GEETHANJALI INSTITUTE OF SCIENCE & TECHNOLOGY

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ASSIGNMENT BOOKLET

HT NO	202U1A0312	BRANCH	ME
STUDENT NAME	sk.Sharif	YEAR/ SEM	I / II
COURSE	B.TECH	REG	R20
SUBJECT NAME	Engineering physics	SUBJECT CODE	

NAME OF THE EXAM	ASSIGNMENT SUBMISSION DATE
ASSIGNMENT 1	30/10/2021
ASSIGNMENT 2	30/10/2021

Note: If the student didn't submitted the assignment, mark it as ABSENT

NAME OF THE EXAM	ASSIGNMENT (05)					ASS (05)	SIGN OF EXAMINER
	Q1	Q2	Q3	Q4	Q5		
ASSIGNMENT 1	5	5	5	5	5	5	[signature]
ASSIGNMENT 2	5	5	5	5	5	5	[signature]
					AVERAGE	5	[signature]

TOTAL ASSIGNMENT MARKS (IN FIGURES)	05

Assignment - 1

1) What do you mean by double refraction? explain construction and working principle of Nicol's prism.

1) **Double refraction:-** Double refraction, also called birefringence, an optical property in which a single ray of unpolarized light entering an anisotropic medium is split into two rays, each travelling in a different direction.

Nicol prism:-

Necessity:- when a unpolarised light incident on the principle section of calcite crystal, it is divided into two refracted rays.

i) ordinary ray
ii) extraordinary ray

Here the two rays are plane polarised. But in order to obtain the plane polarised light efficiently from the double refraction phenomena, Nicol devised an ingenious optical device made from calcite for producing and analyzing plane polarised light called Nicol's prism.

Def:- It is an optical device made from a calcite crystal for producing and analyzing plane polarized light.

Principle:-

The basic principle involved in the working of Nicol's prism is,
i) Double refraction ii) Total internal reflection.
The Nicol's prism is made in such a way that it eliminates one of the rays by total internal reflection.

Construction:-

The Nicol prism is constructed from calcitic crystal whose length is nearly three times of its width. The crystal is in the form of parallelogram having acute angle 71° and obtuse angle 109°. The crystal is grounded such that the acute angle 68° on

The it is cut into two pieces diagonally. These two pieces are polished and again cemented together with canada balsam. The sides of the crystal are blackened to absorb the totally reflected rays.

Working: The working of the nicol's prism in the following manner when an unpolarised light is incident in the surface PR due to the phenomena of double refraction, it is divided into two refracted rays.

i) E. Ray long BC

ii) O. Ray long BD

The diagonal PS (i.e.) canada balsam layer can be acts as rarer medium. so light simply passes through layer and emergent from the nical.

For o.Ray passing from denser medium to rarer medium, It is totally internally reflected at the canada balsam layer when the angle of the incidente is grater than critical angle. This totally internal reflected O.Ray is completely absorbed by black surfaces Thus Finally only E Ray will emergent from the crystal which is plane polarized.

Derive the conditions for obtaining principal maxima, minima and secondary maxima in a diffraction due to single slit.

) The path difference b/w the wave lengths from A and B in the direction θ is given by,

Path difference $= BC = A\sin = e\sin$

corresponding phase difference $= \frac{2\pi}{\lambda} \times$ pth difference

$= \frac{2\pi}{\lambda} e\sin\theta$.

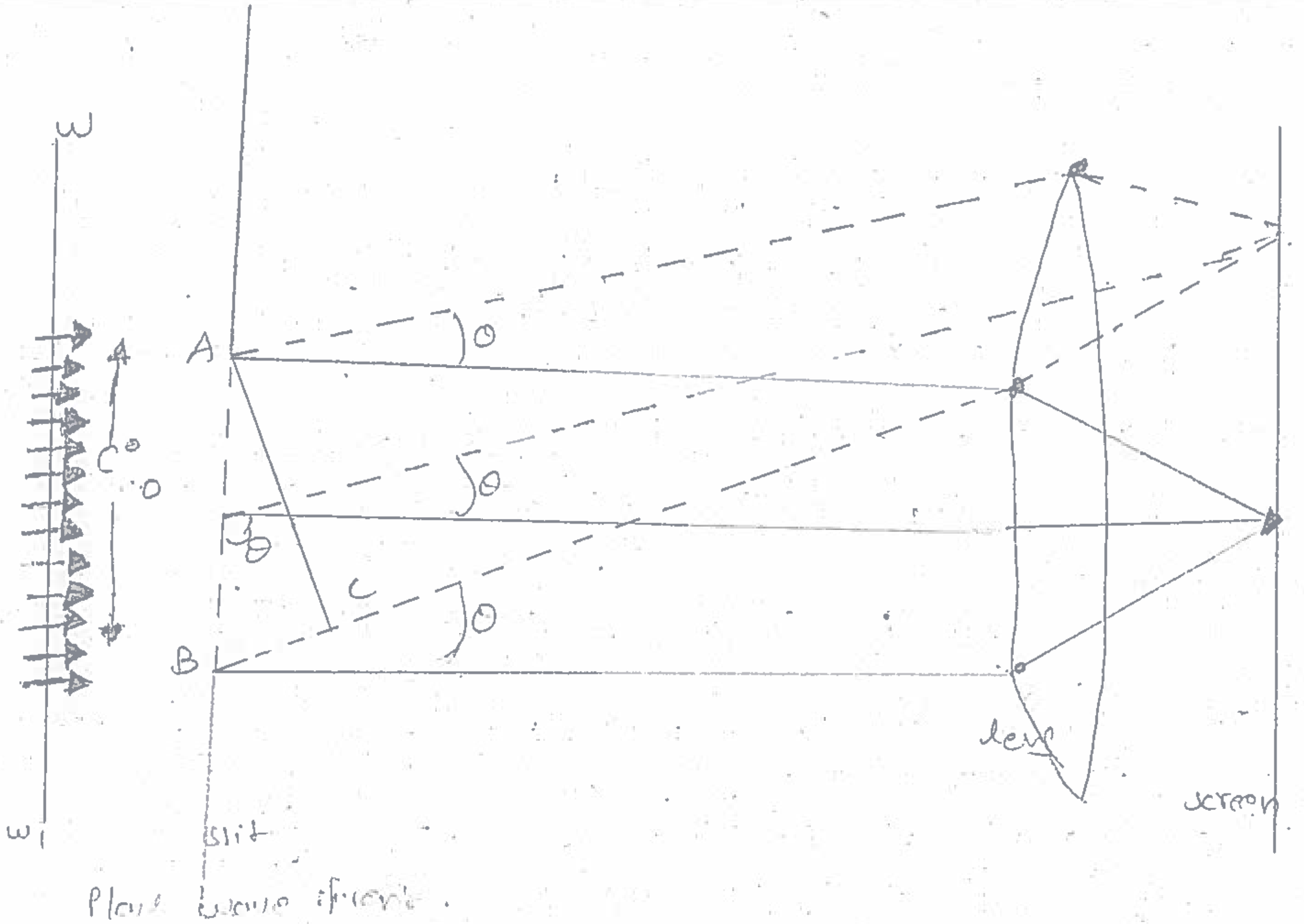


Fig1. Fraunhofer diffraction - single slit.

