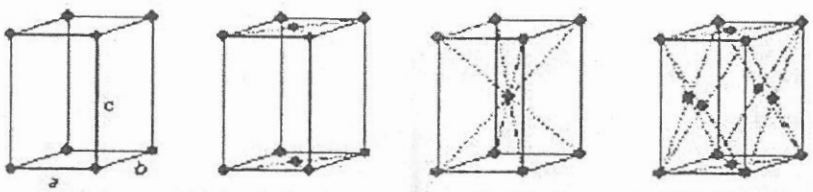
- Has a periodic and repeating pattern.

	• Each lattice point has the same environment. • Gives crystals their regular geometric shape. **Bravais lattice :**A Bravais lattice is a set of all possible three-dimensional crystal lattices that can be formed by repeating a unit cell in space. A Bravais lattice is an infinite arrangement of points in space in which every lattice point has an identical environment. **Classification:** The 14 Bravais lattices belong to **7 crystal systems**: **Primitive Cell (Unit Cell):**A primitive cell is the smallest unit cell containing only one lattice point and capable of generating the whole crystal lattice by repetition. **Characteristics:** • Contains exactly **one lattice point.** • Has the smallest possible volume. • Repeating the primitive cell forms the complete crystal.
4 b)	**Sketch the crystal systems with neat diagrams**
Ans	**CRYSTAL SYSTEMS**: There are thirty two types of crystal systems based on Geometric consideration. But there are seven basic groups of crystal systems. They are distinguished depending upon the lattice parameters. **CUBIC CRYSTAL SYSTEM**: The configuration of the lattice parameters in this crystal system is $a = b = c$ & $\alpha = \beta = \gamma = 90°$ The intercepts made by the unit cell on three crystallographic axes is same.  Simple Face-centered Body-centered CUBIC The angles between crystallographic axes are same and they are mutually perpendicular to each other. The Bravais lattices under this crystal system is simple,body centred and face centred. Examples for this crystal system are $NaCl, CaF_2, NaClO_2$ etc., **TETRAGONAL CRYSTAL SYSTEM:** The configuration of the lattice parameters for this crystal system is $a = b \neq c$ & $\alpha = \beta = \gamma = 90°$ The intercepts made by the unit cell on two crystallographic axes is same but on the third axis it is different.  Simple Body-centered TETRAGONAL The angles between crystallographic axes are same and they are mutually perpendicular to each other. Bravais lattices under this crystal system are simple,

body-centred. Examples for this crystal system are $NiSO_4$,SnO_2 etc.,

ORTHORHOMBIC CRYSTAL SYSTEM: The configuration of the lattice parameters for this crystal system is $a \neq b \neq c$ & $\alpha = \beta = \gamma = 90°$

The intercepts made by the unit cell on the three crystallographic axes are different. The angles between the crystallographic axes are same and they are mutually perpendicular to each other.



ORTHORHOMBIC

The Bravais lattices under this crystal system are simple,base-centred,body-centred,face-centred. Examples for this crystal system are KNO_3,$BaSO_4$ etc.,

MONOCLINIC CRYSTAL SYSTEM: The configuration of the lattice parameters for this crystal system is $a \neq b \neq c$ & $\alpha = \beta = 90° \neq \gamma$.

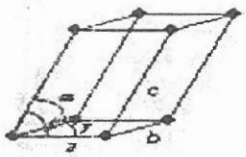
The intercepts made by the unit cell on the three crystallographic axes are different and one axis is perpendicular to the other two axes the angle between other two axes is other than 90°.

MONOCLINIC

The Bravais lattices under this crystal system are simple,base-centered. Examples for this crystal system are Na_2SO_3,$FeSO_4$, etc.,

TRICLINIC CRYSTAL SYSTEM: The configuration of the lattice parameters for this crystal system is $a \neq b \neq c$ & $\alpha \neq \beta \neq \gamma \neq 90°$.

The intercepts made by the unit cell on the three crystallographic axes are different and the angles between the crystallographic axes are not equal and they are other than 90°.



TRICLINIC

The Bravais lattices under this crystal system are simple. Examples for this crystal system are $CuSO_4$,$K_2Cr_2O_7$,etc.,

TRIOGONAL OR RHOMBOHEDRAL CRYSTAL SYSTEM: : The configuration of the lattice parameters in this crystal system is $a = b = c$ & $\alpha = \beta = \gamma \neq 90°$.

The intercepts made by the unit cell on the three crystallographic axes are the same and the angles between the crystallographic axis are the same and it is other than 90°.

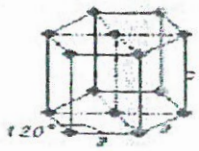
RHOMBOHEDRAL

The Bravais lattices under this crystal system is Simple. Examples for this crystal system are

$CaSO_4$ etc.,

HEXAGONAL CRYSTAL SYSTEM: The configuration of the lattice parameters this crystal system is $a = b \neq c$, $\alpha = \beta = 90°, \gamma = 120°$.

The intercepts made by the unit cell on two crystallographic axes are the same and on the third axis it is different. One axis is perpendicular to the two axes and e angle between the other two axes is equal to 120°.



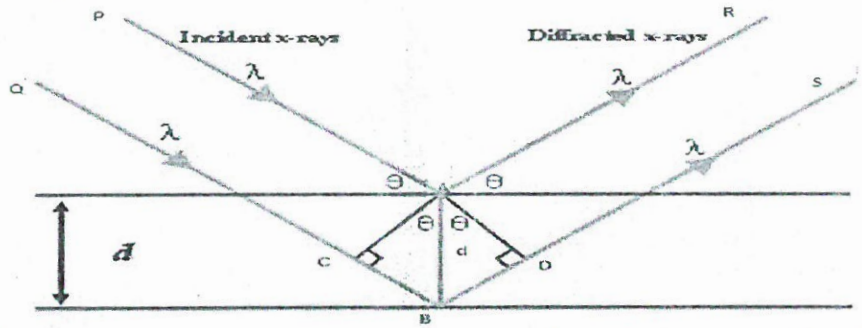
HEXAGONAL

The Bravais lattices under this crystal system is simple. Examples for this ystal system Are SiO_2,AgI etc.,

OR

5 a) Explain Bragg's law.

