TEL AVIV UNIVERSITY אוניברסיטת תל אביב

סילבוס מפורט

Syllabus for "Advanced Optics " course

This course is similar to the "Fundamentals of Light Matter Interaction" course

Course No. : 0321-4832-01. Course hours: Wednesday 14:00-17:00
Exam dates: 25/07/2021 and 30/08/2021

Dr. Hadas Soifer, 403 Physics Shenkar bld., School of Physics and Astronomy
Email: hadassoifer@tauex.tau.ac.il

Prof. Haim Suchowski, 415 Physics Shenkar bld., School of Physics and Astronomy
Email: haimsu@post.tau.ac.il

Mr. Uri Arieli, 322 Physics Shenkar bld., School of Physics and Astronomy
Email: uriarieli14@gmail.com

The course aims to provide the student with definitions, background and basic knowledge in the research field of light-matter interaction. The topics that will be covered in the course are listed as follow (some of the subjects will be briefly outlined):

1. Linear Optics – Overview from Geometric optics, Beam Optics, Wave optics :
   Length scale in optics, geometric optics and its limits, Maxwell's equations of isotropic media, interfaces, interferometers, thin-film Structures, ABCD formalism, Gaussian beams and paraxial wave equation, Fourier Optics.

2. Classical and semi-classical treatment of Light-Matter Interaction:
   Lorentz oscillator, Drude model, susceptibility and complex refractive index, Kramer-Kronig relation, Sellmeier equations, anisotropic media, polarization optics, electronic transitions in atoms, two-level interactions, Rabi-oscillations, density matrix formulation, energy and phase relaxation, dispersion, absorption, N-level dynamics.

3. Nonlinear optics:
   Nonlinear perturbation theory and coupled mode equations, anharmonic classical oscillator model, second order & third order effects, phase-matching mechanisms, vibrational transitions in molecules and Raman-nonlinearity, Kerr nonlinearity.

4. Ultrafast Optics:
   Definition of ultrashort pulses, propagation of ultrashort optical pulses through dispersive optical elements, femtosecond lasers and their applications, characterization of ultrashort pulses, temporal-lens, introduction to coherent control.

5. <u>Advanced Topics:</u>
   Introduction to optical spectroscopy and ultrafast spectroscopy techniques. Pump-probe spectroscopy. Introduction to nano-photonics and metamaterials.

The final grade will be combined of:

- Three sets of HW that will be 12% from the final grade.
- Numerical assignment that will be 8% from the final grade
- Final exam that will be 80 % from the final grade. Must pass requirement.

Textbooks:

[1] Fundamentals of Photonics, 2nd Edition by B. E. A. Saleh and M.C. Teich
[2] Photonics by A. Yariv and P. Yeh
[3] Ultrashort Laser Pulse Phenomena, 2nd Edition by J.C. Diels and W. Rudolph
[4] Rick Trebino's website: http://www.frog.gatech.edu/talks.html