let the width of the slit be divided into an equal parts and the amplitude of the wave from each part is 'a'. The phase difference b/w any two sucessive waves from these parts would be,

$$1/n\,[\text{Total phase}] = 1/n\left[\frac{2\pi}{\lambda} e\sin\theta\right] = d \;(\text{cast})$$

Using the method of vector addition of amplitudes, the resultant amplitude R is given by

$$R = \frac{a\sin(nd/2)}{\sin(d/2)}$$

$$R = \frac{a\sin(\pi e\sin\theta/\lambda)}{\sin(\pi e\sin\theta/n\lambda)}$$

$$R = \frac{a\sin\alpha}{\sin(\alpha/n)} \quad \text{where } \alpha = \pi e\sin\theta/\lambda$$

$R = \frac{a \sin\alpha}{\alpha/n}$ ($\because \alpha/n$ is very small)

$R = n \frac{a \sin\alpha}{\alpha}$

$R = A \frac{\sin\alpha}{\alpha}$ ($\because na = A$)

Intensity, $I = R^2 = A^2 \left[\frac{\sin\alpha}{\alpha}\right)^2$ ....(1)

Principal maximum:

The resultant amplitude R is given by

$$R = \frac{A}{\alpha}\left[\alpha - \frac{\alpha^3}{3!} + \frac{\alpha^3}{5!} - \frac{\alpha^7}{7!} + \dots\right]$$

$$R = A\left[1 - \frac{\alpha^3}{3!} + \frac{\alpha^4}{5!} - \frac{\alpha^6}{7!} + \dots\right]$$

I will be maximum, when the value of R is maximum, for maximum value of R, the negative terms must vanish i.e. $\alpha = 0$.

$$0 = \pi e \sin\theta / \lambda$$

$$\sin\theta = 0$$

$$\theta = 0$$

$$R = A$$

$$I_{max} = R^2 = A^2$$

minimum intensity:-

I will be minimum, when $\sin\alpha = 0$

$$\alpha = \pm\pi, \pm 2\pi, \pm 3\pi$$

$$\alpha = \pm m\pi$$

$$\frac{\pi e \sin\theta}{\lambda} = \pm m\pi$$

where $m = 1, 2, 3$

This we can obtain the points of minimum intensity on either side of the principle maximum. For $m = 0$, $\sin\theta = 0$, which corresponds to principal maximum.

Secondary maxima:-

In between these minima, we get secondary maxima. The positions can be obtained by differentiating the expression of I w.r.t α and equating to zero. we get.

$$\frac{dI}{d\alpha} = \frac{d}{d\alpha}\left[A^2\left(\frac{\sin\alpha}{\alpha}\right)^2\right] = 0$$

$$A^2 \cdot \frac{2\sin\alpha}{\alpha} \cdot \frac{\alpha\cos\alpha - \sin\alpha}{\alpha^2} = 0.$$

either $\sin\alpha = 0$ or $\alpha\cos\alpha - \sin\alpha = 0$.

$\sin\alpha = 0$ gives positions of minima

Hence the positions of secondary maxima are given by

$$\alpha\cos\alpha - \sin\alpha = 0$$

$$\Rightarrow \alpha = \tan\alpha$$

The values of α satisfying the above equation are obtained graphically by plotting the curves $y = \alpha$ and $y = \tan\alpha$ on the same graph. The points of intersection of two curves gives the value of α which satisfy the above equation. The plots of $y = \alpha$ and $y = \tan\alpha$ are shown in Figure 2.

The points of intersection are $\alpha = 0, \pm\frac{3\pi}{2}, \pm\frac{5\pi}{2} \ldots$

Substituting the above values in equation (1) we get the intensities in various maxima.

$\alpha = 0$, $I_0 = A^2$ (principal maxima)

$\alpha = \frac{3\pi}{2}$, $I_1 = A^2\left[\frac{\sin(3\pi/2)}{3\pi/2}\right]^2 = \frac{A^2}{22}$ (1 secondary maxima)

$\alpha = \frac{5\pi}{2}$, $I_2 = A^2\left[\frac{\sin(5\pi/2)}{5\pi/2}\right]^2 = \frac{A^2}{62}$ (II secondary maxima)

and so on.