Ans Consider a crystal made up of equidistant parallel planes of atoms with the interplanar spacing as d. Consider a monochromatic X-ray beam of wavelength λ having a common wavefront falls at an angle θ on these planes. Each atom scatters the X-rays more or less uniformly in all directions, but because of periodic arrangement of atoms, the scattered radiation from all atoms in a set of planes in phase where they interfere constructively.In all other directions there is destructive interference.



Consider a ray PA reflected at atom A in the direction AR frome the Plane 1 and another ray QB reflected at another atom B in the direction BS. Now atom A draw two perpendiculars AC and AD on QB and BS respectively. The two reflected rays will be in phase or out of phas depending on the pathdifference. When the pathdifference (CB + BD) is equal to integral multiple of λ then it is constructive

interference a bright spot is produced.

Pathdifference = CB + BD

From the ΔABD AB = d, $\angle$ ACB = 90° , $\angle$ CAB =θ

$$\sin\theta = \frac{BC}{d} \text{ , BC} = d\sin\theta$$

From the ΔABC AB = d, $\angle$ ADB = 90° , $\angle DAB$ =θ

$$\sin\theta = \frac{BD}{d} \text{ , BD} = d\sin\theta$$

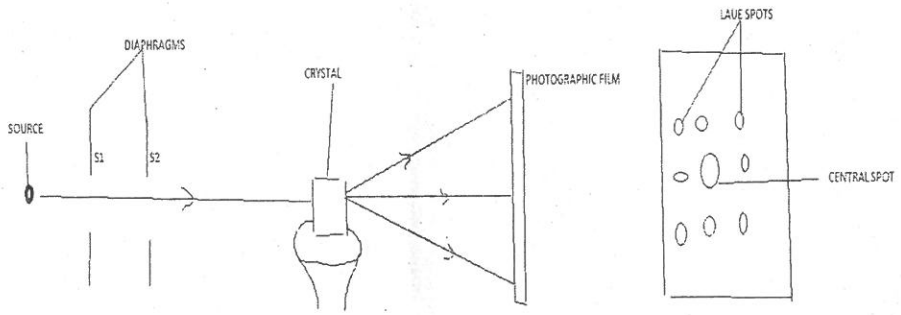
Pathdifference = CB + BD = $d\sin\theta + d\sin\theta = 2d\sin\theta$

According Bragg's $\mathbf{2d\sin\theta = n\lambda}$

This is known as Bragg's law. d is the interplanar spacing of planes and n is an integer it takes the values n = 1,2, etc., n is called order of the spectrum. λ is the wavelength of X-rays.

5 b) Analyze Laue's method to determine crystal structure.

Ans Laue suggested that the crystal can be used as a three dimensional grating. In Laue method the sample is single crystal and white radiation(polychromatic) is used to get the Laue Photograph. This method is hardly used for crystal structure determination.



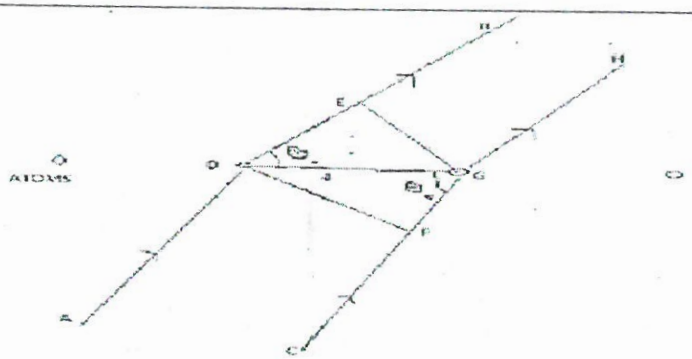
A heterogeneous (having different wavelength) beam of X-rays in the wavelength range 0.2 to 2.0Å originating from a suitable source is collimated by pin-hole arrangements in lead diaphragms into a fine pencil. The size of the pin hole should be kept very small to get a sharp intereference pattern. The small is the pinhole diameter,sharper is the interference pattern.

X-rays which penetrate the crystal are scattered from different diffraction planes as there is a whole range of wavelengths. Each family of crystal planes picks out the wavelength which it can diffract at the angle which it finds itself. The diffraction pattern consists of a bright central spot and a set of spots arranged in a definite pattern about the central spot. The symmetrical pattern caused by diffraction of X-rays by crystal planes is called the Laue pattern.

LAUE THEORY:

Consider a row of regularly spaced atoms. Let a parallel beam of X-ray meet such a row of atoms at an angle θ. Let 'a' be the constant of spacing between the atoms.

All atoms become centres of scattered waves.



AD is an X-ray incidenting on atom at the point D and is getting diffracted in the direction DB. CG is another X-ray incidenting on atom at the point G and is getting diffracted in the direction GH. GE is the normal drawn on to the first ray from the point G. DF is the normal drawn on to the second ray from the point D. The time in which first ray is going from D to E the second ray is going from F to G.

The path difference between these two rays is = DE – FG

In the Δ DFG DG = a ∟DFG = 90°

∟DGF = θ_0

$$\cos\theta 0 = \frac{FG}{DG} = \frac{FG}{a}$$

$\therefore$ FG = acos θ0

In the Δ DEG DG = a ∟DEG = 90°

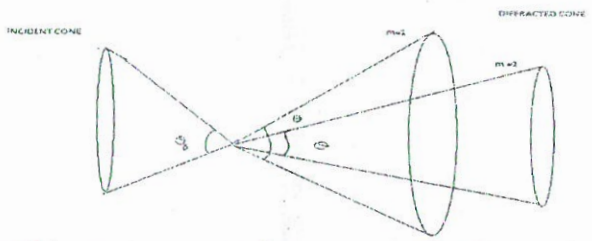
∟GDE = θ

$$\cos\theta = \frac{DE}{DG} = \frac{DE}{a}$$

$\therefore$ DE = acos θ

The path difference = DE – FG = a(cos θ -cos θ0) = mλ

$$\cos\theta = \cos\theta 0 + \frac{m\lambda}{a} \quad \text{where m=0,1,2,3 etc.,}$$



Different cones will be formed with different values of m with the same apex. The cones when they meet the film are recorded as concentric circles.

