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# IV Semester B.Sc. Degree Examination, September/October - 2022

## PHYSICS

### Physical Optics, Lasers, Holography and Fiber Optics

(Semester Scheme : CBCS -Freshers)

Paper : IV



**Time : 3 Hours** **Maximum Marks : 70**

*Instructions to Candidates :*

1. **All Multiple-Choice Questions in PART A are to be compulsorily answered in page - 1**
2. **Non-programmable Scientific Calculators are allowed.**

## PART-A

**Answer ALL questions. Each question carries ONE MARK.** **(10 × 1 = 10)**

1. On introducing a thin transparent plate in one of the paths of the interfering beams in a biprism experiment, the fringe system

   a) Rotates b) Disappears

   c) Broadens d) Shifts

2. Brilliant colours seen on soap bubbles is due to

   a) Interference of light b) Diffraction of light

   c) Dispersion of light d) Reflection of light

3. In a biprism experiment, air between the biprism and the screen is replaced by an oil, then the fringe width

   a) Remains same b) Decreases

   c) Increases d) Becomes unequal

4. In case of diffraction, interference occurs between light waves coming from

   a) Two different sources

   b) The source and the obstacle

   c) Different wave fronts from a single source

   d) Different points on the same wave front

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5. Wave lengths of light used in an optical instrument are $\lambda_1 = 400$ nm and $\lambda_2 = 500$nm, then ratio of the resolving powers is

a) 16:25 b) 9:1 c) 4:5 d) 5:4

6. Zone plate behaves like a

a) Concave lens with multiple foci
b) Convex lens with multiple foci
c) Convex lens with single focus
d) Concave lens with single focus

7. Which of the following is not a characteristic property of laser beam?

a) Directionality
b) Coherence
c) Monochromaticity
d) Speed

8. The active medium in Ruby laser is

a) Aluminum ions
b) Chromium ions
c) Oxygen
d) Aluminum and Chromium ions

9. The principle of optical fiber is

a) Frequency modulation
b) Population inversion
c) Total internal reflection
d) Doppler effect

10. Which of the following is not a cause of energy loss inside an optical fiber?

a) Radiative loss b) Scattering c) Absorption d) Reflection

## PART - B

**Answer Any Five Questions. Each question carries TWO Marks.** **(5×2=10)**

11. Write the conditions for constructive and destructive interference.

12. State two essential conditions to obtain sustained interference.

13. Define resolving power of diffraction grating and write its mathematical form.

14. Mention any two differences between prism spectrum and grating spectrum.

15. Mention any two applications of laser.

16. What is meant by

a) Coherence time and

b) Coherence length

17. Mention any two advantages of optical fibers over copper cables for communication.

18. Mention the expression for the attenuation co-efficient and explain the symbols.

## PART - C

**Answer any FIVE questions. Each question carries SIX MARKS.** **(5 × 6= 30)**

19. Give the theory of interference of transmitted light through a thin film. **(6)**

20. Explain with necessary diagram, the formation of interference fringes by a thin wedge-shaped air film and hence obtain the expression for the fringe width. **(6)**

21. Arrive at the expression for the focal length of zone plate. **(6)**

22. Describe the theory of diffraction grating for oblique incidence. **(6)**

23. With relevant diagrams, explain the construction and working of He-Ne laser. **(6)**

24. a) Distinguish between spontaneous and stimulated emission. **(2+4)**

    b) Explain the characteristics of laser.

25. Explain the step index and graded index optical fibers. **(6)**

26. What is meant by numerical aperture? Arrive at the expression for the numerical aperture in terms of refractive indices of the core and cladding materials. **(6)**

## PART - D

**Answer Any FOUR Questions. Each question carries FIVE Marks.** **(4×5=20)**

27. In a biprism experiment, the central bright fringe is shifted to the position of the $5^{th}$ bright fringe on introducing a transparent glass plate of refractive index 1.5 in the path of one of the interfering beams. If the wavelength of light used is 600 nm, find the thickness of the glass plate.

28. In Newton's rings experiment, the diameters of $5^{th}$ and $15^{th}$ rings are respectively 0.336cm and 0.59cm. Find the radius of curvature of the planoconvex lens used, if the wavelength of light used is 589nm.

29. A diffraction grating having 4000 lines per cm is set normal to the incident light of wavelength 500 nm. Calculate the dispersive power of the grating in the third order spectrum.

30. Two pin holes 1.5mm apart are placed in front of a source of light of wavelength 500 nm and are seen through a telescope. If the diameter of the objective of the telescope is 4 cm, find the minimum distance from the telescope at which the pin holes are just separated.

31. A laser pulse of power 1mW lasts for 10 ns. If the number of photons emitted per pulse is $3.491 \times 10^7$, calculate the wavelength of laser. Given: $h = 6.625 \times 10^{-34}$ J s and $c = 3 \times 10^8 ms^{-1}$. Given : $h = 6.625 \times 10^{-34}$ Js and $c = 3 \times 10^8$ $ms^{-1}$.

