



## *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](mailto:paltiel@mail.huji.ac.il)

*Coordinator Office Hours:* Prof. Ronen Rapaport

*Teaching Staff:*

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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 subject 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 Sridinger Wizenberg
- o spins

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*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 Quatum Optics*
  - *MO Scully & MS Zubairy, Quantum Optics*

*Applied Quantum Mechanics*

*Herbert Kroemer, Quantum Mechanic 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*