Each Laue spot corresponds to an interference maximum for a set of crystal planes satisfying Bragg's condition for a particular wavelength selected from the incident X-radiation. Hence a measurement of the position and intensity of the Laue spots can be utilized to understand or arrive at the atomic arrangement in the crystal.

	UNIT-III
6 a)	**Illustrate various types of polarization mechanisms in dielectrics**
Ans	**Electronic polarisation:** An electric strain produced in an atom due to the application of electric field is

called electronic polarisation. It is a result of displacement of positively charged nucleus and electron cloud of an atom in opposite direction to the applied field

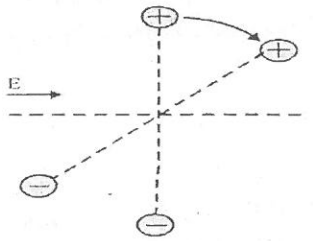
$$\alpha_e = \varepsilon_o(\varepsilon_r - 1)E/N$$

Ionic polarisation

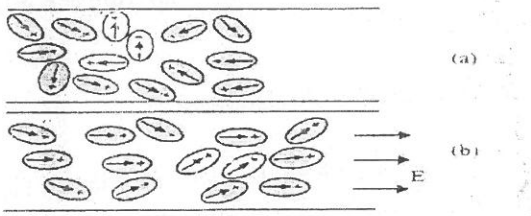
The ionic polarization is due to the displacement of cations and anions in opposite directions and occurs in an ionic solid.

$$\alpha_a = \frac{e^2}{\omega_o^2}\left(\frac{1}{m} + \frac{1}{M}\right)$$

Dipolar polarisation (or) Orientation Polarisation.



Orientation of dipole molecule



Dipole orientation (a) In zero field
(b) In the presence of strong field

In the absence of an external electric field, the orientation of dipoles in a dipolar Molecule (H_2O, CO) is random so that net polarization is zero.

When electric field is applied, the dipoles try to orient in the field direction.

This kind of polarization is due to the alignment of already existing dipoles in the polar substances is called Dipolar Polarization.

$$\alpha_d = \frac{\mu^2}{3\,k_B T}$$

6 b) Discuss Frequency dependance of polarization mechanisms

Ans

Frequency dependence of polarization:

On application of an electric field, a polarisation process occurs as a function of time. Polarisation $P(t) = P[1-\exp(-t/t_r)]$ Where 'P' is the maximum polarisation attained on application of a static field & t_r is the relaxation time for the particular polarisation process.

Electronic polarisation:

Electronic polarisation is extremely rapid. Even when the frequency of the application voltage is very high in the optical range ($\sim 10^{15}$ Hz), electronic polarisation occurs during every cycle of the applied voltage.

Ionic polarisation:

Ionic polarisation is due to displacement of ions over a small distance due to

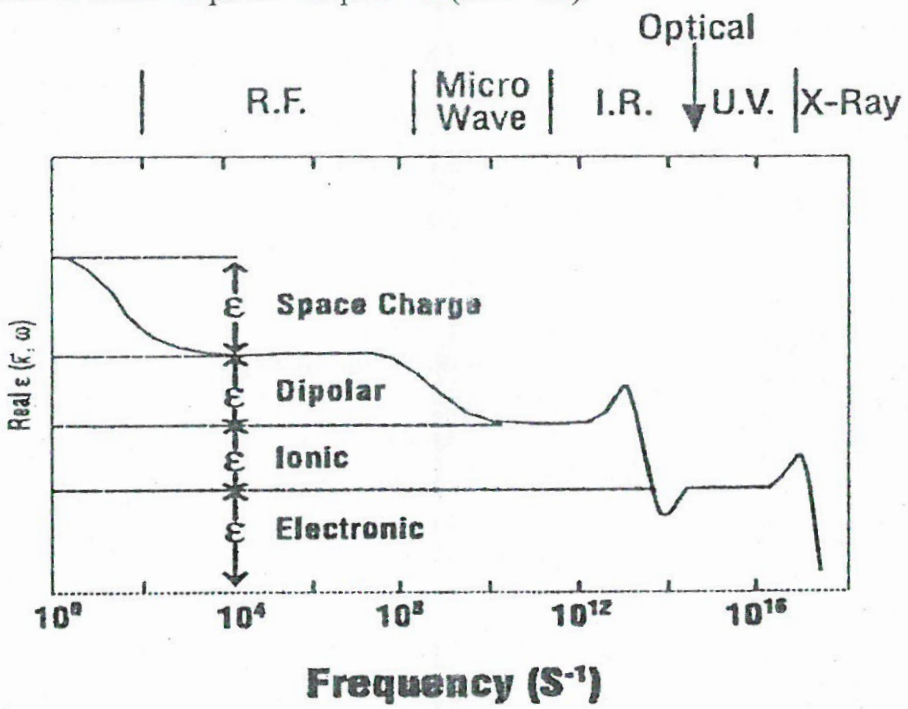
the applied field. Since ions are heavier than electron cloud, the time taken for displacement is larger. The frequency with which ions are displaced is of the order as the lattice vibration frequency (~10^{13} Hz). This means that for optical frequency the ions do not respond, as the time required for lattice vibrations is nearly 100 times larger than the period of applied voltage at optical frequency. Hence, at optical frequencies, there is no ionic polarisation. If the frequency of the applied voltage is less than 10^{13}Hz, the ions respond. So at 10^{13}Hz, we have both electronic polarisation and ionic polarisation responding.

