MUMBAI UNIVERSITY

SEMESTER-2

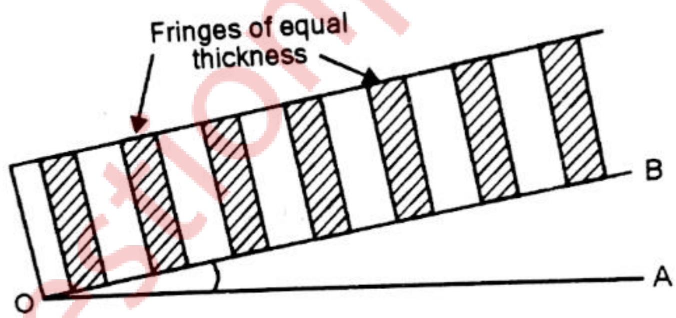
APPLIED PHYSICS-2 SOLVED PAPER MAY 2018

Q.1 Attempt any five questions

Q.1(a)Explain how interference in wedge shaped film is used to test optical flatness of given glass plate. (3 marks)

Answer :

1.The phenomenon of interference is used in testing the plainness of the surface of glass plate.



2.If two surfaces OA and OB are perfectly plane,the air film between them would gradually vary in thickness from O to A.The fringes are of equal thickness as each fringe is the locus of points at which the thickness of the film has a constant value.

3.To test the optical flatness of a surface,the specimen surface to be tested(OB) is placed over an optically plane surface (OA).

4.The fringes are observed in the field of view.

5.If the fringes are of equal thickness then surface is plane.

6.If the fringes are not of equal thickness then surface is not plane.

7.In this way interference in wedge shaped film is used to test optical flatness of given glass plate.

Q.1(b)What is diffraction grating?

What is the advantage of increasing the number of lines in the grating?

(3 marks)

Answer :

1.A diffraction grating is an arrangement consisting of a large number of parallel slits of same width and separated by equal opaque spaces.

2.It is obtained by ruling equidistant parallel lines on a glass plate with the help of a diamond.

3.The lines act as opaque spaces and the incident light cannot pass through them.The space between the two lines is transparent to light and acts as a slit.

4.The spacing between the lines is of the order of wavelength of visible light.The number of a lines in a plane transmission grating is of the order of 15000 to 20000 per inch.

Advantage of increasing the number of lines in the grating are :

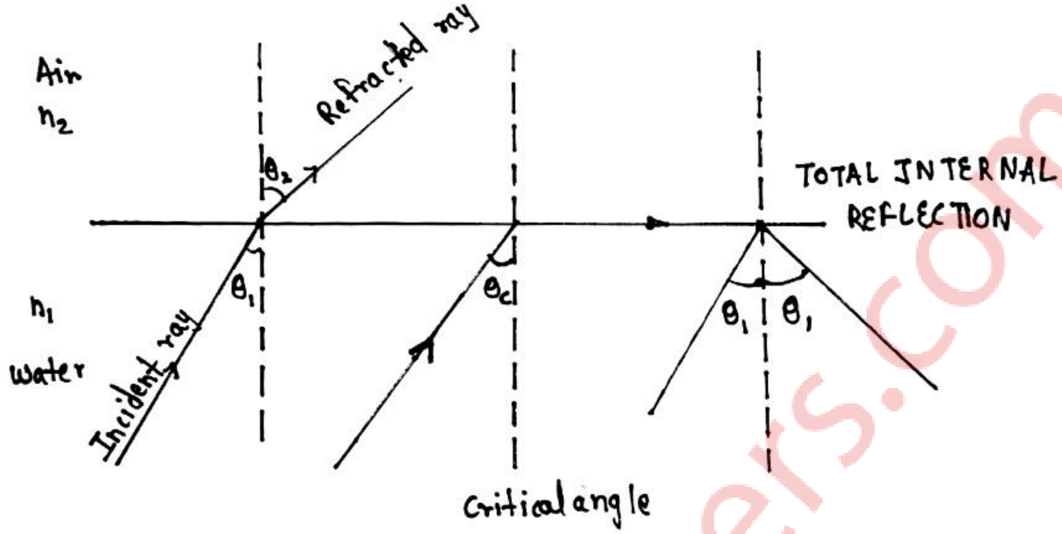
(a) The number of principal maxima that can be seen on a screen increases.
(b) The distance between two adjacent principal maxima increases.

Q.1(c)With neat ray diagram explain the concept of total internal reflection (TIR). (3 marks)

Answer:

1.Total internal reflection is the phenomenon which occurs when a propagated wave strikes a medium boundary at an angle larger than a particular critical angle with respect to the normal to the surface.

2.It refers to the complete reflection of a ray of light within a given medium from the surrounding surface. Here, the ray of light continues to be reflected within the medium (glass, water etc.) without being refracted.



3.When a ray of light is passing from a denser medium to rarer medium,if we increase the angle of incidence with normal,then at an angle known as critical angle(θ_c) a particular condition arrives in which the refracted ray becomes parallel to the boundary surface.

4.If any ray of light moving from denser medium to rarer medium strikes the boundary surface having incident angle greater than critical angle,then the ray of light continues to be reflected within the medium being refracted.

This is known as total internal reflection(TIR).

Q.1(d)Differentiate between spontaneous and stimulated emission. (3 marks)

Answer:

Sr.no.	**Spontaneous emission**	**Stimulated emission**
1.	When an atom in an excited state makes a transition into ground state by emission of photon, without any external stimulus, it's called spontaneous emission.	When an atom in an higher energy state is forced by a photon to make a transition into ground state resulting into emission of another photon is called stimulated emission.
2.	It is not useful for LASER.	It is useful for LASER.
3.	Spontaneous emission does not require an external electromagnetic stimulus to release energy	Stimulated emission does require external electromagnetic stimuli to release energy.

4.	The probability of spontaneous emission to take place is higher than the probability for stimulated emission to take place	The probability of stimulated emission to take place is higher than the probability for spontaneous emission to take place

Q.1(e)Find cylindrical co-ordinates of a point $(3\bar{\imath} + 4\bar{\jmath} + \bar{\boldsymbol{k}})$ (3 marks)

Answer:

The point is (3,4,1)

r $=\sqrt{\boldsymbol{x}^2 + \boldsymbol{y}^2}$

$=\sqrt{3^2 + 4^2}$

= 5

θ = $\tan^{-1}(\frac{y}{x})$

= $\tan^{-1}(\frac{4}{3})$

= 53.13°

= 0.2952$\boldsymbol{\pi}$

z = z = 1

Point in cylindrical system is $(5, 0.2952\boldsymbol{\pi}, \mathbf{1})$

Q.1(f)In Newtons's ring experiment,what will be the order of dark ring which will have double the diameter of 40th dark ring? (3 marks)

Answer :

For dark ring

$\mathbf{D^2_n = 4\, n\, \lambda\, R}$

$D^2_{40} = 4 \times 40 \times \lambda \times R$ …………(1)

Let n^{th} be the order of ring whose diameter is double the diameter of 40^{th} dark ring .
$(2D_{40})^2 = 4 \times n \times \lambda \times R$................(2)

From equation 1 and 2

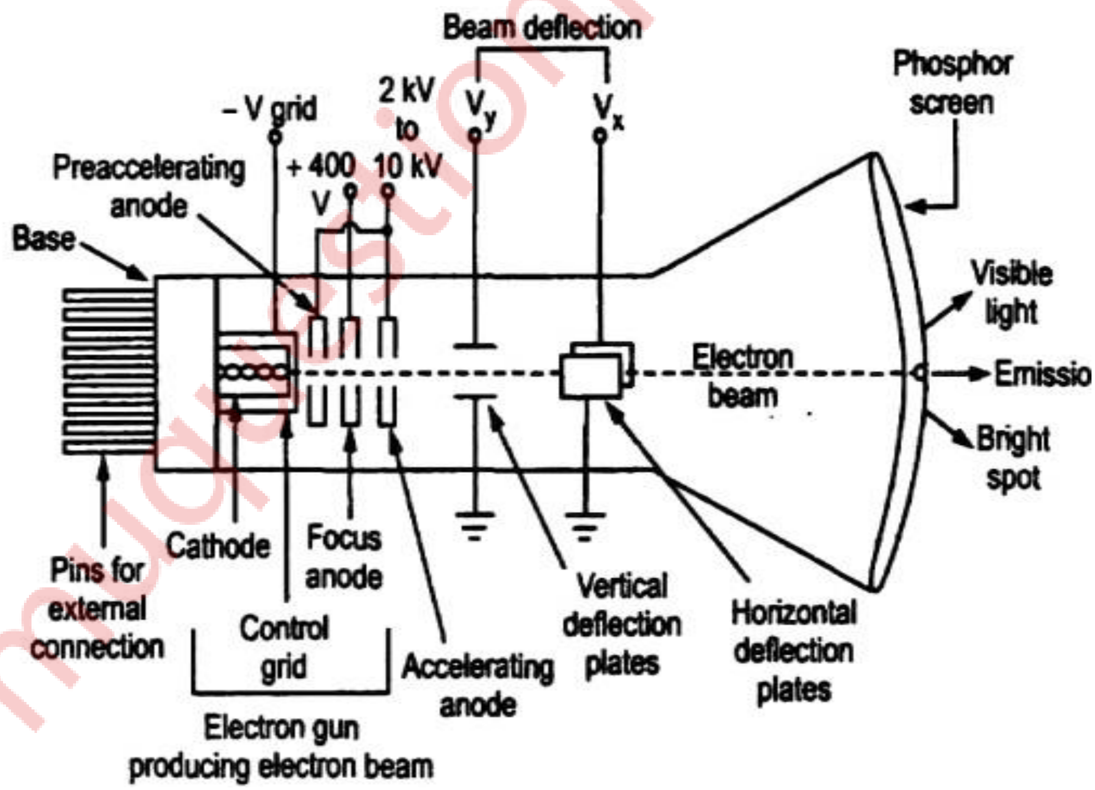
$$\frac{D_{40}^2}{4D_{40}^2} = \frac{40}{n}$$

n= 160

Value of n = 160

Q.1(g)Draw the block diagram of cathode ray tube and briefly explain its parts.

(3 marks)



Answer :

The main parts of the CRT are

i) Electron gun

ii) Deflection system

iii) Fluorescent screen

iv) Glass tube or envelope

v) Base

ELECTRON GUN

1.The electron gun section of the cathode ray tube provides a sharply focused, electron beam directed towards the fluorescent-coated screen.

2.This section starts from thermally heated cathode, emitting the electrons.

3.The control grid is given negative potential with respect to cathode.

4.This grid controls the number of electrons in t beam, going to the screen.

5.The light emitted is usually of the green colour.

Deflection System

When the electron beam is accelerated it passes through the deflection system, with which beam can be positioned anywhere on the screen.

Fluorescent Screen

1.The light produced by the screen does not disappear immediately when bombardment by electrons ceases, i.e., when the signal becomes zero.

2.The time period for which the trace remains on the screen after the signal becomes zero is known as “persistence or fluorescence” .

3.The persistence may be as short as a few microsecond, or as long as tens of seconds or even minutes.

4.Medium persistence traces are mostly used for general purpose applications. Ø Long persistence traces are used in the study of transients.Long persistence helps in the study of transients since the trace is still seen on the screen after the transient has disappeared.

Glass Tube

1.All the components of a CRT are enclosed in an evacuated glass tube called envelope.

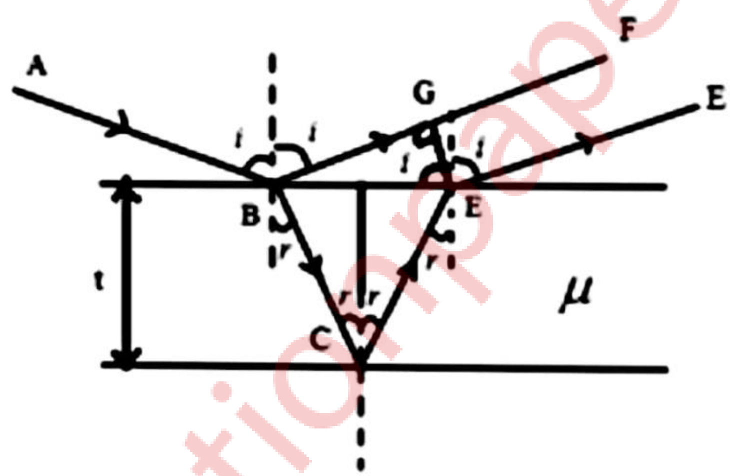
2.This allows the emitted electrons to move about freely from one end of the tube to the other end.

Base

The base is provided to the CRT through which the connections are made to the various parts.

Q.2(a)Derive the conditions of maxima and minima due to interference of light reflected from thin film of uniform thickness. (8 marks)

Answer:



Consider a thin film of uniform thickness (t) and R.I (μ)

On Reflected side,

The ray of light BF and DE will interfere.

The path difference between BF and DE is,

$\Delta = \mu(BC + CD) - BG$

$BC = CD = t/\cos r$..........(1)

Now,

$BD = (2t) \tan r$ ....(2)

$BG = BD \sin i$

$BG = (2t) \tan r \sin i$

$BG = 2t\mu \sin r(\sin r / \cos r)$
$BG = 2\mu t(\sin^2 r/\cos r)$..........(3)

Substituting (i) and (iii) in Δ :

$\Delta = \mu(t / \cos r + t / \cos r) - 2\mu t(\sin^2 r / \cos r)$

$= 2\mu t \cos r(1 - \sin^2 r)$

$\Delta = 2\mu t \cos r$

This is a geometric path difference. However, there is a phase change of π, as ray BF is reflected from a denser medium. Hence we need to add ±λ2 to path difference

$\Delta = 2\mu t \cos r \pm \lambda 2$

For Destructive Interference:

$\Delta = n\lambda$

$2\mu t \cos r \pm \lambda 2 = n\lambda$

$2\mu t \cos r = (2n \pm 1)\lambda 2$.....(n=0,1,2,...)

This is the required expression for constructive Interference or Maxima.

For Destructive interference:

$\Delta = (2n \pm 1)\lambda/2$

$2\mu t \cos r \pm \lambda/2 = n\lambda$

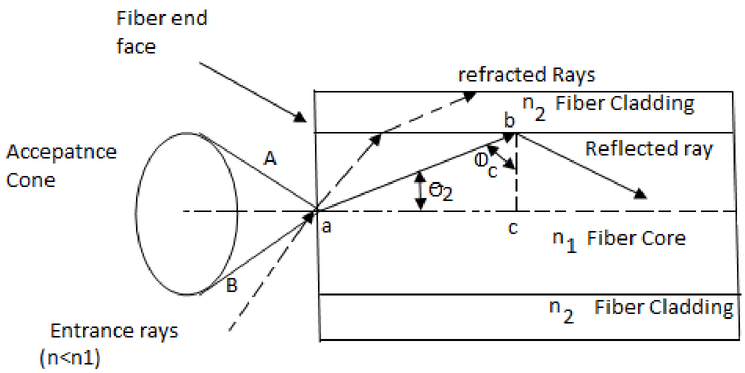
$2\mu t \cos r = n\lambda$

This is the required expression for destructive interference.

Q.2(b)Derive the formula for numerical aperture of step index fibre and give it's physical significance.The N.A of of an optical fibre is 0.5 and the core refractive index is 1.54.Find the refractive index of cladding. (7 marks)

Answer:

Numerical Aperture is the ability of fiber to collect the light from the source and save the light inside it by maintaining the condition of total internal reflection.



Consider a light ray entering from a medium air of refractive index n_0 into the fiber with a core of refractive index n_1 which is slightly greater than that of the cladding n_2.

Applying Snell's law of reflection at point A,

$\sin\Theta_1 / \sin\Theta_2 = n_1 / n_o = n_1$ as $n_0 = 1$

In right angled Δabc

$\theta_2 = \pi / 2 - \emptyset_c$

$\sin\theta_1 = n_1 \sin(\pi / 2 - \emptyset_c)$

$= n_1 \cos\emptyset_c$

$\cos\emptyset_c = (1 - \sin\emptyset_c{}^2)^{1/2}$

From the above equation

$\sin\theta_1 = n_1(1 - \sin\emptyset^2{}_c)^{1/2}$

When the TIR takes place, $\phi_c = \theta_c$ and $\theta_1 = \theta_a$

$\sin\theta_a = n_1(1 - \sin\theta_c{}^2)^{1/2}$

$\sin\theta_c = n_2/n_1$

$\sin\theta_a = n_1[1 - (n2/n1)^2]^{1/2}$

N.A.$= \sin\theta_a$

N.A. $= \sin\theta_a = \sqrt{n_1^2 - n_2^2}$

Thus,the formula for numerical aperture of step index fibre has been derived.

PHYSICAL SIGNIFICANCE OF NUMERICAL APERTURE :

1.It is the parameter which provides information about the acceptance angle.

2.Smaller N.A is not an advantage because it makes it harder to launch power into fibre.

SOLUTION OF PROBLEM :

N.A. = $\sqrt{n_1^2 - n_2^2}$

$0.5^2 = 1.54^2 - n_2^2$ $n_2 = 1.4566$

Refractive index of cladding = 1.4566

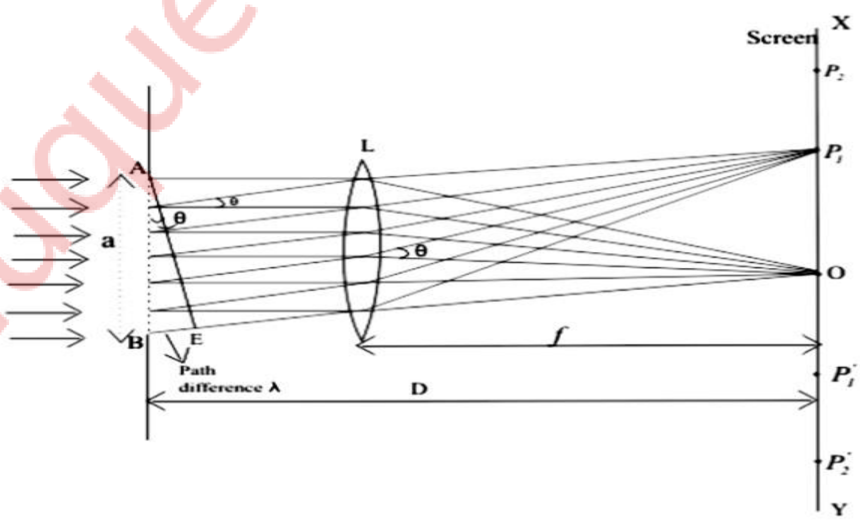
Q.3(a)Discuss the Fraunhoffer diffraction at single slit and obtain the condition for minima.

In plane transmission grating the angle of diffraction for second order principal maxima for wavelength 5 x 10^{-5} is 35^o.Calculate number of lines/cm for this diffraction grating. (8 marks)

Answer:

Fraunhofer diffraction at single slit :

1.Let us first consider a parallel beam of light incident normally on a slit AB of width 'a' which is of order of the wavelength of light.



2.A real image of diffraction pattern is formed on the screen with the help of converging lens placed in the path of the diffracted beam

3.All the rays that starts from slit AB in the same phase reinforce each other and produce brightness at point O on the axis of slit as they arrive there in the same phase

4.The intensity of diffracted beam will be different in different directions and there are some directories where there is no light

5.Thus diffraction pattern on screen consists of a central bright band and alternate dark and bright bands of decreasing intensity on both sides

6.Now consider a plane wave front PQ incident on the narrow slit AB. According to Huygens principle each point t on unblocked portion of wavefront PQ sends out secondary wavelets in all directions

7.Their combined effect at any distant point can be found y summing the numerous waves arriving there from the principle of superposition

8.Let C be the center of the slit AB.The secondary waves, from points equidistant from center C of the clit lying on portion CA and CB of wave front travel the same distance in reaching O and hence the path difference between them is zero

9.These waves reinforce each other and give rise to the central maximum at point O

i) Condition for minima :

1.We now consider the intensity at point P1 above O on the screen where another set of rays diffracted at a angle θ have been bought to focus by the lens and contributions from different elements of the slits do not arise in phase at P1

2.If we drop a perpendicular from point A to the diffracted ray from B,then AE as shown in figure constitutes the diffracted wavefront and BE is the path difference between the rays from the two edges A and B of the slit.

3.Let us imagine this path difference to be equal to one wavelength.

4.The wavelets from different parts of the slit do not reach point P1 in the phase because they cover unequal distance in reaching P1.Thus they would interfere and cancel out each other effect. For this to occur

$BE = \lambda$

Since $BE = AB\sin\theta$

$a\sin\theta = \lambda$

or $\sin\theta = \lambda/a$

or $\boldsymbol{\theta = \lambda/a}$ ---(1)

As angle of diffraction is usually very small so that $\sin\theta = \theta$

5.Such a point on screen as given by the equation (1) would be point of secondary minimum

6.It is because we have assume the slit to be divided into two parts, then wavelets from the corresponding points of the two halves of the slit will have path difference of $\lambda/2$ and wavelets from two halves will reach point P_1 on the screen in a opposite phase to produce minima

7.Again consider the point P_2 in the figure and if for this point path difference BE = 2λ ,then we can imagine slit to be divided into four equal parts

8.The wavelets from the corresponding points of the two adjacent parts of the slit will have a path difference of $\lambda/2$ and will mutually interfere to cancel out each other

9.Thus a second minimum occurs at P_2 in direction of θ given by
$\theta = 2\theta/a$

10. Similarly nth minimum at point P_n occurs in direction of θ given by
$\boldsymbol{\theta_n = n\theta/a}$ ---(2)

$(a+b)\sin\theta = m\,\lambda$
$(a+b)\sin 35 = 2 \times 5 \times 10^{-5}$

$a+b = 1.7434 \times 10^{-4}$

$N = \frac{1}{a+b}$

$= 5735$ lines/cm

Number of lines/cm = 5735

Q.3(b)What is the difference between photography and holography?

Explain holography technique to obtain 3D image of an object. (7 marks)

Answer:

Holography	Photography
1. The light from the object is scattered directly onto the recording medium in the recording of holography.	**1.** A lens is required in photography to record the image
2. A laser is required to record a hologram.	**2.** A photograph can be recorded using normal light sources e.g.sunlight,etc.
3. In photography,only intensity is recorded so photography produces 2-D picture of the object.	**3.** In holography, both intensity as well as phase of light wave is recorded,thus holography gives 3-D picture of object.
5.There is a need of vibration less table for holography.	**5.**There is no need of vibration less table for photography.
6. When a hologram is cut in half, the whole scene can still be seen in each piece.	**6.**When a photograph is cut in half, each piece shows half of the scene.

Holography technique to obtain 3D image of an object:

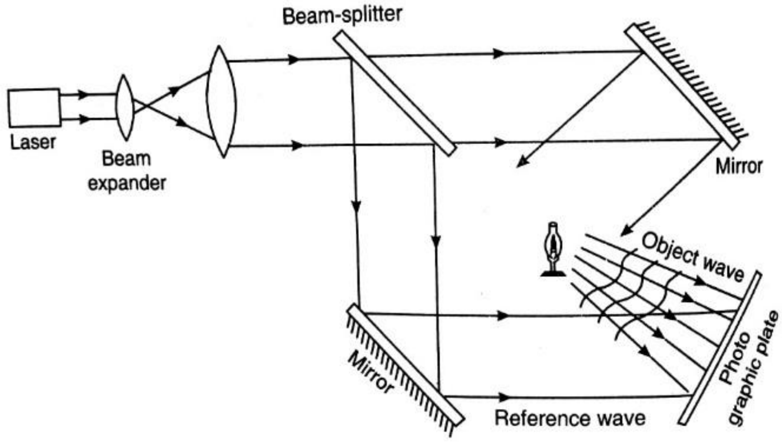
1. Holography is the science and practice of making holograms. Holography is actually a recording of interference pattern formed between two beams of coherent light coming from the same source.

2. In this process,both the amplitude and phase components of a light wave are recorded on a light sensitive medium such as a photographic plate. The recording is known as a hologram.

3. Holography requires an intense coherent light source.It became a practical proposition only after the invention of LASERS.

4. Holography is a two step process.In the first step,recording of hologram is done where the object is transformed into a photographic record and the second step is the reconstruction in which the hologram is transformed into image.

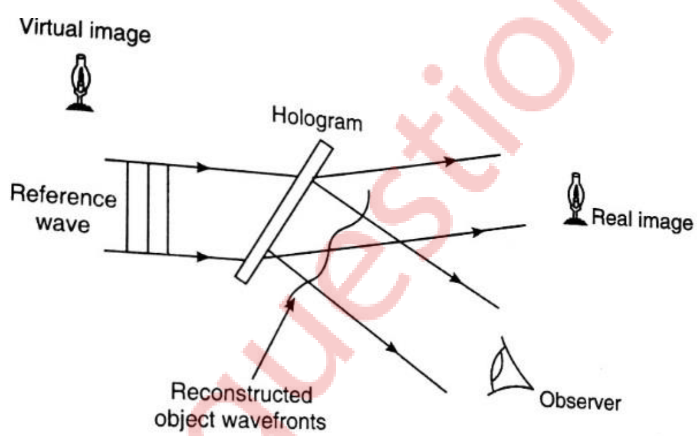
Construction process :



1.During the recording process we superimpose on the scattered wave emanating from the object,the another coherent wave(called as reference beam) of the same wavelength.

2.These 2 waves interfere in the plane of recording medium and produce interference fringes.This is the recording process of hologram.

Reconstruction process :



1.The reproduction of the image from the hologram is known as reconstruction of the hologram.

2.In this process,a wave identical to reference beam is used.

3.When the hologram is illuminated by the reconstruction wave,2waves are produced.

4.One wave appears to diverge from the object and provides the virtual image of the object.

5.The second wave converges to form the real image of the object.

Q.4(a)Find the divergence of vector field $F=x^2yz\bar{\imath} + xz\bar{\jmath}$ (5 marks)

Answer:

Divergence = $\frac{d(x^2yz)}{dx} + \frac{d(xz)}{dy}$ = 2xyz

Divergence = 2xyz

Q.4(b)Explain how A.C voltage and its frequency is measured using CRO.

(5 marks)

Answer:

Method to Measure Voltage :

1.The simplest way to measure signal is to set the trigger button to auto that means oscilloscope start to measure the voltage signal by identifying the zero voltage point or peak voltage by itself. As any of these two points identified the oscilloscope triggers and measure the range of the voltage signal.

2.Vertical and horizontal controls are adjusted so that the displayed image of the sine wave is clear and stable. Now take measurements along the center vertical line which has the smallest divisions. Reading of the voltage signal will be given by vertical control.

Method to Measure Frequency :

1.Increase the vertical sensitivity to get the clear picture of the wave on the screen without chopping any of its amplitude off.

2.Now adjust the sweep rate in such a way that screen displays a more than one but less than two complete cycles of the wave.

3.Now count the number of divisions of one complete cycle on the graticule from start to end.

4.Now take horizontal sweep rate and multiply it with the number of units that you counted for a cycle. It will give the period of the wave. The period is the number of seconds each repeating waveform takes. With the help of period, you can simply calculate the frequency in cycles per second (Hertz).

Q.4(c)A wedged shaped air film having an angle of 40 seconds is illuminated by monochromatic light and fringes are observed vertically through a microscope.

The distance measured between consecutive fringes is 0.12 cm.

Calculate wavelength of light used. (5 marks)

Answer :

$\beta = 0.12$ cm

$\theta = 40$ seconds $= 1.9392 \times 10^{-4}$ radians

$\beta = \frac{\lambda}{2\theta}$

$\lambda = \beta \times 2\theta$

$= 0.12 \times 2 \times 1.9392 \times 10^{-4}$

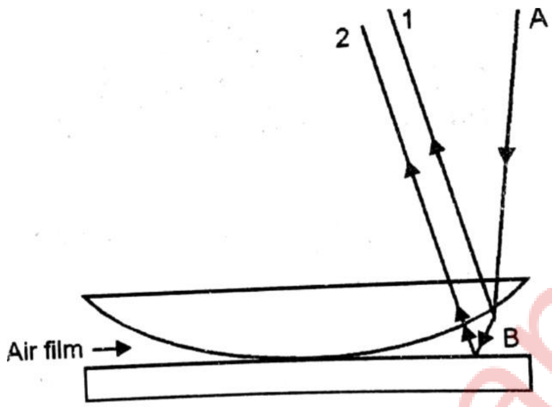
$= 4654$ A^{o}

Wavelength of light used = 4654 A^{o}

Q.5(a)Explain Newton's ring experiment and show that diameters of n^{th} dark rings are proportional to square root of natural numbers. (5 marks)

Answer:

Newton's ring experiment:



1.When a plano-convex lens of large radius of curvature is placed on a plane glass plate,an air film is formed between the lower surface of the lens and upper surface of the plate.

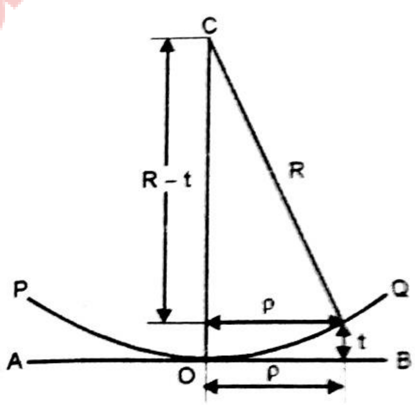
2.The thickness of the film gradually increases from the point of contact outwards.

3.If monochromatic light is allowed to fall normally on this film,a system of alternate bright and dark concentric rings,with centre dark is formed in the air film.

4.These rings were first studied by Newton and hence they are known as Newton's rings.

5.They can be seen through a low power microscope focused on the film.

6.Newton's rings are formed as a result of interference between the waves reflected from the top and bottom surfaces of the air film formed between the lens and the plate.



Let ρ be the radius of a Newton's ring corresponding to the constant film thickness t.

Path difference between two interfering rays = 2μtcos(r+ θ) + λ/2

$R^2 = \rho^2 + (R-t)^2$

$\rho^2 = 2Rt - t$

t<<R

$2t = \frac{\rho^2}{R}$

Path difference between the interfering rays is $\frac{\rho^2}{R}+\frac{\lambda}{2}$

For dark rings :

Path difference = $\frac{\rho^2}{R}+\frac{\lambda}{2}$

$=(2n+1)\frac{\lambda}{2}$

If D is the diameter of Newton's ring

$\rho=\frac{D}{2}$

$\frac{D_n^2}{4R} = n\,\lambda$

$\mathbf{D_n \; \alpha \; \sqrt{n}}$

Thus proved that the diameters of nth dark rings are proportional to square root of natural numbers.

Q.5(b)Write Maxwell's equation and give its physical significance. (5 marks)

Answer:

The Maxwell's equation and their physical significances are :

1. Maxwell's first equation is ∇. D = ρ

Integrating this over an arbitrary volume V we get

$\int_V \nabla.D\, dV = \int_V \rho\, dV.$

But from Gauss Theorem, we get

$$\int_s D.dS = \int_v \rho \, dV = q$$

Here, q is the net charge contained in volume V. S is the surface bounding volume V. Therefore,

Maxwell's first equation signifies that:

The total electric displacement through the surface enclosing a volume is equal to the total charge within the volume.

2. Maxwell's second equations is $\nabla.B = 0$

Integrating this over an arbitrary volume V, we get

$$\int_v \nabla.B = 0.$$

Using Gauss divergence theorem to change volume integral into surface integral, we get

$$\int_s B.dS = 0.$$

Maxwell's second equation signifies that:

The total outward flux of magnetic induction B through any closed surface S is equal to zero.

3. Maxwell's third equation is $\nabla \times E = (- \partial B/\partial t) . dS$

Converting the surface integral of left hand side into line integral by Stoke's theorem, we get

$$\oint_c E. dl = - \int_s \partial B/\partial t. dS.$$

Maxwell's third equation signifies that:

The electromotive force (e.m.f. $e = \int_C E.dl$) around a closed path is equal to negative rate of change of magnetic flux linked with the path (since magnetic flux $\Phi = \int_s B.dS$).

4. Maxwell's fourth equation is

$\nabla \times H = J + \partial D/\partial t$

Taking surface integral over surface S bounded by curve C, we obtain

$$\int_s \nabla \times H. dS = \int_s (J + \partial D/\partial t) dS$$

Using Stoke's theorem to convert surface integral on L.H.S. of above equation into line integral, we get

$$\oint_c H.dl = \int_s (J + \partial D/\partial t).dS$$

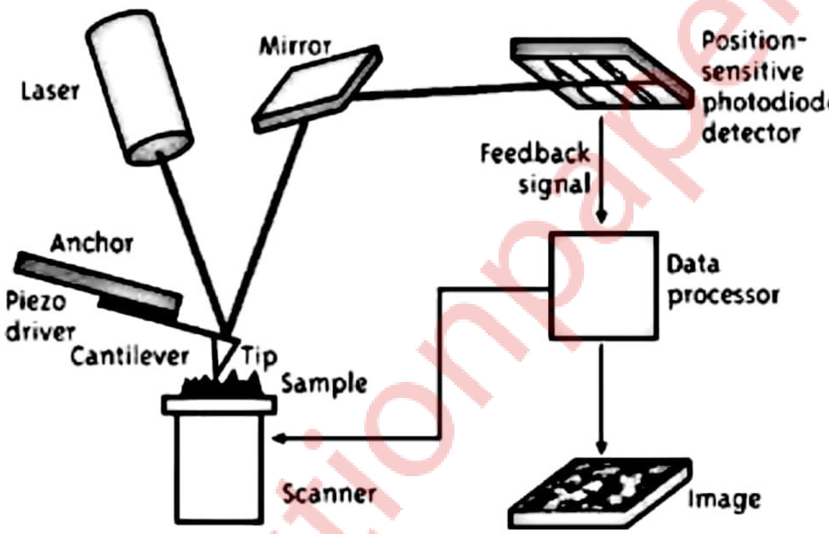
Maxwell's fourth equation signifies that:

The magneto motive force (m.m.f. = Φc H. dl) around a closed path is equal to the conduction current plus displacement current through any surface bounded by the path.

