האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

Waves and Optics - 77305

Last update 05-09-2019

HU Credits: *5*

Degree/Cycle: *1st degree (Bachelor)*

Responsible Department: *Physics*

Academic year: *0*

Semester: *1st Semester*

Teaching Languages: *Hebrew*

Campus: *E. Safra*

Course/Module Coordinator: *Yaron Bromberg*

Coordinator Email: *yaron.bromberg@mail.huji.ac.il*

Coordinator Office Hours: *Sunday 11-12*

Teaching Staff:

Dr. Yaron Bromberg
Mr. Yoav Romach
Ms. Ayala Glick

Course/Module description:
Study of waves, with an emphasis on optics. The course teaches basic physical (dispersion, wave packets, monochromaticity, diffraction and polarization) and mathematical (Linear response, Fourier analysis, Separation of variables and complex numbers) concepts.

Course/Module aims:
Understanding wave and optics phenomena, with emphasis on everyday effects.

Learning outcomes - On successful completion of this module, students should be able to:
1. Calculate wave properties from a microscopic model.
2. Analyze optical systems (diffraction, interference and polarization).

Attendance requirements(%):
0

Teaching arrangement and method of instruction: Frontal lecturing, including some lab demonstrations. Some video and visual aids.

Course/Module Content:
0. Introduction –
Waves and optics on different scales, introduction to modern physics
Fourier and linear response theory for the damped-driven harmonic oscillator
1. Wave equations – examples in longitudinal waves in a harmonic spring-mass chain, Energy flux
2. Harmonic waves – amplitude, phase, phase velocity, wavelength, frequency and spatial frequency.
3. Boundary conditions, impedance, reflection and transmission coefficients, standing waves and eigen-modes and frequencies.
4. Harmonic decomposition, musical tones.
5. Sound waves (adiabatic vs. isothermic).
6. Sounds in solids, transverse and longitudinal waves, seismic waves
7. Pulse propagation, group velocity, wavepackets and dispersion
8. Doppler effect (classical and relativistic) in one dimesion.
9. Surface water waves – Airy theory, Tsunamis.

10. Two and Three dimensional waves, free expansion and standing waves in various geometries.
11. super-sonic sources – shocks, Mach cones and Cherenkov radiation.
12. Eikonal expansion and Fermat's principle.
13. Geometrical optics – Lenses, mirrors, snell's law, systems (microscopes and telescopes), Caustics and aberrations (spherical).
14. Coherence and the interference of monochromatic waves. Interferometers – Michelson, Mach-Zehnder, Sagnac.
15. Diffraction – Fresnel and Fraunhofer, Fourier properties of a lens, evanescent waves and the diffraction limit for scalar waves. Diffraction gratings and holography.
16. Maxwell's equations and vectorial waves.
17. Fresnel coefficients for reflection and transmission from interfaces.
18. Polarization – general Jones states and matrices, Stokes parameters.
19. Birefringence and polarization control. Ordinary and extraordinary refraction.
20. Microscopic origin of the refractive index
21. A brief discussion of non-linear waves, wave mixing and stability analysis.

Required Reading:
None

Additional Reading Material:
1. גלים ואופטיקה, פרופ' עודד אגם, הוצאת האוניברסיטה הפתוחה (הספר המרכזי שילווה את הקורס)
2. Vibrations and Waves, A.P. French, M.I.T
3. Lectures on Physics, Richard Feynman
4. Waves, Berkley Physics Course, Vol III
5. Waves, C.A. Coulson
6. Physics of Waves, W.C. Elmore and M.A. Heald
7. Physics of Vibrations and Waves, H.J. Pain
8. Optics, Eugene Hechet
9. Principles of Optics, Born and Wolf
10. Introduction to Fourier Optics, J. Goodman
11. Prof. Daniel Steck's online book (see his website)

Course/Module evaluation:
End of year written/oral examination 90 %
Presentation 0 %
Participation in Tutorials 0 %
Project work 10 %
Assignments 0 %

Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information: