Physics 558a, Spring 2013

Quantum Mechanics
(Part I of graduate level QM at USC)

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http://physics.usc.edu/~bars/

Assignments and Links

Class times: Tu,Th 12:00-1:50 PM at KAP-137
Office hours: SSC-216B, Tu,Th 3:00 PM - 4:00 PM, or by appointment.

Course Website: http://physics.usc.edu/~bars/558a/

Pre-requisites:

Quantum Mechanics at undergraduate level, Classical Mechanics at graduate level, Mathematical Physics or equivalent.

Books

— *Quantum Mechanics*, (book online, pdf file)
Author: Itzhak Bars.

— *Modern Quantum Mechanics*, Addison-Wesley, 1994,
Author: J.J. Sakurai.

— *Principles of Quantum Mechanics*, 2nd Ed., Plenum Press, 1994,
Author: R. Shankar.

— Material from other sources will also be used, and provided as class notes or internet links.

Grading

30% - In class participation is expected in the form of asking and answering questions and presenting assignments at the blackboard. The goal is to generate class discussions and greater interaction between students and teacher. The assignments will include reading material and homework problems. Students should expect to be called upon randomly to discuss the material in class. 30% of the grade will be assigned on the basis of in-class performance.

30% - Reading and homework problems will be assigned approximately once per week. Many sources with solutions to problems are available in the internet. Students can share ideas but are expected to write up their own work *clearly*. Copying solutions from each other, from the net or a solution manual will be considered plagiarism and will result in an automatic F grade for the course*. The assignments, which should be turned in by the Thursday of the following week, will be graded. The solutions will be posted at the course internet site.
*See: The Trojan Integrity Guide and Guide for Avoiding Plagiarism

40%- Final exam, Wednesday, May 15, 2:00-5:00 PM, location: same as classroom.

Course content:

The general topic is the formulation of Quantum Mechanics and its applications in Physics. The lectures will correspond to the **contents** of chapters 1-7 and perhaps also Ch.8 in "Quantum Mechanics" by I. Bars, as outlined below. Problem solving will be emphasized with extensive homework.

- Chap 1- Overview of Quantum Mechanics from the early stages in 1900 to the beginning of the 21st Century. Semi-classical intuitive approach to QM.
- Chap. 2 - Quantum rules and their relation to classical mechanics. Moyal star product. Free and interacting systems. Translations in space and momentum.. Time evolution and the Hamiltonian.
- Chap. 3 - General structure of quantum mechanics. Postulates, ket-bra formalism, measurement, compatible and incompatible observables, uncertainty relation, matrix formulation of QM, general solution of a quantum problem. Entanglement in QM.
- Chap. 4 - Interactions. Solving the Schrodinger equation in one dimension. Piecewise continuous potentials. Harmonic oscillator and other solvable models. Using supersymmetry to solve problems. Path integrals.
- Chap. 5 - Operator methods. Harmonic oscillator, coherent states, normal ordering, fermions, general quadratic system of many particles, string as an infinite number of particles.
- Chap. 6 - Central force problem. Separation of center of mass, radial and angular operators; general properties of angular momentum, operator approach for angular momentum, spherical harmonics; radial and angular equations in d-dimensions, free particle; harmonic oscillator in 3 dimensions, degeneracy and SU(3) symmetry; Hydrogen atom.
- Chap. 7 - Properties of rotations. Lie group of rotations, representations of rotations and angular momentum, D-functions and matrices for spin j=1/2, j=1 and general j; Addition of angular momentum, reduction to irreducible representations; Clebsch-Gordan coefficients, Wigner symbols, tensor operators.
- Chap. 8 - Symmetry in classical and quantum mechanics. Conservation laws, Noether's theorem, examples of symmetries in physical systems; A brief tour of Lie groups and supergroups; SL(2,R) or Lorentz groups in 2+1 dimensions and its unitary representations.

Depending on the previous preparation of the class, it is likely that time will not permit to cover all the topics. In that case, a selection will be made among the topics that are close to the end of this list.