BPHCT-137

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME
(B.SC.G)

WAVES AND OPTICS

Valid from 1st January, 2022 to 31st December, 2022

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2022)

Dear Student,

Please read the section on assignments in the Programme Guide for B. Sc. that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignment is in this booklet, and it consists of two parts, Part A and B. The total marks of all the parts are 100, of which 35% are needed to pass it.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO.: ……

NAME: ……

ADDRESS: ……

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COURSE CODE:……..

COURSE TITLE: ……

ASSIGNMENT CODE: ……..

STUDY CENTRE: …….. **DATE:** ……..

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
3) Leave 4 cm margin on the left, top and bottom of your answer sheet.
4) Your answers should be precise.
5) Solve Part A and Part B of this assignment, and **submit the complete assignment answer sheets containing Parts A and B within the due date.**
6) The assignment answer sheets are to be submitted to your Study Centre as per the schedule. **Answer sheets received after the due date shall not be accepted.**

   We strongly suggest that you retain a copy of your answer sheets.
7) This assignment is **valid from 1st January, 2022 to 31st December, 2022**. If you have failed in this assignment or fail to submit it by 31st December, 2022, then you need to get the assignment for the year 2023, and submit it as per the instructions given in the Programme Guide.
8) **You cannot fill the examination form for this course** until you have submitted this assignment. For any queries, please contact: srjha@ignou.ac.in, drsgupta@ignou.ac.in. We wish you good luck.

Tutor Marked Assignment
WAVES AND OPTICS

Course Code: BPHCT-137
Assignment Code: BPHCT-137/TMA/2022
Max. Marks: 100

Note: Attempt all questions. The marks for each question are indicated against it.

PART A

1. a) The mathematical expression for one dimensional wave travelling along the positive *x*-direction is given as

$$y(x,t) = 0.02 \sin(42\,x - 1886t)\,\text{m}$$

where *x* is in meters and *t* is in seconds. Determine the direction of propagation of the wave and calculate its amplitude, wavelength, frequency and velocity. (2×5)

b) Determine the frequencies of the fundamental mode and the next two harmonics that can be set up on a sitar string of length 1.0 m. Take the speed of waves of the string to be $2.8 \times 10^3 \text{ms}^{-1}$. (5)

c) The electric field vectors of two light waves propagating along the positive *z*-direction are given as

$$\vec{\mathbf{E}}_1(z,t) = \hat{\mathbf{x}}\, E_{01}\cos(kz - \omega t)$$

$$\vec{\mathbf{E}}_2(z,t) = \hat{\mathbf{y}}\, E_{02}\cos(kz - \omega t + \phi)$$

where $\hat{\mathbf{x}}$ and $\hat{\mathbf{y}}$ are unit vectors along *x* and *y*-axes, respectively. Show that when these two waves superpose, we obtain elliptically polarised light. Also show that the linear and circular polarisations are special cases of elliptical polarisation. (5+5)

2. a) Derive an expression for the displacement of the *n*th bright fringe in Young's double-slit experiment when a thin transparent plate of refractive index μ and thickness *t* is introduced in the path of one of the constituent interfering beams of light. Will there be any change in the fringe-width after the introduction of the plate? (8+2)

b) i) Distinguish between fringes of equal inclination and fringes of equal thickness. (5)

ii) Newton's rings are formed in reflected light of wavelength 5890×10^{-8} cm with a liquid between the plane and curved surfaces. The diameter of the fifth ring is 0.3 cm and the radius of curvature of the curved surface is 100 cm. Calculate the refractive index of the liquid, when the ring is bright. (5)

c) Explain how Michelson interferometer is used to determine the refractive index of a thin plate. (5)

PART B

3. a) What is a zone plate? How does a positive zone plate differ from a negative zone plate? Show that each Fresnel zone has nearly the same area. (3+3+4)

b) In the Fraunhofer diffraction pattern due to a single slit, the intensity of the central spot is maximum. Explain on the basis of geometrical considerations. (5)

c) The Fraunhofer diffraction pattern due to a single slit of width 0.4 cm is obtained with the help of a lens of focal length 30 cm. If the wavelength of light used is 5890 Å, calculate the distance of the first dark fringe and the consecutive bright fringe from the axis. (5)

d) The radius of the fifth zone of a zone plate is 2 mm. Considering the zone plate as a converging lens, calculate its focal length for light of wavelength 4800 Å. (5)

4. a) What do you understand by spatial and temporal coherence? (3)

b) Explain the meaning of coherence length. (3)

c) What is the difference between spontaneous emission of radiation and stimulated emission of radiation? (3)

d) How is holography different from ordinary photography? (3)

e) What are the advantages of using optical fibre as communication medium? (3)

5. a) In a laser, the lasing levels are the first excited state and the ground state of the active medium. If the energy of the first excited state is 1.5eV, calculate the frequency of the laser light. (5)

b) The refractive index of the core and cladding materials of an optical fibre is 1.46 and 1.38, respectively. Calculate the critical angle, numerical aperture and acceptance angle at the air-fibre interface. (5)

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