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Subject: Optics

UNIT IV-POLARIZATION

1. What is polarization?

If is possible to transform unpolarised light in to polarized light. Polarized light waves in which the vibrations occur in a single plane. The process of transforming unpolarized light in to polarized light is known as ***polarization.***

2. What is polarized light?

The light which has acquired the property of one-sidedness is called ***polarized light.***

3. What is plane polarized light?

When the vibrations of the light are confined along a single direction perpendicular to the direction of propagation, the light is known as ***plane polarized.***

4. What are circularly and elliptically polarized lights?

If the vibrations of the light are along a circle or an ellipse lying in a plane perpendicular to the direction of polarization, the light said to be circularly or elliptically polarized light.

5. What is plane of vibration?

The plane in which the vibrations take place (ie., the plane containing the direction of vibration and the direction of propagation) is called the ***plane vibration.***

6. What is plane of polarization?

A plane perpendicular to the plane of vibration is called the ***plane of polarization.*** The plane of polarization is the plane passing through the direction of propagation and containing no vibrations.

7. What is double refraction?

The phenomenon of producing two refracted rays by a crystal is ***double refraction***. It is also birefringence.

8. What is Nicol prism?

It is an optical device made from a Calcite crystal for producing and analyzing plane polarized light.

9. Write the uses of Nicol prism?

(i)Nicol prism is used as polarizer and analyzer

(ii)It is used for the production of circularly and elliptically polarized light.

(iii)In conjunction with a quarter wave plate, it is used for analyzing all kinds of polarized light.

10. What is a quarter wave plate?

A double refracting crystal plate having a thickness so as to produce a path difference of $\lambda/4$ or a phase difference of $\pi/2$,between the ordinary and extra-ordinary rays is called a ***quarter wave plate*** or ***$\lambda/4$ plate.***

11. What are the uses of quarter wave plate?

(i)The quarter wave plate is used for producing circularly and elliptically polarized lights.

(ii)In conjunction with a nicol prism, it is used for analyzing all kinds of polarized light.

12. What is a half wave plate?

A doubly refracting crystal plate having a thickness such as to produce a path difference of $\lambda/2$ or phase difference of π between the ordinary and extra-ordinary rays is called a ***quarter wave plate*** or ***$\lambda/2$ plate.***

13. What are the uses of half wave plate?

If plane polarized light is passed through a half wave plate, the emergent light is also plane polarized but its direction of vibration is inclined at angle 2 to that of the incident light, where is the angle between the incident vibration and the principal section of the plate.

Hence, such a plate is used in polarimeters as half-shade devices to divide the field of view into two halves presented side by side.

UNIT I-GEOMETRICAL OPTICS

1. Define curvature, radius of curvature.

A lens has two curved surfaces, each surface having a curvature.

The length of the radius of curvature of surface is called the radius of curvature.

2. Define principal axis, principal focus.

The line joining the centers of curvature of the two curved surfaces is called the principal axis.

The focal point to which a set of ray parallel to the principal axis is caused to coverage or appear to diverge is the principal focus.

3. What is optical centre?

For every lens, there is a point on the principal axis for which ray passing through it are not deviated by the lens. Any ray passing through it emerges in a direction parallel to the incident ray. Such a point is called the **optical centre.**

4. Define focal length, focal plane.

The distance between the focal point and the optical centre of the lens is called the focal length of the lens.

The plane perpendicular to the principal axis of lens and passing through its focal point is known as the focal plane.

5. What is the power of the lens?

The power the lens is the reciprocal of its focal length.

P=1/f diopter

6. Define Cardinal point.

Two focal points, two principal points and two nodal points. These six points are known as cardinal points of an optical system.

7. What is an aberration?

The departures of real images from ideal images, in respect of the actual size, shape, and position, are called ***aberration*.**

8. Define monochromatic, chromatic aberrations.

The aberrations (defect) due to wide-angle incidence and peripheral incidence, which occur even with monochromatic light, are called ***monochromatic aberrations*.**

Aberrations that occur due to dispersion of light are called **chromatic aberrations**.Choromatic aberration occurs with light that contains atleast two wavelengths.

9. What is spherical aberration?

An image formed by paraxial rays will be surrounded by a diffuse halo formed by peripheral rays and consequently the image is blurred. This phenomenon is known as ***spherical aberration**.*

10. Define coma, aplanatic lens.

The effect of rays from an object point not situated on the axis of the results in an aberration called ***coma*.**

A spherical lens, which is free from the defect of spherical aberration and coma, is called an aplanatic lens.

11. What is Astigmatism?

12. What is curvature of the field?

The image of an extended object due to a single lens is not a flat one but it will be curved surface. The central portion of the image nearer the axis is in focus but the outer regions of the image away from the axis are blurred. This defect is called ***curvature of the field*.**

13. Define Distortion. What are the types of distortion?

The failure of a lens to form a point image due to a point object is due to the presence of spherical aberration, coma and astigmatism. The variation in the magnification produced by a lens for different axial distances result in an aberration called ***distortion*.**

The types of the distortion are (i) pin-cushion distortion (ii) barrel shaped distortion.

14. Write merit and demerits of the Huygens eyepiece?

(i) The Huygens eyepiece is fully free from chromatic aberration because the distance between the lenses is equal to half the sum of their focal lengths.

(ii) Spherical aberration is also minimum because the distance between the two lenses is equal to the difference of their focal lengths.

(iii) The field of view of this eyepiece is smaller than that of Ramsden's eyepiece.

15. Write merit and demerits of the Ramsden's eyepiece?

(i) The field of view of this eyepiece is farly wide.

(ii) It is not entirely free from chromatic aberration since the distance between the two lenses is not equal to half the sum of their focal lengths. However, chromatic aberration is minimized by using an achromatic combination both for the field lens and the eye lens.

(iii) Spherical aberration is minimized by using two Plano-convex lenses thereby spreading deviation over four surfaces.

UNIT II- INTERFERENCE

1. What is interference?

If two waves of the same frequency travelling approximately the same direction and have a phase difference that remains constant with time, they may combine so that their energy is not distributed uniformly space but is a maximum at certain points and a minimum at other points. This effect known as ***interference***.

2. What is air wedge?

A wedge shaped (V-shaped) air film enclosed in between two glass plates is called ***air wedge***.

3. What is interference filter?

An ***interference filter*** is an optical system which transmits a very narrow range of wavelength and thus provides a monochromatic beam of light.

4. What is Michelson interferometer?

Michelson interferometer is an interferometer which is based on the principle of interference. It is used to find the wave length of monochromatic light and thickness of thin strips.

5. What is basic principle of Michelson interferometer?

The two interfering beams are formed by splitting the light from a source into two parts of equal intensity by reflection and refraction. These beams are sent in two perpendicular directions and are finally brought together after reflection from plane mirrors to produce interference fringes.

6. What are the applications of the Michelson interferometer?

(i) The wavelength of the given source of light,

(ii) The refractive index or thickness of a transparent material,

(iii) The resolution of wavelengths.

7. What are Newton's rings?

Newton's rings are formed when a Plano-convex lens a large radius of curvature placed on a glass plate, a thin film of air is enclosed between lower surface of the lens and upper surface of the plate. The thickness of the air film is very small at the point of contact and gradually increases from the centre outwards. The fringes produced with monochromatic light are circular. The fringes are concentric circle with the point of contact as the centre.Newtonoriginallyobserved these concentric fringes and hence they are called ***Newton's rings***.

8. What is meant by hologram?

` In holography, the image of the object to be photographed is not directly recorded but the light waves reflected from the object after interference with direct ray recorded. The photographic record is called a ***hologram***.

9. Define Brewster's fringes

When a beam of monochromatic light falls in succession on two thick plates of transparent material, it is divided in to several portions by reflection at various surfaces. Some of the reflected rays produce interference and interference fringes are observed. Such fringes were first observed by Brewster in 1815 and are known as ***Brewster's fringes.***

10. Define Haidinger fringes.

When the film is of uniform thickness, the change in path difference is only due to change in radius. If the thickness of the film is large, the path difference will change appreciably even when radius changes in a small way. Fringes are produced in this case due to the superposition of rays, which are equally inclined to normal. These fringes are called fringes of equal inclination. The fringes of equal inclination are known as ***Haidinger fringes***.

11. What are stationary waves?

These waves showing alternate formation of nodes and antinodes due to the interference of the incident and the reflected waves are called ***stationary waves*** in light.

UNIT III-DIFFRACTION

1. Define diffraction.

When waves encounter obstacles, they bend round the edge of the obstacles, if the dimensions of the obstacles are comparable to the wavelength of the waves. The bending of waves around the edges of an obstacle is called ***diffraction***.

2. What is Fraunhoffer diffraction?

Fraunhoffer diffraction pattern, the incident wave front must be plane and the diffracted light is collected on the screen with the help of a lens.Thus,the source of light should either be at large distance from the slit or collimating lens must be used.

3. What is a transmission grating?

A diffraction grating is an extremely useful device and in one of its forms it consists of a very large number of narrow slits side by side. The slits are separated by opaque spaces. When a wave front is incident on a grating surface, light is transmitted through the slits and obstructed by the opaque portions. Such a grating is called a ***transmission grating***.

4. Define dispersive power.

Dispersive power of grating is defined as the ratio of the difference in the angle of diffraction of any two neighboring spectral lines to the difference in wavelength between the two spectral lines.

$d\theta/d\lambda=n/ (a+b) \cos\theta =nN'/\cos\theta$

5. Define resolving power.

The ability of an optical instrument, expressed in numerical measure, to resolve the images of two nearby points is termed as its ***resolving power***.