Q.5(c)Explain construction and working of atomic force microscope.

(5 marks)

Answer:



An Atomic Force microscope (AFM) consists of following components:

1.LASER

2.Photodiode

3. Cantilever with a sharp tip

4.Detector and feedback circuit

5.Pizoelectric scanner

WORKING OF ATOMIC FORCE MICROSCOPE :

1.AFM consists of microscope cantilever with a sharp tip (probe) at its end used to scan the specimen surface.

2.The cantilever is typically silicon or silicon nitride with the tip radius of curvature of the orders of nm. Basically, AFM is modified TEM in which limitations of TEM is overcomed. When the tip is bought close to the sample, force between the tip and sample leads to the deflection of the cantilever according to the Hook`s law. Instead of using an electrical signal, the AFM relies on forces between the atom on the tip and in the sample.

3.The force present in the tip is kept constant and the scanning is done. As the scanning continues, the tip will have vertical movements depending upon the topography of the sample. The force present in the tip is kept constant and the scanning is done. As the scanning continue the tip will have vertical movement depending upon the topography o the sample.

4.A LASER beam is used to have a record of vertical movement of the needle. This information is later converted into visible from using photo diode. Depending upon the situation, AFM measures different types of forces like a Vander Waal's forces, capillary force, mechanical contact force etc.

Q.6(a)Explain different types of carbon nanotubes and give its applications.

(5 marks)

Answer:

1.A carbon nanotube is a small cylindrical carbon structure made out of graphene. The tube comprises hexagonal structures.

2.There are many different types of carbon nanotubes, but they are normally categorized as either single-walled (SWNT) or multi-walled nanotubes (MWNT).

The different types of carbon nanotubes are :

Single-walled nanotubes (SWNT) :

(i) Single-walled nanotubes (SWNT) consists of a graphene sheet rolled on leading to a single cylinder.Two halves of a Fullerene molecule closes the structure at both ends.

(ii) They have diameters ranging from 1nm to 5nm and are usually well over 1 mm in length.

(iii) The length to diameter ratio is generally about 1000 so that they can be considered as nearly one-dimensional structures.

Multi-walled nanotubes (MWNT) :

(i)MWNT is arrangement of several coaxial tubes of graphene sheets forming a tube like structure.Each MWNT has from 2 to 50 such tubes.

(ii) The separation between neighbouring tubes is roughly about 0.34-0.36 mm.

(iii) They have inner diameters from 1.5 to 15 nm and outer diameters from 2.5 to 30 nm.They are usually over 1 mm in length

APPLICATIONS OF CNT:

1.Improving Structural Properties

2.Enhancing electrical and thermal conductivity

3.Energy harvesting/storage

4.Electromagnetic interference (EMI) shielding

5.Construction of nanoscale electronic devices.

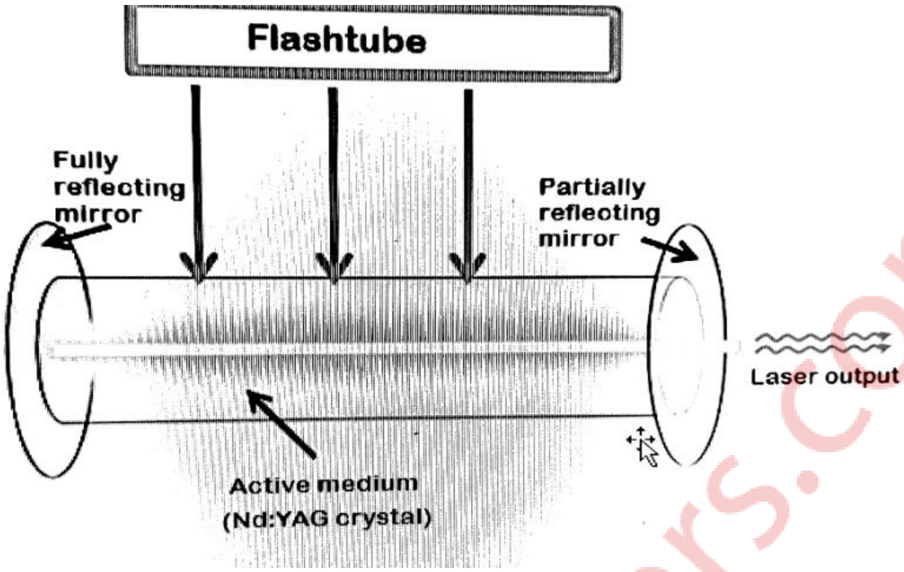
6.The electron emission concept of CNTs is used in developing a flat-panel display.

Q.6(b)Explain construction and working of Nd:YAG LASER. (5 marks)

Answer:

Neodymium-doped Yttrium Aluminum Garnet (Nd: YAG) laser is a solid state laser in which Nd:YAG is used as a laser medium.

Construction of Nd:YAG LASER :



Nd:YAG laser consists of three important elements: an energy source, active medium, and optical resonator.

Energy source :

The energy source or pump source supplies energy to the active medium to achieve population inversion. In Nd: YAG laser, light energy sources such as flashtube or laser diodes are used as energy source to supply energy to the active medium.