Orientation polarisation:

The orientation polarisation is even slower than ionic polarisation the relaxation time for the orientation polarisation in a liquid is less than that in a solid. Orientation polarisation occurs when the frequency of the applied voltage is in the audio range. At 10^6 to 10^{10} Hz range contribution due to orientation polarisation gets added.

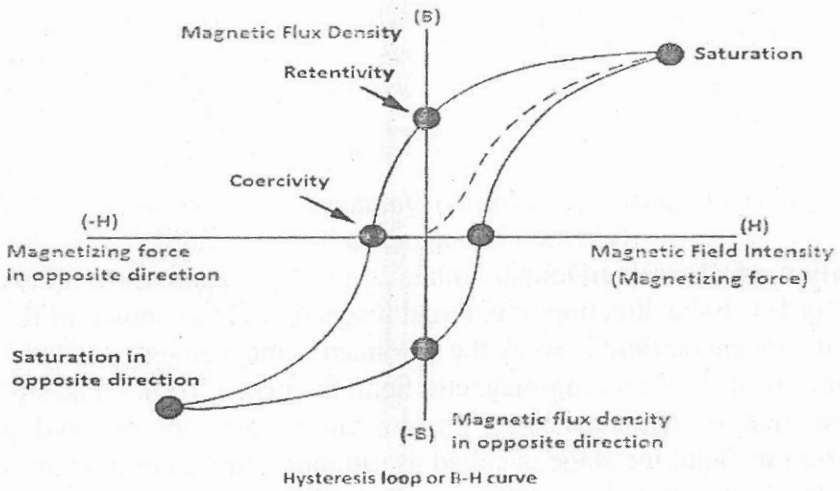
Space charge polarisation:

Space charge polarisation is the slower process, as it involves the diffusion of ions over several interatomic distances. The relaxation time for this process is related to the frequency of successful jumps of ions under the influence of the applied field, a typical value being 10^2Hz. correspondingly, space charge polarisation occurs at power frequencies (50-60Hz).



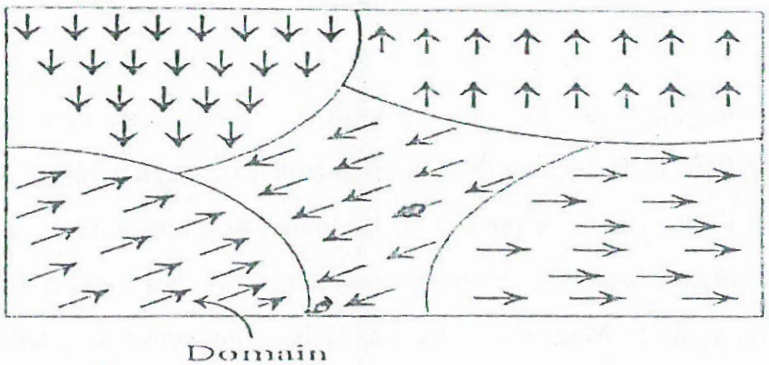
The above fig. Illustrates all the four types of polarisation at different frequency range.

OR

7 a)	**Explain Hysteresis curve in mechanisms.**
Ans	Below the Ferro magnetic **Curie** temperature ferromagnetic materials exhibit the **hysteresis** in B verses H curve as shown in figure. **Hysterisis** refers to the lag of magnetization behind the magnetizing filed.The variation of flux density B with magnetic field intensity H is not linear. But it performs a closed loop is known as **hysteresis loop**. Take a magnetic material completely in the unmagnified state. If we increase the applied magnetic field, the magnetization of the material first increases rapidly and then slowly until it attains a saturation value. Now the magnetic field is decreasing the rate of decrease of magnetization is less.Thus some amount of magnetism is present in the material even at H=0. This is known as **residual magnetism** (or) remnant magnetism (B_r). For certain values of negative magnetizing force Magnetic induction B becomes zero. The amount of negative field which is used to destroy the residual magnetism is known as **coercivity** or **coercive field H_c**. Further increasing the magnetic field in the same direction we attain negative saturation value. Finally the field once again reversed to get complete close loop. Thus B is lagging behind H. This is known as **hysteresis**.  Hysteresis loop or B-H curve
7 b)	**Analyze Domain concept for ferro magnetism & Domain walls, what are anti ferro and ferri magnetic materials**
Ans	**DOMAIN THEORY OF FERROMAGNETISM:** **Weiss** proposed the concept of domains in 1907 to explain the hysteresis effect of ferromagnetic. A region of ferromagnetic material where all the magnetic moments are aligned in the same direction is called **domain** varying from 10^{-9} to 10^{-5} m^3. Each domain contains about 10^{17} to 10^{21} atoms which are spontaneously magnetized. In each domain spontaneous magnetization is due to parallel alignment of all magnetic dipoles. The direction of spontaneous magnetization varies from domain to domain. These

domains are oriented randomly so that the net magnetic moment is always zero. Each domain possess dipoles aligned in the same direction. When magnetic field is applied the domains may tend to rotate in the direction of B.Thus magnetic material will be strongly magnetized

the external magnetic field induction B. In ferromagnetism the adjacent atomic dipoles are interact with **exchange coupling**.The resultant magnetization may hence be zero or nearly zero. When an external field is applied there are two possible ways of alignment of a random domain.



1.Displacement of Boundaries of the domains: The domains which are oriented favourable with respect to the external magnetizing field increases in size while those oriented opposite to the external field are reduced as shown in Fig.(b). Fig.(a) shows domain arrangement in a ferromagnetic specimen when no magnetic field is applied.

