

Tutorial 5

Polarization and Modern Optics I

- Production and detection of linearly and circularly polarized light;
- Double refraction, quarter wave plate;
- Optical activity; Principles of fibre optics, attenuation;
- Pulse dispersion in step index and parabolic index fibres; Material dispersion, single mode fibres;

Q1:

Explain why information carrying capacity of an optical fibre can be enhanced by reducing the pulse dispersion. How does one minimize pulse dispersion using a graded index optical fibre ?

10

2013

Q2:

For a multimode step index optical fibre, the core refractive index is 1.5 and fractional index difference is 0.001. Calculate the pulse broadening for 1 km length of the fibre. Over a length of 2 km of the fibre, calculate the minimum pulse separation that can be transmitted without overlap.

10

2014

Q3:

Find out the angle between the reflected and refracted rays when a parallel beam of light is incident on a dielectric surface at an angle equal to the Brewster's angle. Explain how do you use this concept to produce linearly polarized light.

10+10=20

2015

Q4:

The refractive indices of core and cladding in a step index optical fiber are 1.52 and 1.48 respectively. The diameter of the core is $30\text{ }\mu\text{m}$. If the operating wavelength is $1.3\text{ }\mu\text{m}$, calculate the V parameter and the maximum number of modes supported by the fiber.

10

2016

Q5:

Explain the principle of producing polarized light by the method of reflection, refraction and double refraction with the help of neat diagrams.

15

2016

Q6:

Sunlight is reflected from a calm lake. The reflected light is 100% polarized at a certain instant. What is the angle between the sun and horizon? 10

2017

Q7:

A plane-polarized light passes through a double-refracting crystal of thickness $40\mu\text{m}$ and emerges out as circularly polarized. If the birefringence of the crystal is 0.00004 , then find the wavelength of the incident light. 10

2017

Q8:

Explain the principle of operation of optical fibre. What are the different losses that take place in optical fibre? 10

2017

Q9:

Distinguish between positive and negative crystals in terms of double refraction. How are these crystals used to make quarter wave plates ? Explain how the quarter wave plate is used in producing elliptically and circularly polarized light. 15

2018

Q10:

How can one convert a left-handed circularly polarised light into a right-handed one (and vice versa) ?

Calculate the thickness of a quarter-wave plate when the wavelength of light is 589 nm .

Given : $\mu_o = 1.544$ and $\mu_E = 1.553$. 10

2019

Q11:

Explain the phenomenon of double refraction in calcite crystal. Considering birefringent crystal as non-conducting material, explain double refraction using electromagnetic theory.

Calculate the thickness of a double refracting plate which produces a path difference of $\frac{\lambda}{4}$ between extraordinary and ordinary waves. 15

Given :

$$\lambda = 5890 \text{ \AA}, \mu_o = 1.53, \mu_e = 1.54$$

2020

Q12:

Show that the phenomenon of Fraunhofer diffraction at two vertical slits is modulation of two terms viz. double slit interference and single slit diffraction. Obtain the condition for positions of maxima and minima. 20

2021

Q13:

A phase retardation plate of quartz has thickness 0.1436 mm. For what wavelength in the visible region will it act as quarter-wave plate? Given that $\mu_o = 1.5443$ and $\mu_e = 1.5533$. 10

2022

Q14:

Write conditions for working of a step-index optical fiber. In a step-index fiber, the core and cladding materials have refractive indices 1.50 and 1.43, respectively.

Find the following : 20

- (i) Critical propagation angle
- (ii) Acceptance angle
- (iii) Total time delay in 1 km length of the fiber
- (iv) Total dispersion in 50 km length of the fiber

2023

Q15.

Explain the phenomenon of double refraction. What are positive and negative crystals? Give their examples.

5

2024

Q16.

What do you understand by optical activity? A linearly polarized light is propagating along the optic axis of a quartz crystal of thickness 0.2 cm. If the difference in the refractive indices corresponding to right circularly polarized and left circularly polarized beams is 7×10^{-5} and the wavelength of the light is $0.5 \mu\text{m}$, calculate the angle of polarization.

10

2024

Q17.

What do you understand by attenuation in optical fibers? What are the factors responsible for the attenuation?

5

2024

Q18.

Consider a 10 mW laser beam passing through a 50 km fiber link of attenuation 0.5 dB/km. Calculate the power of the laser at the end of the link.

10

2024