PHE-09

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

OPTICS

Valid from January 1, 2024 to December 31, 2024

It is compulsory to submit the Assignment before filling up the Term-End Examination Form.

Please Note

- **You can take electives (56 to 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.**
- **You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.**
- **At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for that course. Otherwise, your result will not be declared and the onus will be squarely on you.**

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

2024

Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation which consists of **one tutor-marked assignment** for this 4-credit course. **Submit your assignments at your study centre.**

Instructions for Formatting Your Assignments

Before attempting the assignment, please read the following instructions carefully:

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

ENROLMENT NO.:……

NAME :……

ADDRESS :……

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COURSE CODE: …….

COURSE TITLE : …….

ASSIGNMENT NO. ……..…

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 and in your own words. Do not copy answers from study material.
5) While solving problems, clearly indicate the question number along with the part being solved. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.
6) **This assignment will remain valid from January 1, 2024 to December 31, 2024**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

Answer sheets received after the due date shall not be accepted.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response.

We wish you good luck.

Tutor Marked Assignment
OPTICS

Course Code: PHE-09
Assignment Code: PHE-09/TMA/2024
Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

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1. a) Describe polarisation of light by reflection. How does degree of polarisation vary with angle of incidence of light? (5)

   b) The sodium lamp used in a physics laboratory gives out light uniformly. Suppose that the lamp uses 60 W. Calculate the magnitude of electric field. (5)

   c) Discuss the concept of missing orders with reference to double slit diffraction pattern. (5)

   d) Discuss spatial evolution of Fresnel diffraction pattern. (5)

2. a) Obtain expressions for reflection and transmission amplitude coefficients when electric vector associated with a plane monochromatic electromagnetic wave is in the plane of incidence. (10)

   b) Obtain an expression for elliptically polarised light resulting due to superposition of two orthogonal linearly polarised light waves. Show that plane polarised light and circularly polarised light are special cases of elliptically polarised light. (10)

3. a) Obtain the expression for shift in fringes when a thin transparent sheet is introduced in the path of one of the waves in a double slit interference experiment. (10)

   b) A plano-convex lens of radius 1.0 m is placed on an optically flat glass plate and is illuminated by an extended monochromatic source. Assume that the point of contact is perfect. The diameters of the 10^{th} and 5^{th} dark rings in the reflected light are 4.50×10^{-3}m and 3.36×10^{-3}m. Next, the space between the lens and the glass plate is filled with a liquid. The diameter of the 5^{th} ring changes to 3.0×10^{-3}m. Calculate the refractive index of the liquid when the ring is (i) dark, and (ii) bright, if the wavelength of light is 589 nm. (10)

4. a) 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)

   b) Discuss Rayleigh's criterion for resolving power of an optical instrument. Obtain an expression for resolving power of a microscope. (10)

5. a) An atomic system consisting of two energy levels, with population of higher energy level less than that of the lower level, is in thermal equilibrium. Show that the absorption of radiation dominates stimulated emission if radiation of appropriate frequency is introduced into the system. Comment on the consequences of this fact for laser action. (10)

   b) Two energy levels of an atomic system are separated by energy corresponding to frequency 3.0×10^{14} Hz. Assuming that all atoms are in one or the other of these two energy levels, compute the fraction of atoms in the upper energy level at temperature 400 K. Take $k_B = 1.38\times10^{-23}\text{JK}^{-1}$ and $h = 6.6\times10^{-34}\text{Js}$. (5)

   c) The refractive indices of the core and cladding materials of an optical fibre are 1.51 and 1.39 respectively. Calculate the numerical aperture and light gathering capacity of the fibre. (5)

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