



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF PHYSICS AND ASTRONOMY  
COURSE OUTLINE

1. **Course:** PHYS 543 Quantum Mechanics II                      Fall 2017

**Instructor:** Dr. Alexander Lvovsky | SB 319 | (403) 220-4124 | [lvov@ucalgary.ca](mailto:lvov@ucalgary.ca) | Office Hours : by appointment

**Lecture Sections:** LEC 1 | MWF 10:00-10:50 am | ST 061

**Course Website:** [ucalgary.ca/~lvov/543](http://ucalgary.ca/~lvov/543)

**Departmental Office:** SB 605, 403-220-5385, [phasugrd@ucalgary.ca](mailto:phasugrd@ucalgary.ca)

2. **Prerequisites:** PHYS 443 or CHEM 373

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:

Assignments: 30%

Midterm tests: 20% (Two in-class tests. Tentative dates: October 4 and October 20)

Weekly quizzes: 10%

Final Examination (3 hours): 40% (To be scheduled by the Registrar)

Percentage to letter grade conversion scale:

>= 90 %	A +	>= 70 %	B +	>= 55 %	C +	>= 40 %	D +
>= 80%	A	>= 65 %	B	>= 50 %	C	>= 35 %	D
>=75 %	A -	>= 60 %	B -	>= 45 %	C -	< 35 %	F

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](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar.

5. **Scheduled out-of-class activities:** Dates and times of approved class activities held outside of class hours.

**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. **Course Materials:**

*Quantum physics: an introduction based on photons (available at Bound and Copied)*

*Introduction to Quantum Mechanics, David J. Griffiths, 2<sup>nd</sup> Edition, Pearson*

7. **Examination Policy:** Calculators are permitted, closed book examinations, formula sheets including integrals and trigonometric identities will be provided. Students should also read the Calendar, [Section G](#), on Examinations
8. **Course fees:** none
9. **Approved Mandatory and Optional Course Supplemental Fees:** None
10. **Human studies statement:** Students in the course will not be expected to participate as subjects or researchers. See also [Section E.5](#) of the University Calendar.

11. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

- (a) **Misconduct:** 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 [Section K](#). Student Misconduct 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 on [assembly points](#).
- (c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at [http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities\\_0.pdf](http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf). Students needing an Accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics and Astronomy, Dr. David Feder, by email (dfeder@ucalgary.ca) or by phone (403.220.3638).
- (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 is 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@ucalgary.ca](mailto:suvpaca@ucalgary.ca).  
SU Faculty Rep: Phone: 220-3913 Email: [science1@su.ucalgary.ca](mailto:science1@su.ucalgary.ca), [science2@su.ucalgary.ca](mailto:science2@su.ucalgary.ca) and [science3@su.ucalgary.ca](mailto:science3@su.ucalgary.ca)  
Student Ombuds Office: 403 220-6420  
Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca); <http://ucalgary.ca/provost/students/ombuds>
- (g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. 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.
- (h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning

and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference - please participate in USRI Surveys.

## 12. OTHER COURSE RELATED INFORMATION:

### (a) Course Description

Theory of angular momentum and applications, hydrogen atom, two-level systems and magnetic resonance, Heisenberg picture and elements of quantum optics.

### (b) Course Learning Outcomes

- Grasp the concepts of spin and angular momentum, as well as their quantization- and addition rules.
- Understand the spectrum of the hydrogen atom.
- Know the concept of identical particles and understand the role played by quantum statistics in e.g. the structure of the periodic table.
- Understand the basic concepts of quantum optics and be able to apply them to calculate photon and quadrature noise statistics of quantum states of light.
- Explain the Zeeman effect and spin-orbit coupling.
- Understand the applications and limitations of perturbation theory.

### (c) Course Learning Incomes

Students taking PHYS 543 are expected to have prior knowledge in the subjects covered in PHYS 443.

### (d) Syllabus

- Heisenberg picture
- Elements of quantum optics (phase-space displacement, phase shift operator, single- and two-mode squeezing, Wigner function)
- Physics of angular momentum
- Hydrogen atom
- Periodic table
- Addition of angular momenta
- Spin-orbit coupling
- Zeeman effect
- Bloch sphere
- Two-level systems and magnetic resonance
- Complex quantum systems and density matrices
- Spin echoes
- Perturbation theory (if time permits)

Department Approval \_\_\_\_\_ Date \_\_\_\_\_