PHY 209 OPTICS 1

Course Guide

COURSE GUIDE

PHY 209
OPTICS I

Course Adapter

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Published by:
National Open University of Nigeria 2008

First Printed 2008

ISBN: 978-058-352-1

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Introduction

We are able to adore the wonders of nature and its creations by perceiving light through one of our sense organs. In a way, light sustains life on our planet. Through we see objects it illuminates, we cannot see light! The study of interaction of light with matter constitutes what we call optics. It is one of the most fascinating courses taught to undergraduate science students. Optical studies have contributed significantly to human understanding of the laws of nature. While studying optics you will realize that there is explosive growth of this subject due to the realization of some well known physical principles for technical applications. This is why optics occupies a prominent place in pure and applied sciences.

The subject of optics emerged as a result of the fundamental work done by scientists of eminence such as Galileo, Newton, Huygens, Young, Fresnel, Fraunhofer, Grimaldi, Arago and Bartholims. Maxwell provided a sound mathematical basis to classical optics. Hertz qualified his work successfully. In India, Sir J.C. Bose and Sir C.V. Raman made significant contributions.

Your study of Optics course begins with the course PHY 209: Optics I. it is intended to establish the **transverse electromagnetic** nature of light. The phenomena of Interference and Diffraction, which reveal the wave behaviour of light, are discussed in PHY 306: Optics II. The development of lasers, fibre optics, holography and the progress made in optical communication, optical storage and optical computing with applications in space, defence and medicine have led to an explosive growth of optics in recent years. You will get a glimpse of some of these topics in the last course, PHY 410.

The Course

PHY 209: Optics (2 units)
This is a 2-credit unit course that is intended to introduce Light. In unit 1 we have shown that light is a transverse electromagnetic wave. The wave equations for E and B are derived from Maxwell's field equations. In Unit 2 we have discussed reflection and refraction of electromagnetic waves. You will also learn that all laws of geometrical optics are inherent in Fermat's principle.

Perception of light by humans is discussed in Unit 3. you will learn that human vision involves a mix of physical and physiological processes. The role of the eye as an image forming device is discussed in detail. Theories of colour vision are also given in brief.

Unit 4 discusses three polarization states of light. You will learn that light can be polarized by reflection, refraction and selective absorption. Light propagation in anisotropic crystals and phenomenon of birefringence are discussed in detail.

Course Aims

This course aims at introducing some important facts and developments which were made to unfold the nature of light, reflection and refraction of light, perception of light and polarization of light.

Course Objectives

After studying this course, you should be able to:

- Name phenomena distinguishing corpuscular and wave models of light;
- Derive an expression for the velocity of electromagnetic waves;
- Specify the frequency ranges of different portions of the electromagnetic spectrum;
- Explain the importance of Poynting Vector;
- Explain reflection and refraction of e.m. waves incident normally and obliquely on the interface separating two optically different media;
- Apply Fermat's principle to explain the reflection and refraction of light
- Solve problems based on reflection and refraction of e.m. waves;
- Explain the functions of different parts of the eye;
- List common eye defects and suggest remedial measures;
- Describe how human eye responds to colour,
- Explain trichromatic and opponent-colour theories of colour vision;
- Explain what is linearly, circularly or elliptically polarized state of light;
- Describe how light can be polarized by reflection;
- Solve simple problems based on Malus' law and Brewster's law;
- Explain how optical birefringence helps in the production of polarized light, and
- Explain the production of linearly polarized light by dichroism

Working Through the Course

This is the first part of your training in optics beyond first year physics. You will get to know the dual nature of light, and appreciate, to large extent, the dual nature of matter itself. In addition, you will also learn reflection and refraction of light, perception of light and polarization of

light. Optics has contributed a lot to the development of science in the past, and still remains just as relevant to the modern world of engineering and technology. It is therefore important for you to understand the language and vocabulary of optics very thoroughly.

The Course Material

You will be provided with the following materials:

Course Guide
Study Material containing study units

With the course comes a light of recommended textbooks which are necessary as supplements to the course material. However, note that it is not compulsory for you to acquire or indeed read them.

Study Units for Optics I

The following study units are contained in this course:

Unit 1 Nature of Light
Unit 2 Reflection and Refraction of Light
Unit 3 Perception of Light
Unit 4 Polarisation of Light

In unit 1, you will learn some important facts and developments which were made to unfold the nature of light.

In unit 2, you will get to know what happens when electric and magnetic fields which make up together what know as light, when such a wave is incident on the boundary separating two optically different media.

Unit 3 shows that perception of light is an interplay between physical and physiological phenomena. You will also get an opportunity to understand internal eye structure and know how light is sensed.

Unit 4 sheds some light on polarization, the simple state of polarized light, as well as birefringence – a property of materials helpful in producing polarized light.

Textbooks

Some reference books, which you may find useful, are given below:

Introduction to Modern Optics – Grant F. Fowles
Fundamentals of optics – Jenkins and White.
Optics – Hecht and Zajac
Optics – Smith and Thompson

Assessment

There are two components of assessment for this course. The Tutor Marked Assignment (TMA), and the end of course examination.

Tutor Marked Assignment

The TMA is the continuous assessment component of your course. It accounts for 30% of the total score. You will be given 4 TMA's to answer. Three of these must be answered before you are allowed to sit for the end of course examination. The TMA's would be given to you by your facilitator and returned after they have been graded.

End of Course Examination

This examination concludes the assessment for the course. It constitutes 70% of the whole course. You will be informed of the time for the examination. It may or may not coincide with the university semester examination.

Summary

This course is designed to lay a foundation for you for further studies in optics. It explains the nature of light, gives an insight into the reflection and refraction of light, human vision and the polarization of light. At the end of this course, you will be able to answer the following types of questions:

- What phenomena distinguish corpuscular and wave models of light?
- What are the frequency ranges of different portions of the electromagnetic spectrum?
- What is the importance of the Poynting Vector?
- Explain reflection and refraction of e.m. waves incident normally and obliquely on the interface separating two optically different media.
- How does the human eye respond to colour?

- When do we say light is linearly, circularly or elliptically polarized?
- How can light can be polarized by reflection?
- How does optical birefringence help in the production of polarized light?

We wish you success.