UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS AND ASTRONOMY
COURSE OUTLINE

1. **Course:** Physics 303, Quantum Mysteries and Paradoxes

   Lecture Sections:

   L01: MWF, 11:00-11:50, ENE 239 Christoph Simon, SB313, Tel. 220 7007, csimo@ucalgary.ca, Office Hours: F 1:30-2:30

   D2L site: https://d2l.ucalgary.ca/d2l/home/16301
   Physics and Astronomy Office SB 605, Tel. 220 8127, phasugrd@ucalgary.ca

2. **Prerequisites:** none

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 (6 to 8)	40%	
In-class Midterm tests (2)	30%	(Feb 12 and March 19, 15% each)
Final Examination	30%	(To be scheduled by the Registrar)

   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.

   Conversion between percentages and letter grades: A+ requires at least 93%, A at least 86%, A- at least 80%, B+ at least 75%, B at least 70%, B- at least 65%, C+ at least 60%, C at least 55%, C- at least 50%, D+ at least 45% and D at least 40%.

   Assignments are due on time as announced. Late assignments will be considered only in well-documented emergencies (e.g. a doctor's note should be provided in case of illness).

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. **Course Materials:** Valerio Scarani, Quantum Physics – A First Encounter (Oxford University Press, 2006)

6. **Examination Policy**: The exams will be closed book, no aids allowed. Students should also read the Calendar, Section G, on Examinations.

7. **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 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) Academic Accommodation Policy: Students with documentable disabilities are referred to the following links: Calendar entry on students with disabilities and Student Accessibility Services.

   (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@ucagary.ca.
SU Faculty Rep. Phone: 220-3913 Email: sciencerep@su.ucalgary.ca
Student Ombudsman

(i) 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.

The following signature lines should be added to the course outline as appropriate

Department Approval_____Date_____

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

Associate Dean's Approval for
Alternate final examination arrangements: _____Date:_____

COURSE SYLLABUS

The scientific method: progress through model building and falsification.

Introduction to physics: fundamental interactions and particles.

Principles of quantum physics: single-particle interference.

The indistinguishability principle.

Interaction-free measurement.

Waves and particles: early history of quantum physics.

Neutron interferometry, spin.

Interference with large molecules, decoherence.

Which-path information, Heisenberg mechanism.

Quantum cryptography: quantum key distribution.

Two-particle interference: quantum correlations.

Quantum eraser.

Impossibility of superluminal communication based on quantum correlations.

Einstein-Podolski-Rosen argument.

Bohm's theory.

Bell's theorem: quantum non-locality.

Polarization of photons.

Experimental tests of Bell's inequalities.

Interpretations of quantum physics: decoherence, many worlds.

Quantum information: qubits.

No-cloning theorem.

Photon bunching.

Quantum teleportation.

Entanglement swapping.

Quantum memories.

Long-distance quantum communication: quantum repeaters.

Quantum computing.