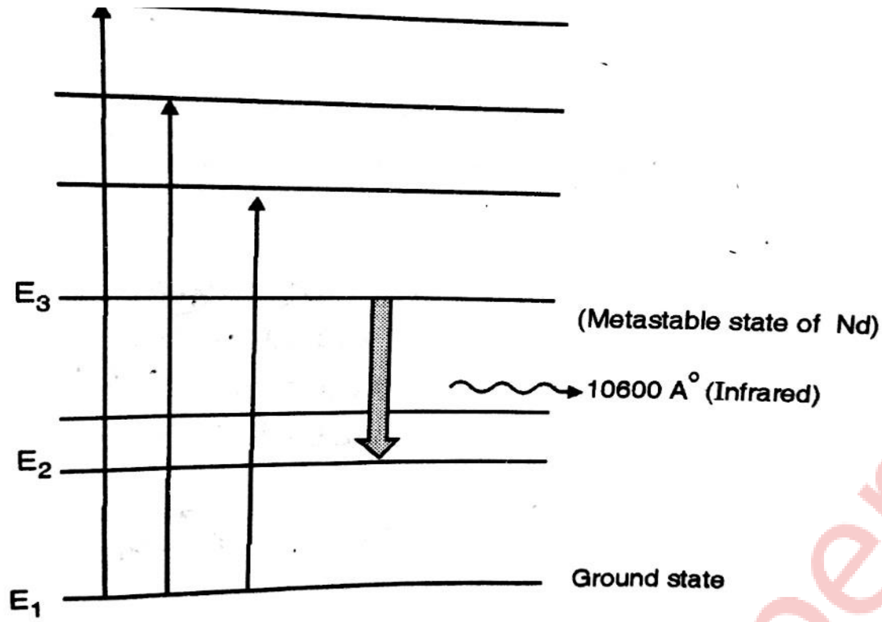
Active medium :

The active medium or laser medium of the Nd:YAG laser is made up of a synthetic crystalline material (Yttrium Aluminum Garnet (YAG)) doped with a chemical element (neodymium (Nd)). The lower energy state electrons of the neodymium ions are excited to the higher energy state to provide lasing action in the active medium.

Optical resonator :

The Nd:YAG crystal is placed between two mirrors. These two mirrors are optically coated or silvered.One mirror is fully silvered whereas, another mirror is partially silvered. The mirror, which is fully silvered, will completely reflect the light.The mirror which is partially silvered will reflect most part of the light but allows a small portion of light through it to produce the laser beam. This mirror is known as a partially reflecting mirror.

WORKING OF Nd:YAG LASER :



1.Energy levels E_1,E_2 and E_3 are of Nd and other levels belong to YAG.E_1 is ground state and E_3 offers metastable state.

2.Pumping takes place with light of 5000 A° to 8000A° which excites Nd^{+3} ions to higher states.

3.The metastable state E_3 rapidly gets populated due to downward transitions from higher energy levels as none of them is metastable.

4.Population inversion takes place between E_3 and E_2.

5.A continuous LASER of 10600 A° in infrared region is given out due to stimulated smission between E_3 and E_2.

Q.6(c)Write a note on electrostatic focusing. (5 marks)

Answer:

Electrostatic deflection is the method of aligning the path of charged particles by applying the electric field between the deflecting plates.

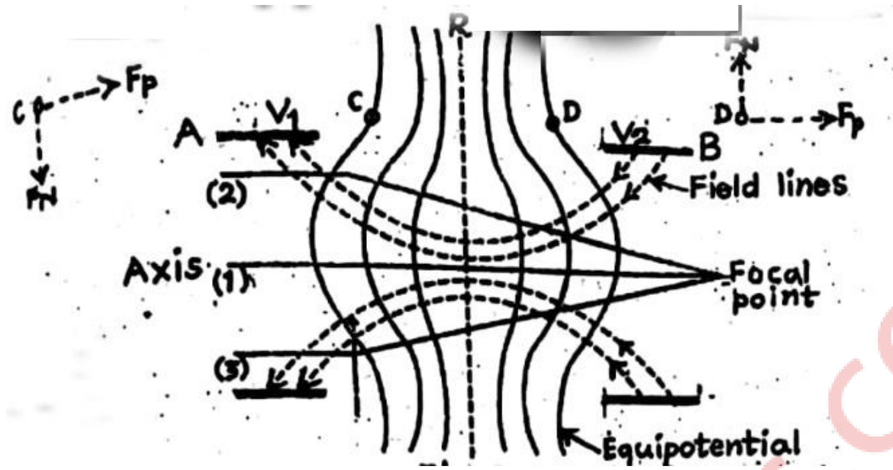


Diagram above represents the electrostatic focusing.A and B are two co-axial cylinders with potentials V1 and V2 such that V2>V1.R is the equipotential ring placed between A and B.

Working :

(1) Consider electron beam 1:

It will remain normal to all the equipotential surfaces and hence it is simply accelerated without any deviation of the path.

(2) Consider electron beam 2:

It will have following 2 effects:

(a) On the L.H.S off R: The parallel component of F_P will move the electron towards right while the normal component F_N will move the electron downwards by applying Fleming's left hand rule at point C.

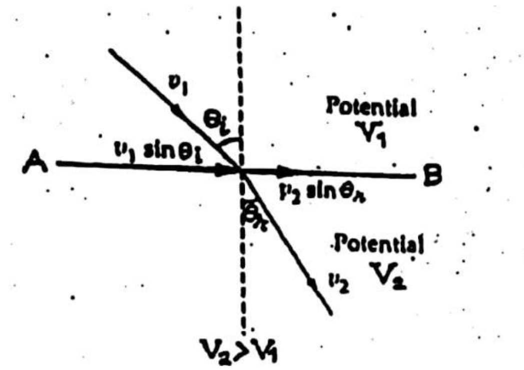
(b) On the R.H.S off R:F_P and F_N will move the electron towards right and towards up respectively by applying Fleming's left hand rule at point D.

(3) Consider electron beam 3:

It's path will be as shown with same case as case(2).

The focal length can be changed by varying V_1 and V_2

(4) Bethe's laws is also followed in electrostatic focusing :



$\frac{v_2}{v_1} = \frac{sin\ \theta_i}{\sin \theta_r}$

(5)Electrostatic focusing is used for accelerating and focusing electron beams.