MSEN 6323 "Quantum Mechanics for Materials Scientists II"

Course Information

Course Number/Section	MSEN 6323
Course Title	Quantum Mechanics for Materials Scientists-II
Term	Spring 2018
Days & Times	Monday and Wednesday 10:00 – 11:15
Location	CB-1.202

Professor Contact Information

Professors	Massimo Fischetti
Office Phones	972 883 5724
Email Addresses	max.fischetti@utdallas.edu
Office Location	NSERL
Office Hours	**By Appointment**
Other Information	

Course Pre-requisites, Co-requisites, and/or Other Restrictions

MSEN 6319 or approval of instructor

Course Description

Advanced quantum-mechanical concepts for study of nanometer-scale materials. Topics include: Hamiltonian formulation of Classical and Quantum Mechanics, Approximation Methods (time independent and time dependent perturbation theory, Born approximation), identical particles, elements of Quantum Statistical Mechanics (density matrix), quantum theory of crystals, second quantization (annihilation and creation operators, phonons, photons), interaction with the electromagnetic radiation. Conditionally, also, quantum information and the interpretation of quantum mechanics.

Student Learning Objectives/Outcomes

You will be expected to achieve the following:

- Understand and explain the application of Quantum Mechanics to describe the nature atoms, molecules and solids.
- Understand and apply methods to obtain approximate solutions of problems of interest to materials science
- Understand and apply the mathematical formulation of Quantum Mechanics
- Understand and explain the nature and physical principles of Quantum Mechanics

You will be expected to demonstrate these objectives by problem solving in homework and exams.

Required Textbooks and Materials

Lecture Notes will be posted on the class Web page:
http://www.utdallas.edu/~mvf100020/MSEN6323_S18.html

Strongly recommended Texts

- David A. Miller, "*Quantum Mechanics for Scientists and Engineers*", (Cambridge, 2008), ISBN 978-0521897839. Some Lectures (mostly on QM I) are available online at the Miller Youtube Channel, https://www.youtube.com/playlist?list=PLWP0zoSOFqlN2x7Iw47MuCjpRrElQ8dXX

Suggested Course Materials

- R.H. Dicke and J. P Wittke, "*Introduction to Quantum Mechanics*", Addison Wesley, New York, 1960), ISBN: 0-201-01510-2
- David Bohm, "*Quantum Mechanics*" (Prentice Hall, 1951, reprinted by Dover, 1979), ISBN 0-486-65969-0
- Feynman, Leighton, and Sands, "*The Feynman Lectures on Physics*", Vol. 3 (Addison Wesley, New York,1970), ISBN 0201021153/978-0201021158. The pdf of these lectures is available on-line from CalTech, http://www.feynmanlectures.caltech.edu/.

Course Content

1. Canonical Quantization
   - Review of Lagrangian and Hamiltonian formulation of Classical Mechanics
   - Canonical Quantization
   - The Copenhagen interpretation
2. Approximation methods
   - Time-independent perturbation theory
   - Time-dependent perturbation theory
   - Elements of scattering theory: Born approximation and partial-waves analysis
3. Identical particles
   - Spin-statistics theorem
   - Elements of Classical and Quantum Statistical Mechanics
   - Density matrix
4. Schrödinger equation in a periodic potential
   - Kronig-Penney model
   - Single-electron dynamics (Hellmann-Feynman and acceleration theorem)
   - Crystals: Lattices, the reciprocal lattice, Bloch theorem
   - Schrödinger equation in a crystal
   - Approximation models: Pseudopotentials, k·p, tight-binding
5. Elements of lattice dynamics
   - Vibrations of a linear chain
   - Phonons in 3D
6. Second quantization
   - Lagrangian formulation of fields
   - Canonical quantization
   - Examples: The Schrödinger, phonon and electromagnetic fields
7. Electron scattering theory in solids
   - Generalities
   - Electron-phonon and electron-impurity scattering
   - Interaction with the electromagnetic field
8. Quantum Information

Grading Policy

Grades will be based on the following weights:
Homework 25 %; Term Exams (2) 25 %; Final Exam 25 %

Homework Assignments

These are **due no later than THE START OF CLASS on the due date**.
Assignments will be posted on the class Web page.
Homework must be presented in a professional, legible manner to be graded.
Collaboration (NOT copying) is encouraged. See Academic Integrity Statement in http://go.utdallas.edu/syllabus-policies.

Exams
Examinations will be held in class or at an assigned time and will be written.

Course Policies
Make-up exams
No make up exams will be given except under extreme circumstances.
Extra Credit
Not offered.
Late Work
Not Accepted.
Special Assignments
None.
Class Attendance
Not required but is highly advised. Clear your calendar for all class dates, including FINALS week.
Classroom Citizenship
The Student Conduct and Discipline policy of the University of Texas at Dallas will be followed. See: http://go.utdallas.edu/syllabus-policies

Field Trip Policies / Off-Campus Instruction and Course Activities
None

UT Dallas Syllabus Policies and Procedures The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus. Please go to http://go.utdallas.edu/syllabus-policies for these policies.

These descriptions and timelines are subject to change at the discretion of the Professor.
The Instructor may change material, course content, and course pace or item sequence at any time.