BPHCT-137

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME
(BSCG)

WAVES AND OPTICS

Valid from 1st January, 2024 to 31st December, 2024

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2024)

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: …………………………………………

…………………………………………………….

…………………………………………………….

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, 2024 to 31st December, 2024**. If you have failed in this assignment or fail to submit it by 31st December, 2024, then you need to get the assignment for the year 2025, 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/2024
Max. Marks: 100

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

PART A

1. a) Obtain an expression for energy transported by a progressive wave on a taut string. Also show that the power transported by the wave is proportional to the wave velocity. (7+3)

   b) The fundamental frequency of a string instrument is 580 Hz. (i) Calculate the frequency of the first and third harmonics generated on it. (ii) If the tension in the string is doubled, calculate the new fundamental frequency. (5)

   c) Show that when two in-phase linearly polarised light waves are superposed, the resultant wave has fixed orientation as well as amplitude**.** Depict the orientation of electric field vector of the resultant wave in the reference plane. (6+4)

2. a) Explain how Michelson interferometer can be used to determine the wavelength of light? (5)

   b) In a Young's double slit experiment, a monochromatic light of wavelength 600nm is used. The slits are 0.2mm apart. An interference pattern is observed on a screen 0.6 m away. Calculate the distance between the central maxima and the third minima on the screen. (5)

   c) A Michelson interferometer is illuminated with monochromatic light. When one of the mirrors is moved $2.5\times10^{-5}\,\text{m}$, 100 fringes cross the field of view. Determine the wavelength of the incident light. (5)

   d) Obtain an expression of the displacement of the nth bright fringe in double slit experiment when a thin transparent plate of thickness *t* and refractive index μ is introduced in the path of one of the two interfering waves. How the fringe-width is affected with the introduction of the plate? (5)

   e) Interference fringes are formed by reflection from a thin air wedge by using sodium light of wavelength of 5893 Å When viewed perpendicularly, 12 fringes are observed in a distance of 1cm. Calculate the angle of wedge. (5)

PART B

3. a) In the experimental set up to observe diffraction pattern of a straight edge, the distance of the edge from the source is 30 cm and the distance of the screen from the edge is 40 cm. The wavelength of the light used is 480 x 10^{-5} cm. Calculate the position of the first and third minima from the edge of the geometrical shadow. (5)

b) Obtain an expression for intensity distribution in a single slit diffraction pattern. (10)

c) A plane light wave of wavelength 580 nm falls on a long narrow slit of width 0.5 mm. (i) Calculate the angles of diffraction for the first two minima. (ii) How are these angles influenced if the width of slit is changed to 0.2 mm? (iii) If a convex lens of focal length 0.15 m is now placed after the slit, calculate the separation between the second minima on either side of the central maximum. (10)

4. a) Explain the three light-matter interactions with the help of atomic level diagrams. Write the corresponding Einstein's equations. (5)

b) Explain the role of resonant cavity in determining the coherence and monochromaticity of a laser light. (5)

c) Describe the types of optical fibres. How can the pulse dispersion in the optical fibre be reduces? (5)

d) A laser cavity of 25 cm length sustains the radiation of 6300 Å. Calculate the number of modes and mode separation. If the spread in wavelength is 0.02 Å, calculate the coherence length and coherence time. (5)

e) The refractive indices of core (n_1) and cladding (n_2) materials of two optical fibres *A* and *B* are as follows:

$(n_1)_A = 1.46$ and $(n_2)_A = 1.38$

and $(n_1)_B = 1.52$ and $(n_2)_B = 1.41$

Which of the two fibres will have higher gathering capacity? (5)

****