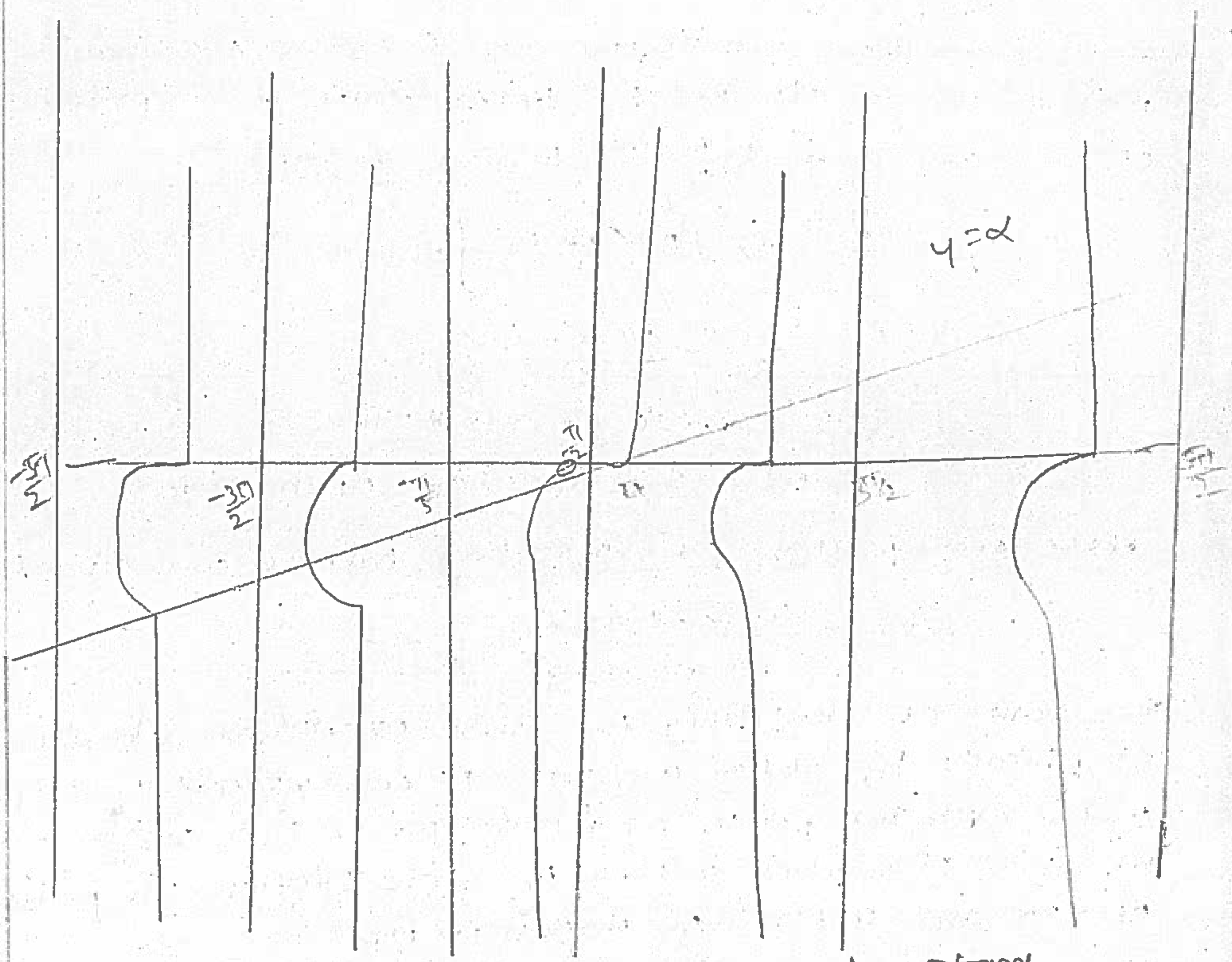


Fig 2 plots of $y = \alpha$ and $y = \tan\alpha$.

From the above expressions, it is evid evident that most of the incident light is concentrated in the principal maximum.

3. provide a detailed description of an optical fibre-based communication system using a block diagram.

A) Fiber optic communication system:

optical fiber communication system is a communication system in which light is used as a carrier, Its purpose to transfer information from a source of distant user.

Principle:

The basic optic fiber communication is the transmission of information by the propagation of optical signal through optical fibres over the required distance It involves deriving optical signal from electrical signal at the transmitting end and conversion of optical signal back to electrical signal at the recieving end.

Construction:

A basic block diagram of the fiber optic communication system is as shown in figure.

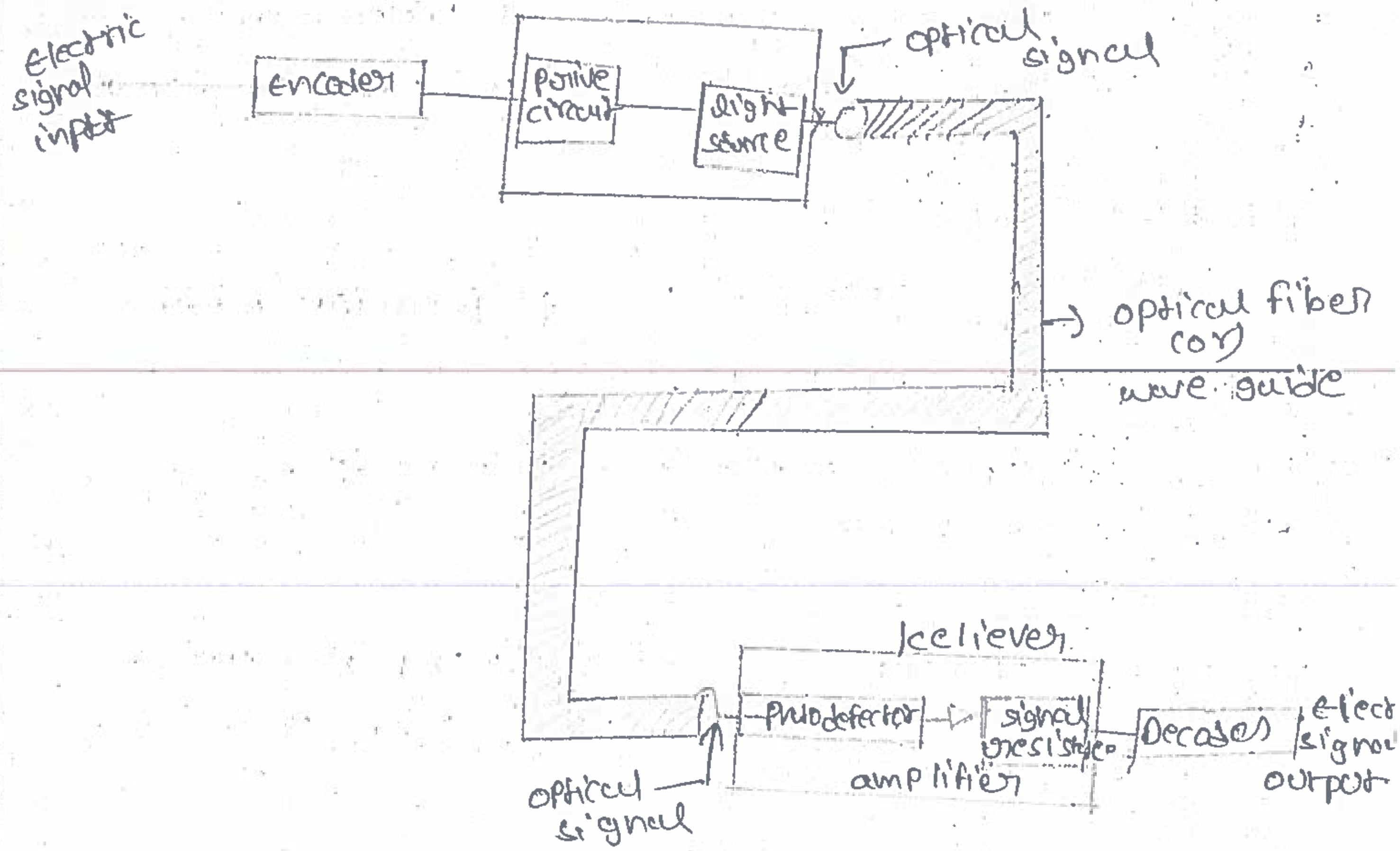


Fig. FOC System.

The main parts of fiber optic communication system are,

1) information signal source
2) Transmitter
3) light source.
4) propagation source
5) photo detector
6) Reciever.

Information signal source:

e information signal source may be voice, music, digital
ta on analog voltage and video signals. Here it
s analog information.

Transmitter:

- transforms an electrical signal (information signal) to be
ransmitted into an optical signal. Transmitter includes
odulator, switches and drive circuits.

Light source:

e optical light source generates the optical energy which
rves as the information carrier. Laser or LED may
e used as light source.

propagation medium:

e optical fiber is used as a propagation medium.

) optical photo detection:

It detects optical energy and converts it into an
electrical signal.

Recievers:-

It consists of (i) photo detector (ii) amplifier signal
restoring circuit. It converts optical signal into
corresponding electrical signal.

orking:

nalog information such as voice of a telephone user
gives rise to electrical signals in analog transmitter.

ese electrical pulses are formed into an
ptical signal with the help of optical transmitter.

t is modulated and carried by the light emitted
y an optical source (such as LED or laser diode). Now
his optical signal is fed into the fiber.

fiberissted into a photo detector. The photo detector defects optical signal is fed into the fiber and converts to pulses of electric current This analog signal will be the same information such as voice which was there at transmitting end. Thus the information is transforme-d from one end to other.

Advantages of fiber optic communication system:-

i) extreamly wide band widths: In optical fiber systems a greater volume of information or messages can be carried out. The reason is that the rate of transmission of information is directly proportional to signal frequency the light has higher frequencies than radio waves or micro waves frequencies.

ii) easy handling: Due to small diameter and light weights optical fibres may be used more easily than copper cables.

iii) Noise free transmission: The optical fiber communication is noise free.

iv) Economical:- The optical fiber communication is economic they deliver signals at low cost.

v) safety: In optical fibers, light signals are launched, which are harmless. In copper cables electricity is conducted, which sometimes become dangerous.

vi) longer life span:- optical fibres have life span about 20-30 years while copper cables have life span 12-15 years. clearly optical fibers have longer life span than copper cables.

vii) easy maintenance: optical fibres are more reliable and can be maintained easily than copper cables.

4) 1) what do you meant by metastable state?

A) The particular excited state of an atom, nucleus, or other system that has a longer lifetime than the ordinary excited states and that generally has a shorter lifetime than the lowest, often stable, energy state, called the ground state.

2) Differentiate between spontaneous and simulated emission?

A)

Spontaneous emission	Simulated emission
1) spontaneous emission is a result of the transition of an atom from the excited state to the lower energy state which happens due natural tendency of the atom to attain minimum energy.	1) Simulated emission of radiation is the process in which photons are used to simulate atom in excited state to fall down to lower energy state.
2) No external agent is involved.	2) photons need to be incident as stimuli.
3) Results is ordinary light.	3) can be utilized to get laser beam.

3) why the refractive index of core is higher than the cladding?

A) The refractive index of the core is higher than that of the cladding so light in the core that strikes the boundaries with the cladding at the angle shallower than critical angle will be reflected back into the core by total internal reflection.

4) what is attenuation?

A) Attenuation means extinction is the gradual loss of flux intensity through a medium is called attenuation.

5) Discuss the types of optical fibers ... index profiles?

A) Types of optical fibers:-

optical fibers are classified into three major categories based on a) material.

b) The number of modes and c) the refractive index profile. The general classification of optical fibers is shown in figure.

classification based on material used:

It can be classified into two types.

1) Glass fiber and

2) plastic fiber.

Glass fibers

If the optical fiber is made by the fusing mixtures of metal oxides and silica glasses, then it is known as glass fiber.

Examples:

1. $GeO_2 - SiO_2$ core, SiO_2 cladding

2. SiO_2 core, $P_2O_3 - SiO_2$ cladding.

Plastic fibers:-

The plastic fibers typically made of plastic and are of low cost and they are flexible, and also they exhibit considerably greater attenuation than glass fibers, the plastic fibers can be handled without special care due to its toughness and durability.

The curve which denotes the variation of refractive index profile and the number of modes that fiber can guide. They are.

1) step- index single mode fiber

2) step- index multi mode fiber.

3) Graded index multi mode fiber.

step-index single mode fiber: The basic structure of a step single mode fiber is shown in figure. It consists of a thin core of uniform refractive index of a higher value. The core is surrounded by a cladding of uniform refractive index of lesser value than that of the fine core.

As the refractive index changes abruptly (or in step) at the core-cladding boundary, the refractive index profile takes the shape of a step.

A typical step index single mode fiber may have a core of diameter value of 5 to 10 um and external diameter of cladding 50-125 um. Due to its small core diameter, only a single mode of light by transmission is possible as shown in figure.

<u>step-index multimode fibers</u>:-

The geometry of the normal cross-section of a typical step-index multimode fiber is shown in figure.

Its core has a much large diameter which makes it easier to support propagation of larger number of modes.

It has a core material with uniform refractive index value and a cladding to core. Thus its refractive index profile takes the shape of a step as shown in figure.

A typical step index multimode fiber has a core diameter of 50 to 200 um and an external diameter of cladding 125 to 300 um. Because the larger diameter of core, propagation of many modes within the fiber is allowed. This is shown in figure by the many different possible light ray passes through the fiber.

<u>Graded Index multimode fiber (GRIN)</u>:-

The geometry of the normal cross-section of a typical graded index fiber is also as shown in figure. A typical graded index multimode fiber has a core diameter of 50 to 200 um and the external diameter of cladding is 100 to 250 um. In a graded index multimode fiber, the refractive index of the core.

is maximum at the core ... gradually decreases towards the cladding. The refractive index profile is also shown in figure.

If the diameter of core is high, then the inter modal dispersion loss must be high. But because of the gradual decreases in the refractive index of the core, the modal dispersion loss is minimized. The light ray propagation for this fiber is also shown in figure.

Assignment - 2

What are nano materials ? explain the synthesis of nano-materials by Ball milling method. mention the applications of nano materials in the engineering field?

Nano materials:-

Nano phase materials are newly developed materials with grain size at the nanometer range (10^{-9}m) (i.e), in the order of 1-100 nm. The particle size in a nanomaterial is 1nm. They are simply called as nanomaterials.

Ball milling:-

In ball milling, small hard balls are allowed to rotate inside a container (drum) and then it is made to fall on a solid with high force to crush the solid into nano crystal.

Construction and working:

The hardened steel or tungsten carbide balls are put in a container as shown in figure 3. along with powder of particles (50 µm) of a desired material. The container is closed with tight lids.

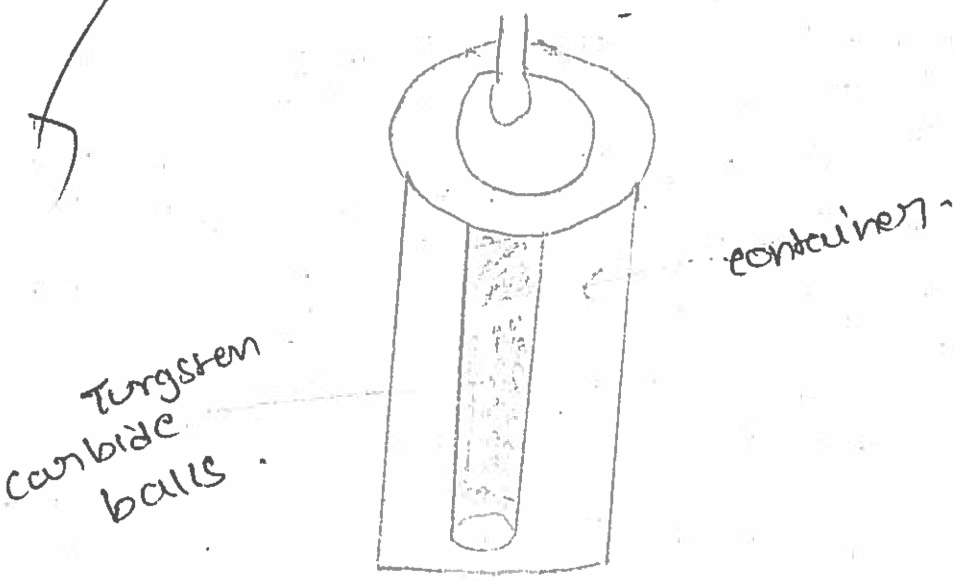


Fig 3 A schematic diagram of ball mill vessel.

the material is rolled to press against the walls. The milling balls impart energy on collisions and produce smaller grain of nano particle.

Ball milling is also known as mechanical alloying or crushing.

Advantages:

i) Few milligrams to several kilograms of nanoparticles can be synthesized in a short time.

ii) This technique can be operated at large scale.

Applications:

i) This method is preffered mainly in preparation of elemental and metal oxide nano crystal like Co, Cr, Al-Fe and Iron.

ii) A variety of intermetallic compounds of nickel and aluminium can be formed.

iii) The ball mill is the key equipment for regrinding. It is widely used for the preparation of cement, the silicate powder, new type building materials, fire-proof materials, chemical fertiliser, black and non-ferrous metal, glass ceramics etc.

-) What are ultrasonic waves? Describe ultrasonic non-destructive method used for flow direction?

A) Ultrasonic waves:- Ultrasound is sound waves with frequencies higher than the upper audible limit of human being. Ultrasound is not different from "normal" sound in its physical properties, expect the humans not hear it. The limit varies from person to person and is approximately 20 kilohertz in healthy young adults.

NDT - Non Destructive Testing:

The purpose of nondestructive testing is to find out whether any flaws or defects exist in a finished product.

without causing damage ... ultrasonic waves are widely employed in inspiration of metal castings, forgings, welded seams and the like. An ultrasonic flaw detector consists of piezoelectric transducer driven by an electric oscillator which produces short pulses of a few megahertz frequency. The transducer converts the high frequency pulses into ultrasonic waves. The transducer is pressed against the transducer sends pulses, the starting pulse reaches rear side of the object, it is rotated and picked up by the transducer. Again the echo pulse is displayed on CRO screen. If there exists a flaw in the way of ultrasonic pulse it constitutes a discontinuity of which the reflection, the echo pulse will be shifted from the position in which would it be in the absence of flaw. The presence of a flaw in the subject. This technique is often used when every piece is to be tested individually and where no fault can be tolerated.

?) Explain the production of ultrasonic waves by piezo electric method?

A) Piezoelectric effect:

when pressure is applied to one pair of opposite faces of crystal like quartz, the other faces develop and opposite electrical charges on them. This is known as piezoelectric effect.

Inverse piezoelectric effect:

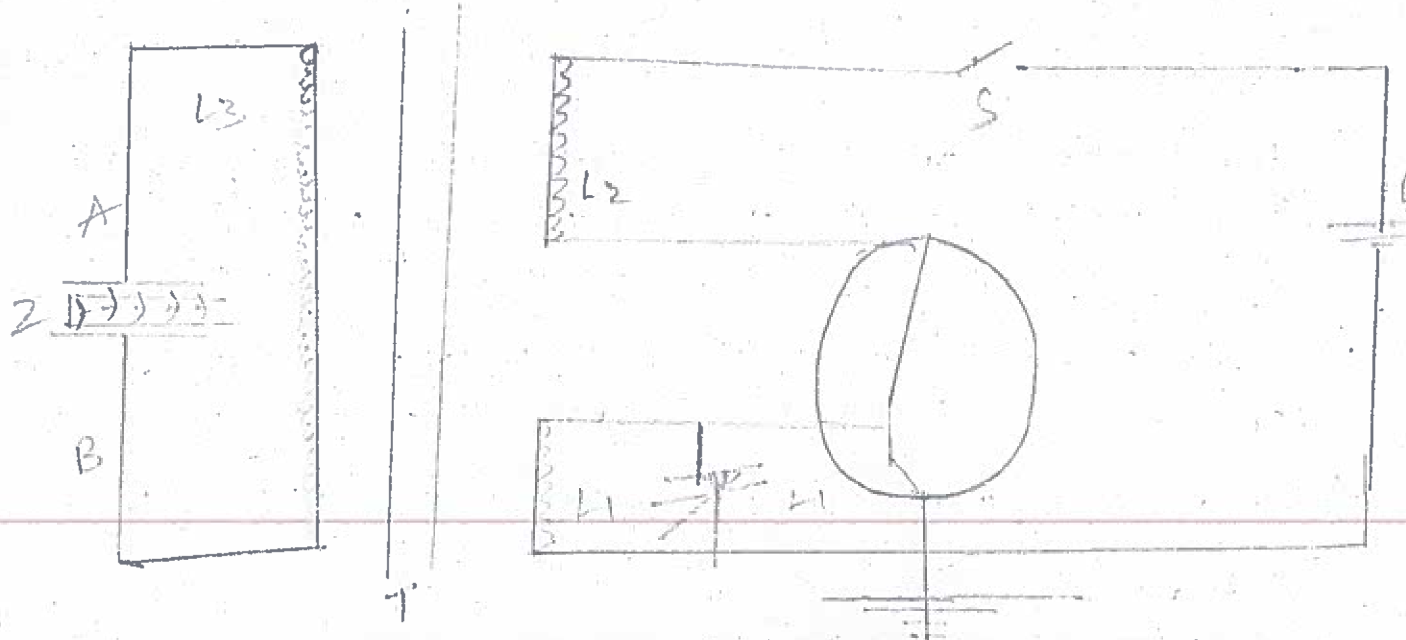
when an AC voltage is applied to the pair of faces of piezoelectric crystal, alternative mechanical expansions are produced and hence crystal starts vibrating. If the applied frequency is equal to vibrating frequency of the crystal, under resonance condition, the ultrasonic waves are produced. This is known as inverse piezoelectric effect.

piezoelectric ultrasonic generator

principle:-

piezoelectric generator is modern ultrasonic generator This is more efficient than magnetostriction generator. It works based on inverse piezoelectric effect.

construction:-



piezoelectric ultrasonic generator.

fig 2: piezoelectric ultrasonic Generator:

The circuit is base tuned oscillator circuit. A thin slice of quartz is placed in b/w metal plates A and B. The coils L1, L2 and L3 are inductively coupled, the coil L2 is connected in the plate circuit while L1 and capacitor C1 for the tank circuit of oscillator

working:-

when the battery is switched on the electronic oscillator produces high frequency oscillations. The oscillation frequency can be varied by the variable oscillator. By transformer action, an oscillatory emf is induced in the coil L3. Then the crystal is under frequency alternating voltage. capacitor C1 is varied till the resonance condition reaches. Thus the vibrating the surrounding air. The frequency of vibration is where Y is the youngs modules, ρ is the density of the material and P = 1,2,3 --- By varying x and wi ultrasonic waves of any frequency can be produced.

$$f = \frac{P}{2L}\sqrt{\frac{Y}{\rho}}$$

Advantages :-

1) Ultrasonic waves with frequencies as high as 500 MHz can be producing.

2) Band width of resonance curve is small to so that we can get stable and constant frequency of ultrasonic waves.

3) using synthetic materials like ceramics, a wide range of frequency is can be generated as low cost.

4) It is insensitive to temperature and humidity.

Disadvantages :-

1) cost of piezoelectric quartz is very high and its cutting and shaping are very complex.

4) Discuss in detail about powder diffraction method?

A) Powder diffraction method :- In nature only few substances are qualities in the form of large crystals. many substances are available in the form of micro crystals or in the form of powder crystals. To study the structure of the micro and powder crystals, this powder method is used. The Bragg's spectrometer is only used to study the geometrical structure of large crystal. This method is very useful to know the size of the crystals, presence of impurities in crystal, orientation of crystals etc. The experimental arrangement arrangement of powder method is a shown in figure.

The . x-ray ...
to pass through a filter which absorbs all the wave lengths expect one wavelength. In this way a monochromatic x-ray beam is obtained. Then the beam passed through two slits S_1, S_2 and it becomes a fine pencil of beam. Then the beam is made to fall on the powder specimen. The specimen is located at the center of a drum shaped cassette while photographic film on the inner surface.

The basic principle involved in this method is that the powder specimen consists of millions of micro crystals are present and the having different orientations. Among the some crystals whose lattice plant satisfying the Bragg's equation, $2d\sin\theta = n\lambda$, the beam derivates by angle 2θ. For various sets which satisfying Bragg's equation produces various cones. The intersections of all those cones on the photographic place form concentric rings as shown.

When the film is kept flat due to narrow width of the film, only some lines are formed on the film. The curvature of the orgs is reverses when the angle of derivation exceeds $90°$. The radii of this rings are used to determine the glancing angles according to following formula:

let l_1, l_2 and l_3 are the distances of the symmetrical lines & D is the diameter of the film.

$$\frac{l}{\pi D} = \frac{\theta_1}{90} \Rightarrow \theta_1 = \frac{90°}{\pi} \times \frac{l_1}{D}$$

$$\text{similarly, } \theta_2 = \frac{90°}{\pi} \cdot \frac{l_2}{D}$$

$$\theta_3 = \frac{90°}{\pi} \cdot \frac{l_3}{D}$$

By using these equations we can calculate the glacing angles. By knowing all these values. The interplanar distance can be calculate by using Bragg's law, $2d\sin\theta = n\lambda$

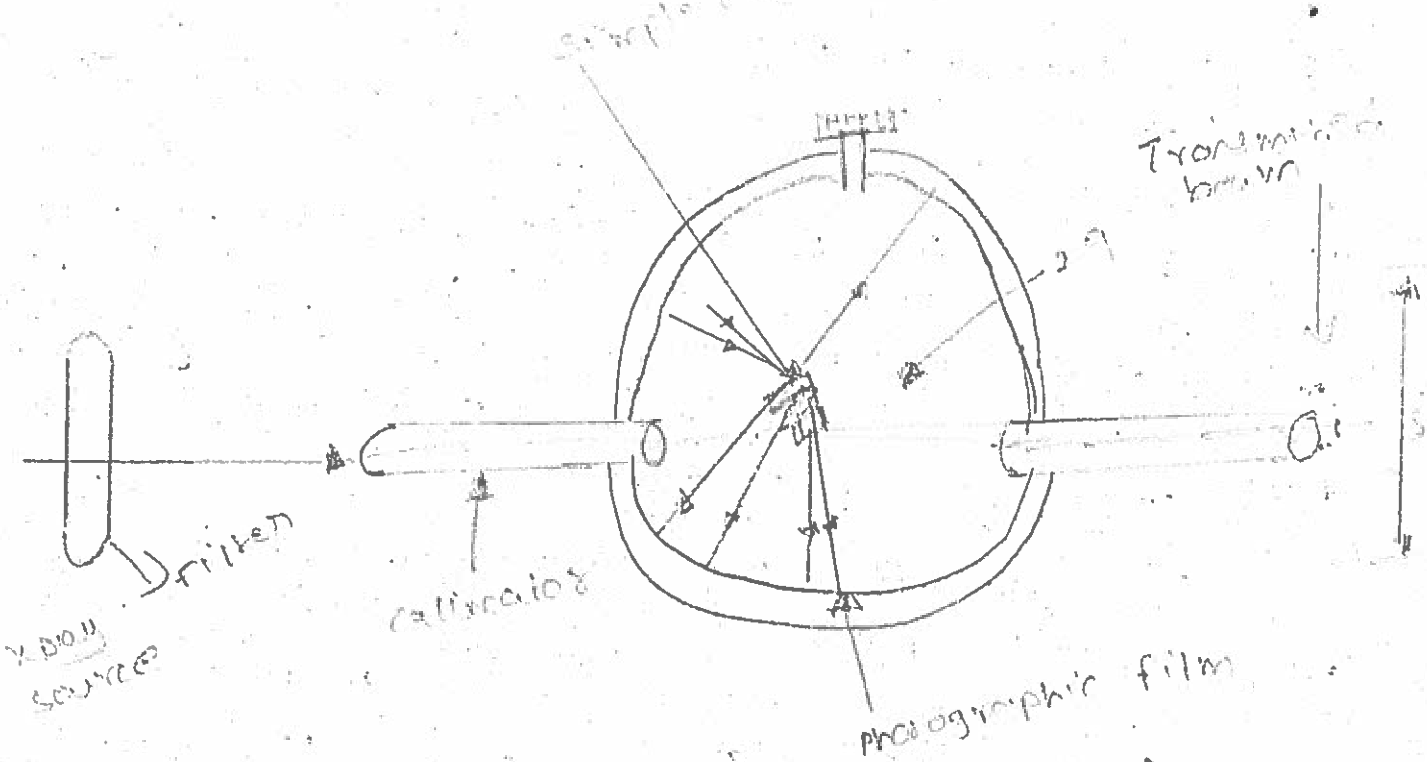


Fig: powder method demonstration

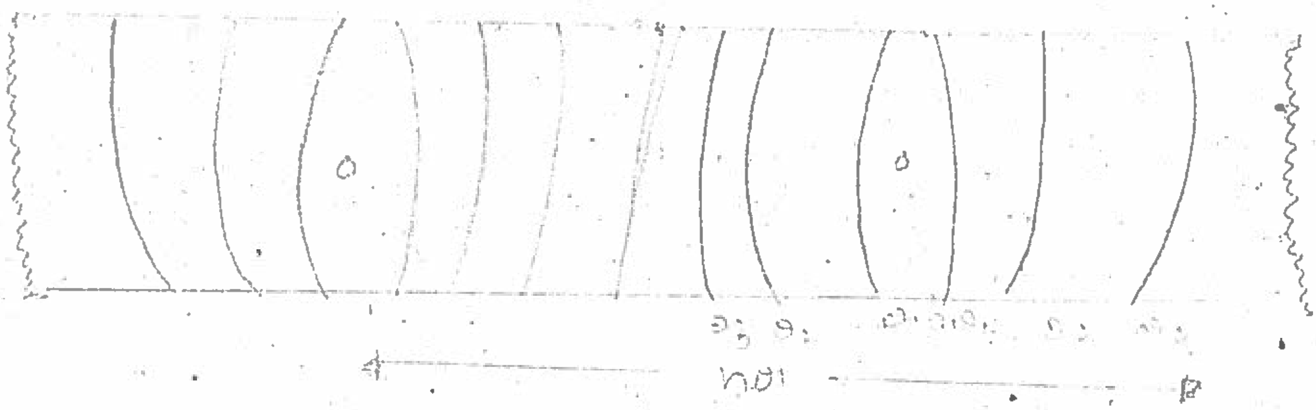


Fig: photo film:

i) show that atomic packing fractions of FCC is more closely packed than SC and BCC?

A) Face centered cubic structure:-

In this type of crystal structure, the unit cell has one atom ceu end correm of the cube and in addition to that it has one atom at centres of each face. It has repetition sequence ABC ABC ABC----

atom has 12 nearest neighbours ... common among metals than body centered cubic structure.

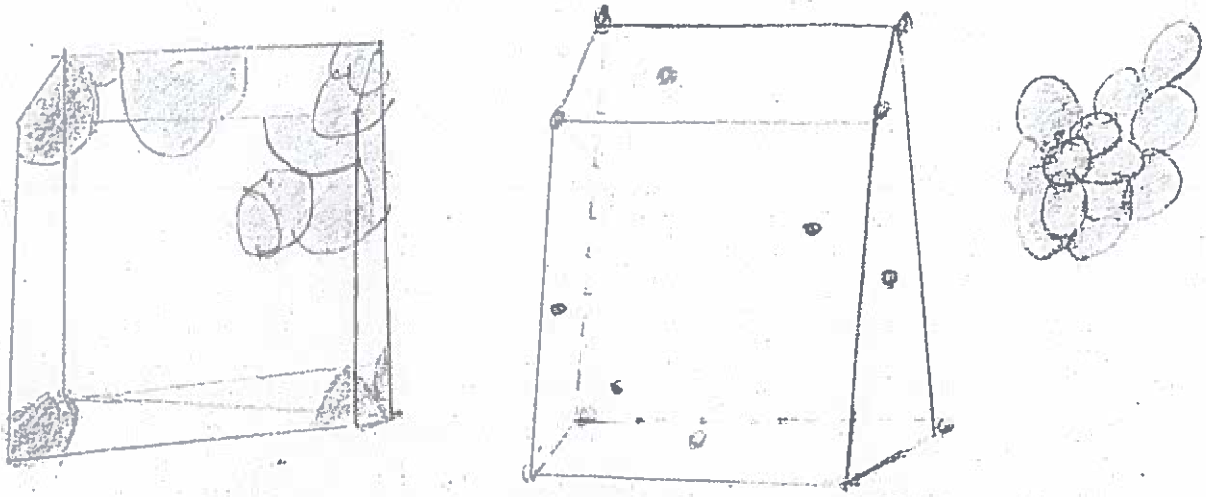


Fig: Face centered cubic crystal structure.

