האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

Physical Optics - 77693

Last update 24-01-2024

HU Credits: 3

Degree/Cycle: 1st degree (Bachelor)

Responsible Department: Physics

Academic year: 0

Semester: 1st Semester

Teaching Languages: English

Campus: E. Safra

Course/Module Coordinator: Itay Shomroni

Coordinator Email: itay.shomroni@mail.huji.ac.il

Coordinator Office Hours: By appointment

Teaching Staff:

Dr. Itay Shomroni

Course/Module description:

Introduction + 3 main chapters

- Introduction: Review of cutting edge research in the field.
- Geometrical optics: Analysis of optical systems using the ray optics approximation. The goal of this chapter is to develop intuition which will guide us along the course.
- Wave optics: Advanced topics in diffraction, holography and polarization. The goal of this chapter is to develop a deep understanding of optical phenomena.
- Coherence and introduction to quantum optics: Coherence is a fundamental concept of waves in general and optics in particular. In the modern view of quantum optics, the non classical properties of light (e.g. photons and entanglement) are reflected by the coherence properties of the electromagnetic waves.In this chapter we will learn what is optical coherence and what can we learn from it on the quantum theory of light.

Course/Module aims:

1. To teach basic concepts in modern optics, with emphasis on optical coherence.

2. To develop a broad and deep understanding of optics, towards advanced research in the field.

Learning outcomes - On successful completion of this module, students should be able to:

1. Analyze a wide range of optical phenomena.
2. Understand and utilize the concept of coherence.

Attendance requirements(%):

100

Teaching arrangement and method of instruction: Frontal lecture and home assignments.

Course/Module Content:

0. Introduction (1.5 weeks)
0.1 Motivation: frontiers of optical research
0.2 What is light?

1. Geometrical optics (2 weeks)
1.1 Eikonal approximation, ray optics and Fermat principal.
1.2 ABCD matrices for analyzing optical systems
1.3 Discussion on the limitations of geometrical optics

2. Wave optics (5 weeks)
2.1 Helmholtz Equation and the paraxial approximation
2.2 Gaussian beams, modes, higher-order Gaussian modes
2.3 Fourier Optics
2.4 Holography

3. Optical Coherence and Introduction to Quantum Optics (4.5 weeks)
3.1 Phase, interference and polarization of the electromagnetic waves
3.2 Interferometers and resonators
3.3 First and second order coherence
3.4 Introduction to quantization of light – what is a photon?
3.5 Coherence of a single photon and quantum interferometry

Total: 13 weeks
The last weeks of the semester will be dedicated to summary and review.

Required Reading:
none

Additional Reading Material:
1. Introduction to the Theory of Coherence and Polarization of Light /E. Wolf
2. Principals of Optics / M. Born and E. Wolf
3. Introduction to Fourier Optics / J. Goodman
4. Optical Coherence and Quantum Optics / L. Mandel and E. Wolf
5. Introduction to Quantum Optics / C. Garry and P. Knight

Grading Scheme:
Written / Oral / Practical Exam 90 %
Essay / Project / Final Assignment / Home Exam / Referat 10 %

Additional information: