Course Outline

UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS and ASTRONOMY

1. **Physics 443, Quantum Mechanics I**

Lecture Sections: TR 9:30-10:45, ST 126

Instructor(s): Dr. Alexander Lvovsky

Office: SB 319, 220-4124
Office Hours: by appointment
Email: lvov@ucalgary.ca
http://www.qis.ucalgary.ca/quantech/443/
Physics and Astronomy office: SB 605, 220-5385

2. **PREREQUISITES:** Physics 325 and 343.

3. **GRADING**: The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Homework	20%
Midterm tests (2)	30%
"Clickers"	5% (2.5% for responding + 2.5% for correct answer)
Final Examination	45%

Percentage grades will be given for all elements of term work and examinations. A weighted course percentage will be calculated for each student after the final exam is written. These scores will then be curved to determine the final grade such that the class median is around B-/C+.

4. **Missed Components of Term Work**. The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in section 3.6: **http://www.ucalgary.ca/pubs/calendar/current/sc-3-6.html**. It is the student's responsibility to familiarize himself/herself with these regulations. See also **http://www.ucalgary.ca/pubs/calendar/current/e-3.html**.

5. **REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY**. If you have a clash with this out-of-class-time-activity, please inform your instructor as soon as possible so that alternative arrangements may be made for you.

6. **TEXTBOOKS**

The primary resource is the *lecture notes* available on the course web site. Other useful textbooks:

- *Principles of Quantum Mechanics,* R. Shankar, (Kluwer, 1994)
- *Introduction to Quantum Mechanics* , D. J. Griffiths (Pearson Prentice Hall, 2005).

7. **EXAMINATION POLICY**: Students are encouraged to read the Calendar, Section G, on Examinations: **http://www.ucalgary.ca/pubs/calendar/current/g.html**.

Department Approval_____ **Date**_____

Associate Dean's Approval for
out of regular class-time activity: _____ **Date:**_____

OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) **ACADEMIC MISCONDUCT** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under K. Student Misconduct (**http://www.ucalgary.ca/pubs/calendar/current/k.html**) to inform yourself of definitions, processes and penalties

(b) **ASSEMBLY POINTS in case of emergency during class time. Be sure to FAMILIARIZE YOURSELF with the information at http://www.ucalgary.ca/emergencyplan/assemblypoints**.

(c) **ACADEMIC ACCOMMODATION POLICY.** Students with documentable disabilities are referred to the following links:

Calendar entry on students with disabilities: **http://www.ucalgary.ca/pubs/calendar/current/b-1.html**
Disability Resource Centre: **http://www.ucalgary.ca/drc/**

(d) SAFEWALK: Campus Security will escort individuals day or night (**http://www.ucalgary.ca/security/safewalk/**). Call **220-5333** for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) FREEDOM OF INFORMATION AND PRIVACY: This course will be conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence**, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page**. For more information see also **http://www.ucalgary.ca/secretariat/privacy.**

(f) STUDENT UNION INFORMATION: VP Academic **Phone**: 220-3911 **Email**: suvpaca@ucagary.ca.
SU Faculty Rep. **Phone:** 220-3913 **Email:** sciencerep@su.ucalgary.ca Website **http://www.su.ucalgary.ca/home/contact.html**.
Student Ombudsman: **http://www.su.ucalgary.ca/services/student-services/student-rights.html**

(i) INTERNET and ELECTRONIC COMMUNICATION DEVICE Information. You can assume that in all classes that you attend, **your cell phone should be turned off**. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

Physics 673, Quantum and Nonlinear Optics, Fall 2010

SYLLABUS

Chapter I. Linear algebra and postulates of quantum mechanics

- Linear spaces
- Basis, dimension
- Inner product. Hilbert space.
- Orthonormal basis.
- Projective measurements. Quantum tomography
- Adjoint spaces
- Linear operators
- Operator observables. Eigenvalues. Diagonalization. Pauli operators
- Hermitian and unitary operators
- Commutator. Simultaneous diagonalization.
- Heisenberg's uncertainty principle
- Functions of operators
- Schrödinger equation

Appendix. Tutorial on optical polarizations
Appendix. Quantum cryptography (BB84)

Chapter II. Entanglement

- Tensor product of Hilbert spaces
- Entanglement. Partial measurements
- Quantum dense coding
- Remote state preparation
- Nonlocality. Einstein-Podolsky-Rosen paradox
- No-cloning theorem
- Quantum teleportation
- Schrödinger cats, nature of quantum measurements
- Interpretations of quantum mechanics. Many-world theory

Chapter III. Motion of a particle

- Infinite dimension Hilbert spaces
- Momentum and position representations. De Broglie wave.
- Wavepackets
- Particle in a box
- Rectangular potential well; nuclear energy levels
- Harmonic oscillator. Vibrational molecular spectra
- Bound states in a Coulomb potential
- Free particle. Potential barrier, reflection and tunneling.

Appendix. Fourier transformation
Appendix. Dirac delta-function

Chapter IV. Rotational motion

- Three-dimensional motion
- Orbital angular momentum operators
- Rigid rotator. Rotational quantum numbers.
- Spin
- The hydrogen atom
- Magnetic moment and magnetic field. Stern-Gerlach experiment