האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

QUANTUM OPTICS - 83836

Last update 01-08-2023

HU Credits: *3*

Degree/Cycle: *2nd degree (Master)*

Responsible Department: *Applied Physics*

Academic year: *0*

Semester: *2nd Semester*

Teaching Languages: *English*

Campus: *E. Safra*

Course/Module Coordinator: *Dr. Shlomi Kotler*

Coordinator Email: *shlomi.kotlerl@mail.huji.ac.il*

Coordinator Office Hours: *Through appointment*

Teaching Staff:

Dr. Adi Pick

Course/Module description:

Quantum optics deals with the question - when does electromagnetic radiation (e.g. light) manifests its particle-like properties. We will want to understand the relevant measurements performed in the mid/end of the 20th century. To that end, we will understand how one can use simple optical devices and an elegant formalism in order to build and analyze these experiments.

Course/Module aims:

- Acquaintance with the field of quantum optics, its basic concepts, and its influence on current state-of-the-art research.
- Acquire the ability to understand and solve relevant problems.

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

Translate a question about the particle/wave properties of light to an experiment, analyze the results (including noise) and show when does the experiment demonstrate a particle or a wave quality.

Attendance requirements(%):

0

Teaching arrangement and method of instruction: Lecture with students participation, home assignments.

Course/Module Content:

1. Quantization of the EM field (short recap).
2. Simple instruments: beam splitters and detectors.
3. Coherence, 2nd order coherence, Hanbury-Brown and Twiss.
4. Advanced detection: homodyne and heterodyne.
5. Quantum states of light: coherent state, squeezed state and cat state.
6. Distribution functions (Wigner, Hussimi, P-representation).
7. Entanglement.

Additional topics (time permitting):

- Non-linear effects for creating squeezed/entangled states.
- Hong-Ou-Mandel effect.

- Polarization ("internal" degree of freedom, photonic spin).
- Two-level system, coupling to classical field (Rabi, detuning, ...)
- Coupling to atoms, cavities.(Jaynes-Cummings model, dressed-states).

Required Reading:
Gerry and Knight, Introductory Quantum Optics.

Additional Reading Material:
- Scully and Zubairy, Quantum Optics

- Lukin and Greiner, Advanced topics in AMO

- Cohen-Tannoudji, Photons and Atoms

Grading Scheme:
Written / Oral / Practical Exam 60 %
Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 40 %

Additional information:
Home assignments are important: a new assignment will be posted every week. Some will include numerics and data analysis of research papers in the field.