Number of atoms per unit cell:-

The unit cell of face centered cubic structure is shown in figure if there are 4 corener atoms one at each its 8 corners. Each corner atom is shared by 8 adjoining or surrounding unit cells.

Hence share of each unit cell = 1/8 of each corner atom.

∴ numbers of atoms in unit cell by the corordination of corner atom = 1/8 × 8 = 1 atom.

In addition, there are 1 atoms at the face centered of the cube each face centered atom is shared by 2 adjoing or sourcemounding unit cells

Hence, the share of the unit cell = 1/2 of each face centered atom.

Number of face centered atoms in the unit cell = 1/2 × 6 = 3 atoms.

Total number of atoms in the unit cell = 1atom + 3 atoms = 4atoms.

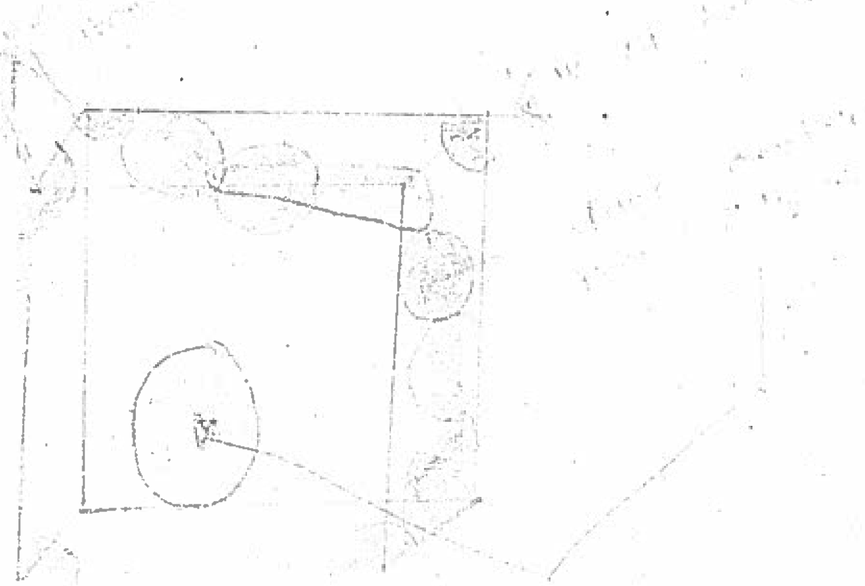


fig: number of atoms in FCC crystal structure

Co-ordination number:-

In these case there are 8 atoms at the corners of the unit cell and 6 corner atoms at the centre of six faces. For any corner atom of the unit cell, the nearest atom is the face centered atom. For any corner atom, there are 4 face centered atoms in its own plane and 4 above this plane and 4 below this plane.

thus, co-ordination number of this case = 4+4+4 = 12

Atomic radius:

In these case, there are 8 corner atoms in the unit cell and 6 atoms at the center of each six faces. These atoms touch each other along the diagonal of any face of the cube. The length of diagonal of the face = 4r.

The front view and cut view of the face structure is shown in figure.

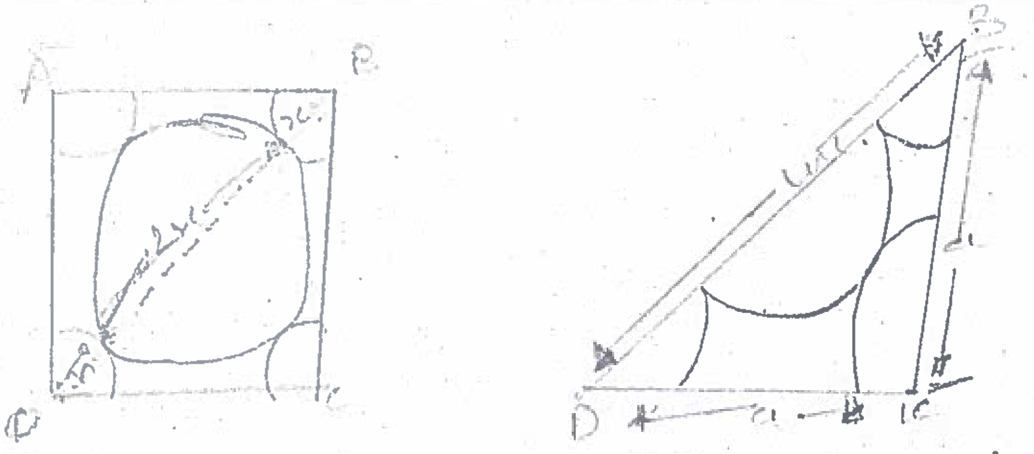


Fig. Atomic radius of FCC crystal structure.

$$DB^2 = DC^2 + CB^2$$

$$(4r)^2 = a^2 + a^2$$

$$16r^2 = 2a^2$$

$$r^2 = \frac{2a^2}{16}$$

$$r = \sqrt{\frac{2a^2}{16}}$$

$$r = \frac{a\sqrt{2}}{4}$$

Packing factor:-

Number of atoms per unit cell = 4

volume of 4 atoms (u) = $4 \times \frac{4}{3}\pi r^3$

side of the unit cell $a = \frac{4r}{\sqrt{2}}$

volume of the unit cell (V) = a^3

∴ atomic packing factor $\Rightarrow \frac{v}{V}$

$$\Rightarrow \frac{4 \times 4/3\ \pi r^3}{a^3}$$

$$= \frac{\frac{16}{3}\pi r^3}{\left(\frac{4r}{\sqrt{2}}\right)^3}$$

$$= \frac{\frac{16}{3}\pi r^3}{\frac{4^3 r^3}{(\sqrt{2})^3}}$$

$$= \frac{\pi\sqrt{2}}{6}$$

$$= 0.74 = 74\%$$

There fore 74% of the volume is occupied by the remaining 26% of the volume is vacant.

Examples:-

copper, Aluminium, nickel, gold, lead and platinum.