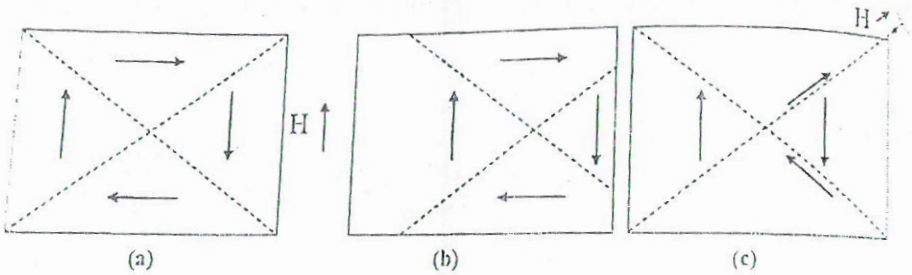
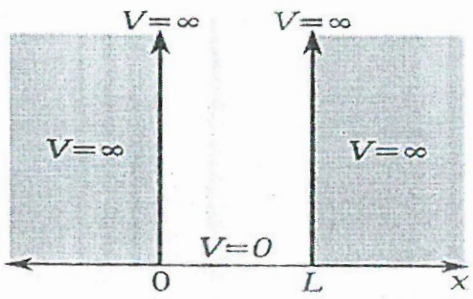


Fig (a) Ferromagnetic domains (b) Domain magnetization by wall movement (c) Domain magnetization by rotation.

Rotation of Domains: Domain rotate until their magnetic moments are aligned more or less in he direction of external magnetic field as shown in fig.(c). When the external magnetic field is weak the specimen is magnetized mostly by the boundary displacement. In the strong magnetic field, the magnetization takes place mostly by the rotation of domains.When the domain vectors are oriented parallel to the direction of field, the stage is called as saturation limit. On the removal of external field the boundaries do not move completely back to their original position and hence the specimen is not completely demagnetized. i.e there still remains some residual magnetism. At high temperatures, the domains are broken up and the ferromagnetic material becomes paramagnetic.

	UNIT-IV
8 a)	**Elaborate De-Broglie's hypothesis of matter waves**
Ans	**Debroglie Hypothesis of matter waves**: Debroglie has suggested that matter, like radiation has dual nature ie., the discrete particles atoms, protons, electrons exhibit wave like properties under appropriate conditions. **Debroglie concept of matter waves**: The following considerations has led the

	Debroglie to the conception of matter waves. **Derivation of Debroglie equation**: The dual nature of light possess both wave and particle properties explained combining Planck's energy of photon E=hν with Einestein mass energy relation $E=mc^2$ (Where c is the velocity of light) to give $h\nu = mc^2$ $\nu = \frac{c}{\lambda}$ we get $\lambda = \frac{h}{mc} = \frac{h}{p}$ .....(1) Where λ is the wavelength of Photon. Debroglie suggested that equation (1) can be applied to material particles as well as photons. Therefore for a particle the momentum is p =mv , where m is the mass and v is the velocity of particle. The Debroglie wavelength is accordingly $\lambda = \frac{h}{mv}$ .....(2) This is known as Debroglie wave equation. **Properties of Matter waves** Lighter is the particle, greater is the wavelength associated with it. Smaller is the velocity of the particle, greater is the wavelength associated with it. Matter waves are electromagnetic waves. Electromagnetic waves are produced only by the charged particles. The velocity of matter waves is greater than the velocity of light. This can be proved as under: $h\nu = mc^2$ or $\nu = \frac{mc^2}{h}$ and $\lambda = \frac{h}{mv}$ ------7------ The wave velocity(ω)is given by $\omega = \nu\lambda = \frac{mc^2}{h} \times \frac{h}{mv}$ $\omega = \frac{c^2}{v}$ As particle velocity v cannot exceed c , hence ω wave velocity is greater than velocity of light.
8 b)	**Estimate the energy eigen values of a particle in a one-dimensional infinite potential well using Schrodinger's wave equation**
Ans	Consider a particle moving inside a box along the X-direction. The motion of particle is confined between x=0 and x=L by infinite hard walls. So the particle has no chance of penetrating them. The particle does not loose energy when it collides with walls. So that it's total energy remains constant. The potential is infinite on both sides of the wall and potential inside the box is zero and is uniform throughout the box. $V = 0 \quad 0 < x < L$ $V = \infty \quad x \leq 0$ and $x \geq L$



Time independent Schrodinger wave equation is applied

$$\frac{\partial^2\Psi_0}{\partial x^2} + \frac{2m}{\hbar^2}(E\text{-}V)\,\Psi_0 = 0$$

Since V = 0 inside the box . The Schrodinger wave equation becomes

$$\frac{\partial^2\Psi_0}{\partial x^2} + \frac{2m}{\hbar^2}(E)\,\Psi_0 = 0$$

Let $\frac{2mE}{\hbar^2} = k^2$

$$\frac{\partial^2\Psi_0}{\partial x^2} + k^2\,\Psi_0 = 0 \quad \text{.....(1)}$$

The general solution of this equation is

$$\Psi_0 = A\sin kx + B\cos kx \quad \text{.....(2)}$$

To determine the constants A and B Boundary conditions are applied.

(1) $\Psi_0 = 0$ at $x = 0$

(2) $\Psi_0 = 0$ at $x = L$

Applying (1) boundary condition

$$0 = A\sin 0 + B\cos 0$$

Therefore $B = 0$

$$\Psi_0 = A\sin kx$$

Applying (2) boundary condition

$$0 = A\sin kL$$

A cannot be zero because already we got B=0 if A=0 is meaningless. Therefore $A \neq 0$

Then $\sin kL = 0$ when $kL = n\pi$

$$\therefore \quad k = \frac{n\pi}{L}$$

$$\text{Since } E_n = \frac{\hbar^2 k^2}{2m} = = \frac{\hbar^2}{2m}\left(\frac{n^2\pi^2}{L^2}\right) = \frac{n^2h^2}{8mL^2}$$

For giving n=1,2,3.... the different energy states can be obtained

n=3, E_3 ——— $\frac{9h^2}{8mL^2}$

n=2, E_2 ——— $\frac{4h^2}{8mL^2}$

n=1, E_1 ——— $\frac{h^2}{8mL^2}$

Now the wave function is $\Psi = A \sin(\frac{n\pi}{L})x$

To determine the constant A Probability density $|\Psi^2| = 1$ is considered.

