



The Hebrew University of Jerusalem

Syllabus

QUANTUM THEORY IN APPLIED PHYSICS - 83880

Last update 20-05-2015

HU Credits: 5

Degree/Cycle: 2nd degree (Master)

Responsible Department: Applied Physics

Academic year: 1

Semester: 2nd Semester

Teaching Languages: Hebrew

Campus: E. Safra

Course/Module Coordinator: Prof. Ronen Rapaport

Coordinator Email: paltiel@mail.huji.ac.il

Coordinator Office Hours: Prof. Ronen Rapaport

Teaching Staff:

Prof Ronen Rapaport
Cohen Eyal

Course/Module description:

Basic concepts.

Non-locality and Bell inequalities. Pure and mixed quantum states. The density matrix. The dipole approximation, Optical Bloch equations, and the interaction of a 2-level atom with a classical EM field. Identical particles, symmetries of the many-particle wavefunction. Variational method and the Helium atom. Exchange density and energy. Hartree and Hartree-Fock approximations, interacting electrons in a metal. Second quantization. light-matter interaction and the quantization of the electromagnetic field and the photon.

Spontaneous and stimulated emission.

Particle under external electric and magnetic field. The Aharonov-Bohm effect and the Quantum Hall effect.

For each subjects possible applications will be discussed.

Course/Module aims:

See learning outcomes

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

Advanced knowledge quantum physics, identical many particle physics,
Second quantization
And applications

Attendance requirements(%):

0

Teaching arrangement and method of instruction: Frontal lecture + Exercise

Course/Module Content:

- Review of concepts and mathematical background
- o History and Background
- o Show operators by matrices
- o marks Dirac
- o View Sredingr Wizenberg
- o spins

o Possible applications (encryption, QWIP)

- *quantum systems (magnetic field)*

- o free particle*

- o particle motion in a magnetic field*

- o Quantum Hall Effect*

- Aharonov- Bohm effect o*

- *approximation methods*

- o MB -time perturbation theory*

- o Time-dependent perturbation theory*

- o Fermi's golden rule*

- o WKB*

- o Feynman's path integral*

- o density matrices*

- *Second quantization*

- o Second quantization of fields*

- o second quantization of the electromagnetic field*

- o coherent states (states uncompressed) classical and quantum coherence .*

- o photon and spin*

- o coupled modes (quantum computers , encrypted communication)*

- *radiation and matter*

- o the interaction of radiation and matter roughly two levels*

- o spontaneous and stimulated emission*

- o Interaction of radiation and Sound*

- o Feynman diagrams*

- o Raman scattering , Bragg scattering and Brillouin scattering*

Required Reading:

NA

Additional Reading Material:

Formalistic books:

- *J. J. Sakurai, Modern Quantum Mechanics*

- *Albert Messiah, Quantum Mechanics*

General

- *Leonard Schiff, Quantum Mechanics*

- *Gordon Baym, Lectures on Quantum Mechanics*

Quantum Optics

- *A Yariv, Quantum Electronics*

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- C Cohen-Tanoudji et. al., *Atom-Photon Interactions*
 - L Mandel & E Wolf, *Optical Coherence and Quantum Optics*
 - MO Scully & MS Zubairy, *Quantum Optics*

Applied Quantum Mechanics

Herbert Kroemer, Quantum Mechanics for Engineering: Materials Science and Applied Physics

Web

<http://aphquantum.weebly.com>

Course/Module evaluation:

End of year written/oral examination 0 %

Presentation 80 %

Participation in Tutorials 0 %

Project work 0 %

Assignments 20 %

Reports 0 %

Research project 0 %

Quizzes 0 %

Other 0 %

Additional information:

NA