PHYC 540 Physical Optics

Catalog Description

The electromagnetic wave theory of light, spectra, interference, diffraction, polarization, and double refraction. Prerequisite: PHYC 122. (3 credit hours)

Course Objectives

By the completion of PHYC 540, the students should accomplish the following objectives:

Understand the nature and properties of light and the electromagnetic spectrum.

Understand the reflection and refraction of light from regular and curved surfaces, image formation by a spherical surfaces and lens aberrations.

Use the principles of reflection and refraction to understand the principles and working of optical instruments.

Understand the properties, propagation and mathematical equations of waves.

Understand the principle of superposition, constructive and destructive interference and their applications in standing waves and beats.

Two beam interference and its applications.

Understand the techniques of interferometery by studying the Michelson and Fabry-Perot interferometers.

They will know resolving power and limits of resolution.

Understand coherent beams, diffraction and diffraction from a single slit.

They will know about diffraction grating, types, resolution and dispersion of a grating and Fresnel diffraction.

They will know about polarization of light, polarizer and methods of producing polarized light.

Understand optical materials, spectroscopy and light emission from optical materials.

Understand properties of laser, blackbody radiation, light-matter interaction, characteristics and production of laser.

Knowledge of light absorption, laser operation, gain medium, 2-, 3- and 4-level lasers and their mathematical equations.

Course Rationale

The sky appears blue in day time while orange-red during the sun set or sun rise time. Why it does not appear green or white in the sun set time? Why we some time see rainbow after rain? Why people see their images in a mirror but cannot see their images in a flat wall or piece of wood. Why can I hear my friend behind a wall but cannot see any source of light if he has in his hands? All these and many others like these questions can appear in people's mind. In order to get answers to all such kind of questions it is important to understand optics and optical phenomena and the principles and physics behind the optical phenomena. Optics is one of the fundamental fields of science in which the properties and characteristics of light are used through different ways (absorption, reflection, refraction, diffraction and polarization) to study natural phenomena. It is very important to use those properties and characteristic for important applications in physical and biomedical sciences. Many developments and inventions have been accomplished in the field of optics. These include but not limited to optical microscopes, telescopes, night vision gargles, optical fibers, laser beams, laser surgeries, cancer detections and materials analysis. Further development and applications of optics are growing rapidly. In order to contribute to such inventions, devices and applications it is very important for the students to understand the basic optics, the physics of optical phenomena and mathematical interpretation of the principles of optics. This course in physical optics gives an opportunity to the students to understand these principles and fundamentals of the optics.

Course Content, Format, and Bibliography

Content

PHYC 340 includes a study of both geometrical optics and physical optics with greater emphasis placed on the latter. Each section is divided into groups of two for laboratory work. The laboratory work is arranged so that each student had an opportunity to use various precision optical instruments.

Nature of light

Reflection and refraction at regular and curved surfaces

Thick and thin lenses

Aberrations of lens and mirrors

Optical instruments

Electromagnetic waves and wave equations

Polarization

Interference

Diffraction

Limits of resolution

Line spectra

Radiation

Laser

Spectrophotometry

Demonstrations:

- Double refraction by mechanical strain on plastic
- Microwave polarization
- Microwave reflection
- Polarization of doubly refracted rays
- Polarization by scattering and reflection
- Polarization by parallel wires
- Fresnel zone diffraction of microwaves
- Single and multiple slit diffraction
- Modulation of a light beam
- Apparent depth of objects in liquids

Laboratory Experiments:

- The speed of light
- The Michelson Interferometer
- The Longacre
- Transmission grating spectrometer
- Concave grating spectrometer

Spectrographic analysis using films

- Newton's rings
- Circular Polarization
- Elliptical polarization of microwave
- Fresnel diffraction
- Measurement of index refraction
- Photoelectric effect
- Polarimeter
- Spectroscopy

Format

Each instructor has written policies regarding attendance, missed work, special needs, rules and responsibilities that are given to the students at the first of the course. The following is a partial example:

Class Lectures: Instructor will provide lectures in the class before assigning problems related to certain topic so that the student have basic knowledge to solve problems.

Laboratory: Hands-on experiments that you can learn from. The experiments are arranged to support the class lectures and provide a way to understand the optical phenomena in a better and more practical way.

Assignment: Assignments and Home works problems are given on regular basis to develop students' skills in optics and optical phenomena discussed in the class. Students get more exposure to a topic when work on an assignment or homework.

Quizzes: reasonable number of quizzes will be given to students. The time, number and style of quizzes will be determined by the instructor. The purpose of quizzes is to keep the students updated in the course and give them a chance to go parallel with the instructor.

Midterm Exams: One or more midterm exams will be given during the semester/term. The number of midterm exams will depend upon the instructor.

Group Projects: Students will be given Oral projects. The projects will be demonstrated through power point slides. Two or more students can make a group. Each group chooses a topic related to the course and deliver a presentation on that topic. The instructor will analyze the presentation for its quality, expressions and knowledge of the students who presented, clarity and other factors.

Final Exam: The final exam will judge the strength of students in the entire course.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Bibliography

Introduction to Optics, Third Edition, F. L. Pedrotti.

Optics and Photonics; an Introduction, Second Edition, F. Graham Smith.