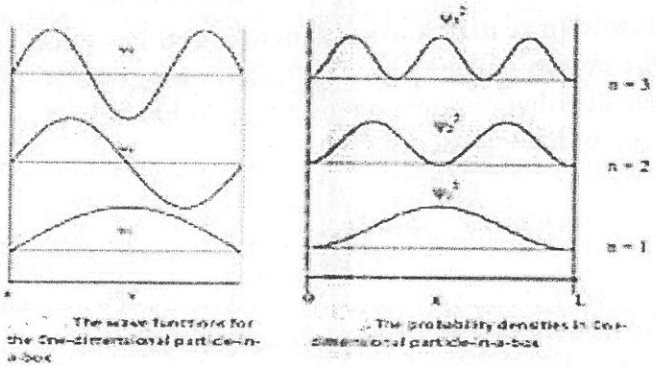
$\int_0^L [A \sin(\frac{n\pi}{L})x]^2 dx = 1$

$A^2 \int_0^L \sin^2(\frac{n\pi}{L})x = 1$

$\frac{A^2}{2}\int_0^L (1 - \cos\frac{2n\pi}{L}x)dx = 1$ $\frac{A^2}{2}L = 1$,

$\therefore A = \sqrt{\frac{2}{L}}$

$\Psi = \sqrt{\frac{2}{L}} \sin(\frac{n\pi}{L})x$ different positions occupied by the particle can be known.



The wave functions for the one-dimensional particle-in-a-box

The probability densities in one-dimensional particle-in-a-box

OR

9 a) Compare and contrast classical free electron theory with quantum free electron theory.

Ans

Comparison of Classical Free Electron Theory and Quantum Free Electron Theory

Classical Free Electron Theory	**Quantum Free Electron Theory**
Proposed by Paul Drude and Hendrik Lorentz.	Developed by Arnold Sommerfeld.
Based on **classical mechanics**.	Based on **quantum mechanics**.
Electrons are treated as classical particles.	Electrons are treated as quantum particles (matter waves).
Obeys **Maxwell–Boltzmann statistics**.	Obeys **Fermi–Dirac statistics**.
All free electrons take part in electrical conduction.	Only electrons near the **Fermi level** take part in conduction.

	Cannot explain the low specific heat of metals. Correctly explains the low specific heat of metals.

Contrast Between Classical Free Electron Theory and Quantum Free Electron Theory

Classical Free Electron Theory	Quantum Free Electron Theory
Based on **classical mechanics**.	Based on **quantum mechanics**.
Proposed by Paul Drude and Hendrik Lorentz.	Developed by Arnold Sommerfeld.
Electrons are treated as classical particles.	Electrons are treated as quantum particles (matter waves).
Follows **Maxwell–Boltzmann statistics**.	Follows **Fermi–Dirac statistics**.
Assumes all free electrons participate in conduction.	Only electrons near the **Fermi level** participate in conduction.
Cannot explain the low electronic specific heat of metals.	Correctly explains the low electronic specific heat of metals.

9 b) Explain the Fermi-Dirac distribution function and its significance in understanding electron occupancy at different energy levels and temperatures.

Ans Fermi-Dirac distribution function gives the probability of finding an electron in an energy level of having energy E.

$$F(E) = \frac{1}{1+\exp(\frac{E-E_F}{K_{BT}})}$$

where:

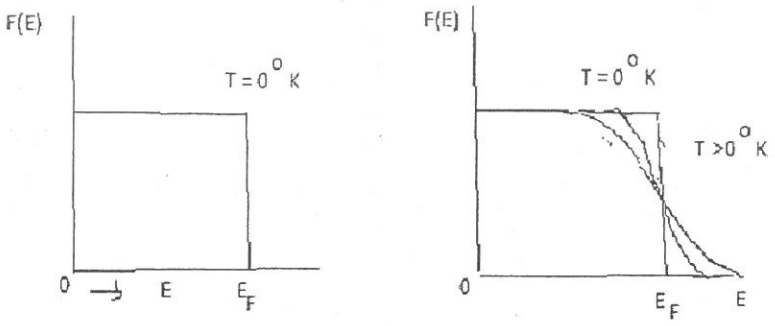
- $f(E)$= Probability of occupancy of an energy level
- E= Energy of the electron
- E_F= Fermi energy
- k= Boltzmann constant
- T= Absolute temperature (K)

1. At Absolute Zero (0 K)

- All energy levels **below the Fermi energy (E_F) are completely filled**.
- All energy levels **above E_F are completely empty**.
- At $E = E_F$, the probability of occupancy is **1/2 (0.5)**.

2. At Temperatures Above 0 K

- Some electrons gain thermal energy and move to higher energy levels.
- Therefore:
  - Energy levels **below** E_F are almost full.
  - Energy levels **above** E_F are partially occupied.
- Only electrons near the **Fermi level** participate in electrical conduction.

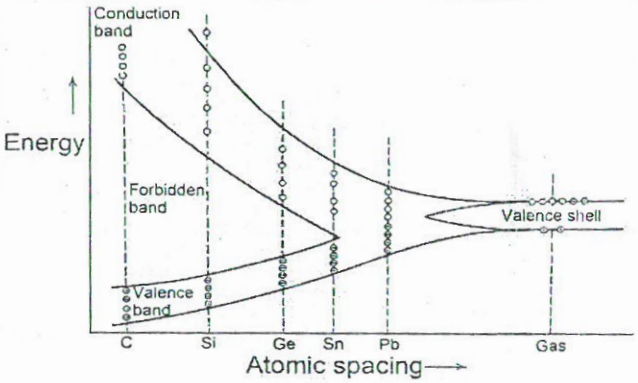


At $T = 0^{o}K$ and for $E<E_F$ the function attains a value 1. When $E>E_F$, F(E) will be zero. This means that at absolute zero all the quantum states below E_F are occupied while all quantum states having energies greater than E_F are unoccupied. So E_F is the maximum energy level which is filled by electron.

