

# Course Syllabus

UNIVERSITY OF CALGARY  
DEPARTMENT OF PHYSICS and ASTRONOMY  
COURSE OUTLINE

## 1. Physics 673, Quantum and Nonlinear Optics

**Lecture Time:** L01: TuTh, 12:30-1:45, ST 027A

**Instructor:** Paul Barclay

Office: SB135, 403 220-8517,

Email: [pbarclay@ucalgary.ca](mailto:pbarclay@ucalgary.ca),

Office Hours: By appointment.

**Webpage:** <https://piazza.com/ucalgary.ca/winter2014/phys673/home>

## 2. PREREQUISITES: PHYS 615 or equivalent.

## 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	40%
Midterm tests (1)	20% (In class, Feb. 25, subject to change)
Final Examination	40% (Take home)

A passing grade on the final is required to pass the course.

A weighted course percentage will be calculated for each student after the final exam is written. Conversion from final course percentage to final course letter grade is as follows:

A+	92 – 100%
A	85 – 91%
A-	80 – 84%
B+	76 – 79%
B	72 – 75%
B-	68 – 71%
C+	64 – 67%
C	60 – 63%
C-	55 – 59%
D	50 – 54%
F	< 50%

## 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. TEXTBOOK: Required: Optical Resonance and Two Level Atoms (Allen and Eberly). A list of recommended texts will be distributed in class.

## 6. EXAMINATION POLICY: Final and midterm exams will be closed book. Students may use a one page formula sheet and calculator as aids. Students are encouraged to read the Calendar, Section G, on Examinations: <http://www.ucalgary.ca/pubs/calendar/current/g.html>.

## 7. In this course, the quality of the student's writing in laboratory reports will factor into the evaluation of those reports. See **also** <http://www.ucalgary.ca/pubs/calendar/current/e-2.html>.

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

Associate Dean's Approval for  
out of regular class-time activity: \_\_\_\_\_ Date: \_\_\_\_\_

## 8. 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@ucalgary.ca](mailto:suvpaca@ucalgary.ca).  
SU Faculty Rep. **Phone:** 220-3913 **Email:** [sciencerep@su.ucalgary.ca](mailto: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.

#### 9. OTHER COURSE INFORMATION:

- (a) **Assignments:** There will be roughly 6-8 assignments. Problem sets will usually be due in class, or at a date/time/location specified on the assignment. One late homework (up to one week late) accepted per term. Further late homework will be penalized 25% per calendar day.

**Schedule of Topics**

**1. Quantum mechanics primer**

Schroedinger, Heisenberg, and density matrix pictures of quantum mechanics; the interaction picture and rotating reference frames in quantum mechanics

**2. 2-level Rabi Problem**

Bloch vector picture; semi-classical dressed-state analysis; density operator (matrix) formalism; Optical Bloch Equations (OBE); power broadening and saturation

**3. Quantization of the light field and quantum states of light**

canonical quantization of the electromagnetic field; quasi-mode picture and quantization of the modes of a dielectric cavity; thermal, coherent, and squeezed states of light.

**4. Theory of spontaneous emission**

semi-classical derivation; quantum derivation; cavity-enhanced Purcell factor

**5. Cavity QED: a first look**

perturbative analysis in the weak-coupling limit, strong and weak coupling in the non-perturbative regime

**6. Introduction to quantum stochastic methods in quantum optics**

quantum Brownian motion, harmonic oscillator coupled to a heat bath, examples with the "Quantum Optics" toolbox

**7. Special topics (time permitting)**