32. Find the ratio of population of two energy levels, if the wavelength of light emitted at 330K is 632.8 nm. Given $k = 1.38 \times 10^{-23}$ $JK^{-1}$, $h = 6.625 \times 10^{-34}$ Js and $c = 3 \times 10^8$ $ms^{-1}$.

33. The angle of acceptance of an optical fiber is 30° when kept in air. Find the angle of acceptance when it is in a medium of refractive index 1.33.

34. The attenuation of light in an optical fiber is 2.2 dB/km. What fractional initial intensity remains after

    a) 2 km and

    b) 6 km

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# IV Semester B.Sc. Degree Examination, September/October - 2022

## PHYSICS

## Optics & Fourier Series

**(CBCS Semester Scheme Repeaters - 2018-19 onwards prior to 2020)**

**Paper : IV**

**Time : 3 Hours** **Maximum Marks : 70**

***Instructions to Candidates :***

1. **Answer any Five questions from each Part**
2. **Use of Non-Programmable scientific calculator is allowed.**

### PART - A

**Answer any FIVE questions. Each question carries 8 marks.** **(5 × 8 = 40)**

1. a) Verify the law of reflection for a spherical wavefront incident on a plane surface using Huygens' wave theory.

   b) Mention the conditions for constructive and destructive interference. **(6+2)**

2. a) Mention the methods of obtaining coherent sources.

   b) Explain with a diagram and necessary theory the interference in a wedge shaped thin film and hence derive an expression for the fringe width. **(2+6)**

3. a) What is Fresnel's half period zone? Show that the radii of the half period zones are proportional to the square root of natural numbers.

   b) Mention any three differences between Zone plate and Convex lens. **(5+3)**

4. a) Explain the Rayleigh criteria for resolution of two closely spaced point objects.

   b) What is dispersive power of a grating? Arrive at the expression for dispersive power of grating. **(4+4)**

5. a) Mention any two characteristics of laser.

   b) Derive a relationship between Einstein's coefficients $A_{21}$ and $B_{21}$, where the symbols have their usual meaning. **(2+6)**

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6. a) Define optical activity. Write the expression for specific rotation of a solution.

   b) What are retarding plates? How can circularly polarized light be produced and detected? (2+6)

7. a) State Fourier theorem ?

   b) Analyse square wave using Fourier's theorem. (2+6)

8. a) What is an optical fibre? Explain the principle involved in its working.

   b) Define numerical aperture. Obtain an expression for the same. (3+5)

## PART - B

**Answer any FIVE questions. Each question carries Four marks.** **(5× 4 = 20)**

9. When a thin sheet of a transparent material of refractive index 1.6 is introduced in the path of one of the interfering beams the central fringe shifts to a position occupied by the sixth bright fringe. If the wavelength of the light used is 589 nm, calculate the thickness of the material.

10. In Newton's ring experiment, the diameters of $4^{th}$ and $24^{th}$ dark rings are 0.4 cm and 0.8 cm respectively. Find the wavelength of light if the radius of curvature of the plano-convex lens is 1 m.

11. A narrow slit illuminated with light of wavelength 560 nm is placed at a distance of 1.5 m from a straight edge. If the distance between the straight edge and the screen s 3.2 m, calculate the distance between the first and the fourth dark bands.

12. Calculate the highest order spectrum for normal incidence which may be seen with monochromatic light of wavelength 600 nm by means of diffraction grating with $6\times10^5$ lines per meter.

13. A laser beam with power per pulse 2 mW lasts for 10 ns, contains $7.5\times10^7$ photons per pulse. Calculate the wavelength of laser light. Give $h = 6.625\times 10^{-34}$ Js and $c = 3\times10^8 ms^{-1}$.

14. Calculate the thickness of a mica sheet required for making a quarter wave plate. Given refractive indices for ordinary and extra - ordinary rays in mica are 1.586 and 1.592, Given, wavelength of light $\lambda = 546$ nm.

15. Obtain a Fourier expression for $f(x) = x^2$ for $-\pi < x < \pi$

16. The refractive index of core of an optical fibre is 1.5. The fractional index difference is 0.02 Calculate the refractive index of cladding and Numerical aperture.

## PART - C

**Answer any FIVE questions. Each question carries 2 marks** **(5 × 2 = 10)**

17. a) Does the phenomenon of interference obey the law of conservation of energy? Explain.

b) A thin film of oil on the surface of water appears coloured. Explain.

c) Can visible light undergo diffraction at a crystal surface? Explain

d) Can resolving power of grating be increased? Explain.

e) A two-level energy system is not suitable for laser action. Justify.

f) Does double refraction occur along optic axis? Explain.

g) Can any function be expressed in the form of Fourier series? Explain.

h) The refractive index of cladding is less than that of core in an optical fibre. Explain.