When $T>0^{o}K$ nearer to E_F, F(E) begins to fall at $E = E_F$, $F(E)= ½$. So $E<E_F$ the energy levels are filled so the probability is one. When temperature increases the electrons which are nearer to Fermi level will go to the higher energy level so the probability in the levels $E>E_F$ is not zero. Since the probability is ½ the electrons may exist in the Fermi level or may not exist in the Fermi level.

UNIT-V

10 a)	**Explain the formation of Energy bands in solids. Based in this, provide a detailed classification of crystalline solids into conductors, semiconductors and insulators with neat Energy band diagrams.**
Ans	**Formation of Energy bands in solids** : In an isolated atom, the electrons are tightly bound and have discrete, sharp energy levels.When two identical atoms are brought closer the outermost orbits of these atoms overlap and interact. When the wave functions of the electrons of the different atoms begin to overlap considerably, the energy levels corresponding to those wave functions split into two as in below Fig.If more atoms are brought together more energylevels are formed and for a solid of N atoms, each of the energy levels of an atom splits into N levels of energy.The levels are so close together that they form an almost continuous band. The width of this band depends on the degree of overlap of electrons of adjacent atoms and is largest for the outermost atomic electrons. In a solid many atoms are brought together so that the split energy levels form a set of bands of very closely spaced levels with forbidden energy gaps between them as shown in Fig.There are two energy bands called valence and conduction bands. The band corresponding to the outer most gaps between these two allowed bands is called forbidden energy gap or band gap since electrons can't have energy values within the forbidden energy gap.



Classification of crystalline solids:

According to the width of the gap between the bands and band occupation by electrons, all solids can be classified broadly into three groups, namely conductors, semiconductors and insulators.

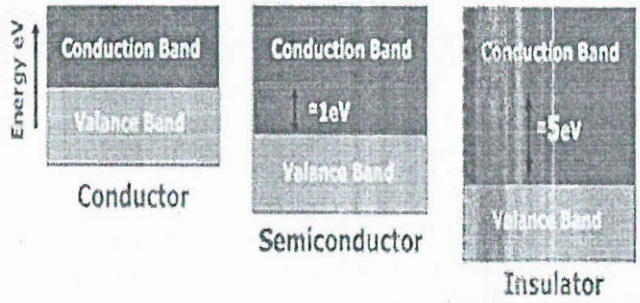


Fig: Classification of Solids on the basis of electricity Conduction

Conductors: - They have very high electrical conductivity and large no. of mobile charge carriers or free electrons which carry electric current. When temperature of conductors increased, its resistivity also increases. They have positive temperature coefficient of resistance .

eg.. Cu, Ag, Al , Au etc… And Gold is the best conductor of electricity

Semiconductors:-

Semiconductors are those materials whose conductivities lie between conductors and insulators. They have poor conductivity than conductors and higher than insulators. Therefore, they are neither good conductors nor good insulators. When temp of a semiconductor is increased, its resistivity decreases or conductivity increases. At higher temp, a semiconductor conducts better.

Therefore,the semiconductors have negative temp coefficient of resistance.

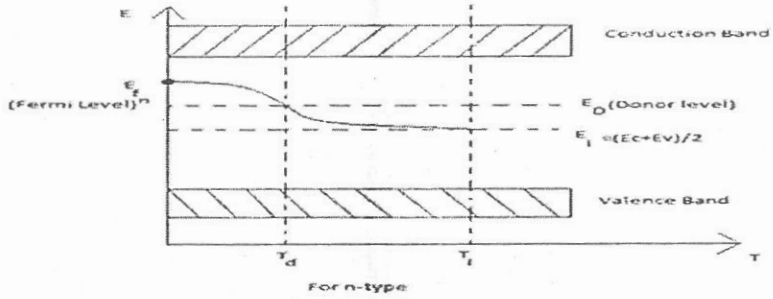
For e.g: Si, Ge,gallium,Arsinic, etc..

Insulators:- Insulators are those materials which are bad conductors of electivity. i.e, they have very high resistivity because they have no charge carriers or free electrons to carry electric current.

For eg: Glass, quartz, rubber, bakelite etc..

10 b)	**Discuss the dependence of Fermi energy on carrier concentration and temperature.**
Ans	**1.Fermi energy variation for Intrinsic Semiconductor:** An intrinsic semiconductor is a pure semiconductor with no impurities. The Fermi-level in an intrinsic semiconductor is nearly midway between the

conductive and valence band. Fermi level is the highest energy state occupied by electrons in a material at absolute zero temperature.



- At 0 K, the valence band is completely filled and the conduction band is empty.
- The Fermi level lies approximately at the middle of the forbidden energy gap (band gap).
- As the temperature increases, more electrons are excited from the valence band to the conduction band.
- However, the Fermi level remains almost at the center of the band gap (it may shift only slightly).

2. Fermi energy variation for Extrinsic Semiconductor

An extrinsic semiconductor is obtained by adding impurities (doping) to a pure semiconductor.

(a) n-type Semiconductor

- Doped with pentavalent (donor) impurities.
- Electrons are the majority carriers.
- The Fermi level lies close to the conduction band.
- As temperature increases, the Fermi level moves slightly toward the center of the band gap.