6. Write the Rayleigh criterion for resolution?

According to Rayleigh, two nearby images are said to resolve if the position of the central maximum of one coincides with the first secondary minimum of the other and vice versa. The same criterion can be conveniently applied to calculate the resolving power of telescope, microscope, grating, prism, etc.

7. Write the Rayleigh condition?

Rayleigh's condition can also be stated that as follows. Two images are said to be just resolved if the radius of the central disc of either pattern is equal to the distance between the centers of two patterns.

UNIT V-SPECTROSCOPY LASERS

1. What is spectrum?

If the beam of light that illuminates the slit of the spectrometer contains more than one wavelength, then the light waves of different length are deviated to different extents by the prism. The image seen in the field of view of the telescope consists of a number of colored images of the slit. Such an image is called a ***spectrum***.

2. Define induced (stimulated) absorption.

An atom in the ground state with energy E_1 absorbs a photon of energy hv and go to exited state with energy E_2 provided the photon energy hv is equal to the energy difference (E_2-E_1).this process is called ***induced(stimulated) absorption***.

3. What is spontaneous emission?

The atom in excited state E_2 (higher energy state) returns to the ground state E_1 (lower energy state) by emitting a photon of energy hv without the action of an external agency.

Such an emission of radiation which is not triggered by an external influence is called ***spontaneous emission***.

4. What stimulated emission?

The process of forced emissions of photons caused by the incident photons is called stimulated emission. It is also called ***induced emission***. This process is the key factor to the operation of a laser.

5. What is meant by population inversion?

In laser technology, the establishment of a situation in which the number of atoms in higher energy level is greater than in lower energy level is called ***population inversion***.

6. What is He-Ne laser?

He-Ne laser is a four level gaseous laser. A mixture of helium and neon gases is used as an active medium. The population inversion is achieved by electrical discharge method.

7. Write the differences between spontaneous and stimulated emission?

	Spontaneous emission	**Stimulated emission**
1	Emission of light radiation is not triggered by external influence	Forced emissions of light radiation caused by incident photon
2	The emitted photon travels in random direction	The emitted photon can be made to travel in particular direction
3	The emitted photon cannot be controlled	The emitted photon can be controlled
4	This process is not a key factor for laser operation	This process is key factor for laser operation

8. What are the uses IR spectrums?

i) The study of infra-red absorption spectra has been of great use in the analysis of chemical compounds determination of molecular structure and detection of organic molecules.

ii) The identification of IR spectra of water and ammonia has made interesting in astrophysics. From this study, it was found that the atmosphere of Venus contains carbon-dioxide and Jupiter and Saturn contain ammonia and methane.

iii) In the world war II.IR photography played a very important part in detecting objects in the dark through mist, fog and cloud.

iv) IR radiation have a wide application in the field of medicine.IR radiation can penetrate deep into the human body. Using this property, the flow of blood can be increased.

9. What are the uses UV spectrums?

i) UV absorption is used to determine vitamin A and for standardizing fish-liver oil concentration.

ii) The photo chemical effect and photo biological effects of UV rays are used in the treatment of rickets.

iii) By UV spectroscopy, many organic compounds can be studied.

iv) Using UV microscope, structure of the bacteria can be studied.

v) UV ray studies are used to determine, surface temperature of some stars.

vi) UV rays are necessary for the healthy growth of the skin, tissues and bones of human body.

10. Write application of Raman spectroscopy?

i) Bhor theory is used in the study of atomic structure. In a similar way Raman Effect is used in the study of molecular structure.

ii) Rotational and vibration energy of the molecules can be studied using Raman Effect. From this molecular structure and binding energy of atoms can be studied.

iii) Studies of nuclear spin, isotopic constitution of nuclei have been successfully carried out using Raman Effect.

iv) Specific heat of solids, brilliance of metals has been explained by Raman Effect.

v) Various chemical effects like strength of chemical bonds, hydrolysis etc. have been understood through Raman Effect.

11. Mention the applications of lasers.

Industry

I) Welding ii) Cutting iii) Drilling

iv) Heat treatment of metallic and non metallic materials.

v) For testing the materials for flaws or defects without damaging them.

Medical

i) Treatment of detached retinas.

ii) Performing micro-surgery and bloodless operation.

iii) Treatment of human and animal cancer and skin tumours.

Scientific and Engineering

i) Laser beam is used to transmit hundreds messages at a time on radio, television and telephone.

ii) Communication between the planets is possible with laser.

iii) Since the laser light waves are not absorbed by water, it is possible to establish under water communication between sub-marines.

iv) Laser is used for forecasting the earth quakes.

12. What are the characteristics (properties) of laser?

i)Laser light highly coherent.

ii) It is highly powerful.

iii) It is also directional and monochromatic.

vi) It is capable of propagation over long distances.

v) Laser beams are not easily absorbed by the water.