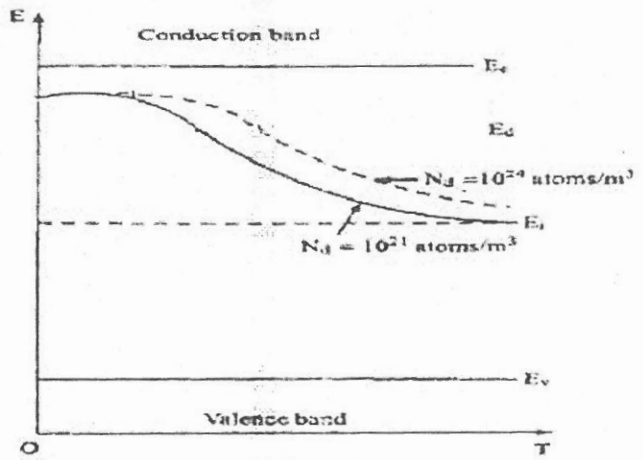
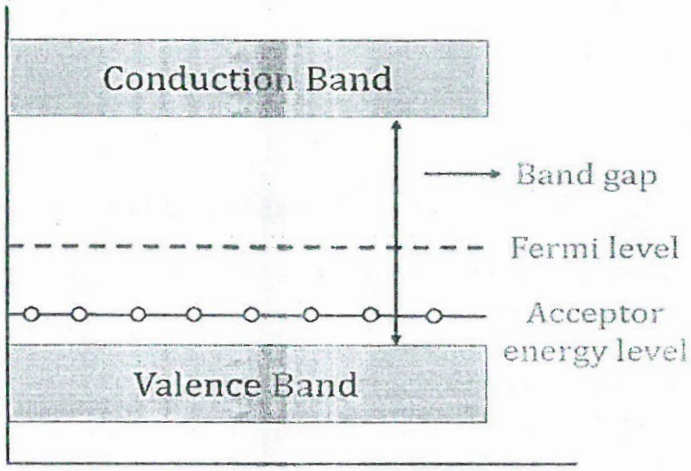


Fig. 8 Variation of Fermi level with T and N_d

(b) p-type Semiconductor

- Doped with trivalent (acceptor) impurities.
- Holes are the majority carriers.
- The Fermi level lies close to the valence band.
- As temperature increases, the Fermi level moves slightly toward the center of the band gap.



Energy level diagram of
P type semiconductor

OR

11 a) What is Hall Effect? Obtain an expression for the Hall coefficient, and Hall voltage.

Ans

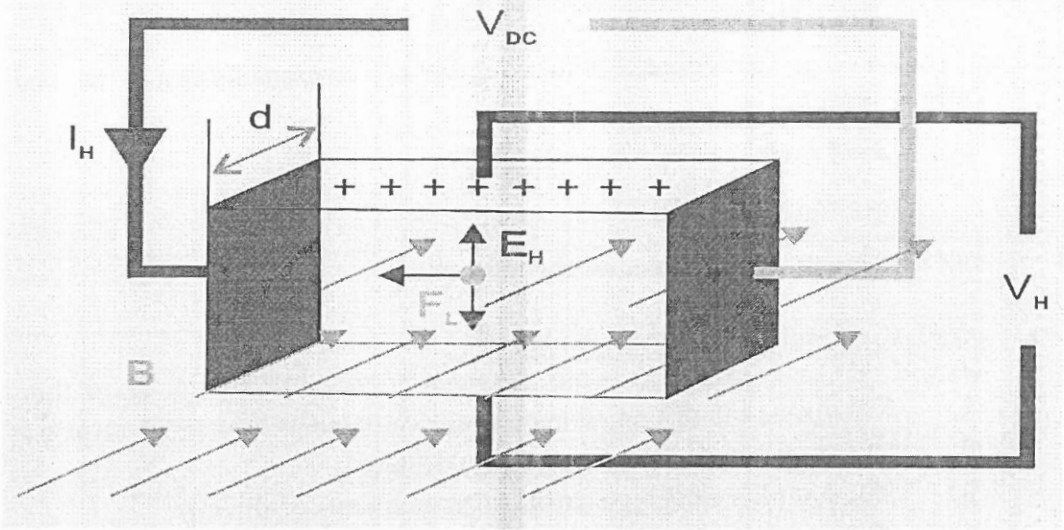
HALL EFFECT:

When a slab of metal or semiconductor carrying current is placed in a transverse magnetic field, a potential difference is produced in the direction normal to both current and magnetic field. This phenomenon is called 'Hall Effect' and the generated voltage is known as 'Hall Voltage'.

Consider a slab of conductor in which a current I is flowing in the positive x-direction. Let a magnetic field 'B' is applied along the Z- direction then the electrons experience a Lorentz force given by

$$F_L = - B.e.V_d$$

V_d - drift velocity



Applying the Fleming's left hand rule, the force exerted on the electrons is in the negative y-direction. As a result, the density of electrons increases in the lower end of the material due to which its bottom surface becomes negatively charged.

On the other hand, the loss of electrons from the upper end causes the top edge of the material to become positively charged. Hence, potential V_H called Hall Voltage appears between the upper and lower surfaces of the semi conductor, which establishes on electric field E_H called the Hall Electric field. The electric field E_H exerts an upward force F_H in the electron.

$$\Rightarrow \mathbf{F_H = - e E_H}$$

At equilibrium position the two forces acting on electrons are equal.

i.e $F_L = F_H$

$$\Rightarrow \mathbf{e E_H = - B.e.V_d}$$

$$\Rightarrow \mathbf{E_H = B V_d}$$

The current density $\mathbf{J = - n e V_d}$

$$\mathbf{V_d = - J/ne \text{ or } E_H = - JB/ne}$$

The Hall Effect is described in terms of the Hall coefficient R_H

$$\Rightarrow \mathbf{R_H = -1/ne}$$

$$\Rightarrow \mathbf{E_H = R_H . JB}$$

$$\Rightarrow \mathbf{R_H = E_H / J B = -1/ ne}$$

Determination of Hall Coefficient:

The Hall electric field per unit current density per unit magnetic induction is called Hall Coefficient

(R_H).

If 'w' is the width of the sample across which Hall Voltage V_H is measured by

	$E_H = V_H / w \quad \Rightarrow R_H = E_H / J B = V_H / J B w$ If 't' is the thickness of the sample, then its cross section is 'wt' and the current density, $J = I / wt \quad \Rightarrow V_H = R_H.I.B / t$ $\Rightarrow R_H = V_H.t / IB$
11 b)	**List the major applications of the Hall effect.**
Ans	**APPLICATIONS OF HALL EFFECT:** The Hall Effect measurements provide the following information about the solid: 1. Determination of type of semiconductor whether it is p-type or n-type. 2. The carrier concentration can be calculated. 3. The mobility of charge carriers can be measured directly. 4. The magnetic flux density can be measured. 5. The power in an electromagnetic wave can be measured.