PHYS 234: Quantum Physics 1  
(Preliminary Syllabus)

Instructor: Norbert Lütkenhaus, RAC 1119  
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Lectures and Tutorials:  
Lecture M,W,F 10:30-11:20 am MC 4021  
Tutorial 101 F 3:30-4:20 pm

Office hours:  
M 11:30- 12:20 pm (Room to be announced)  
W 12:00-1:30 pm  (Room to be announced)  
Additional office hours can be arranged on demand, and then will be held at my office RAC 1119.

Teaching Assistants:  
Razieh Annabestani  
John Donohue  
Matthew Graydon  
Aimee Heinrichs  
Sergei Mikheev  
Mehdi Saravani

Textbook:  
Main text:  
David McIntyre  
Paradigms in Physics: Quantum Mechanics  
Available online  
Download as soon as possible, as this link may become inactive at any time  
Auxiliary textbook:  
B. Schumacher, M. Westmoreland  
Quantum Processes, Systems, and Information  
Cambridge University Press (2010) [about 80 CAD]

In addition, there are many other textbooks on Quantum Physics and I would advise students to take a look at as many as possible as they all deal with topics slightly differently. An explanation that resonates with one person may not resonate with another, so the usefulness of reading about the same material presented in a variety of formats cannot be overstated.
ACE Website
We will be using the ACE website to make material for the lectures available, including assignments and handwritten lecture notes.

Announcements will be made via the ACE system as online notification, but also as emails. Please remember to initialize the forwarding mechanism in ACE so that all email notifications reach you even if you are not logged into the system.

Tutorials:
Tutorials will be held as small tutorial groups (ca 20 students/group). Solutions to assignments will be discussed and marked assignments will be returned. Assistance will also be provided with any question you may have with the material covered in the lectures.

Assignments: Assignment questions will be issued weekly Fridays. For assignments, not necessarily all questions handed out will be graded.
In addition to those weekly assignments there will be online quizzes. They are intended to help you to check your understanding, but do not count towards the final grades

Please Note: No late assignments will be accepted for credit without prior consultation with the course instructor.
Drop Box Location: The assignments should be submitted on time to the drop box located opposite to PHY 211A, in the second floor of the physics building.

Examinations:
– Midterm is tentatively scheduled for Tuesday, November 1, 7-10 pm.
– Final Exam is scheduled by Registrars Office.
In both cases, further details will be provided closer to date.
Please Note: Student travel plans are not considered acceptable grounds for granting an alternative examination time. (see http://www.registrar.uwaterloo.ca/exams/finalexams.html)

Additional Tasks: During the semester, additional tasks will be required for which a total of 5% of the final grade will be assigned. The primary aim of these tasks will be to take students beyond the domain of the ‘assigned textbook’ as a source of course material and get them to explore other texts as well. Further information will be provided as the course progresses.

Grading: The instructor will choose the best of
– 20% Assignments, 5% Additional Tasks, 30% Midterm test, 45% Final Exam
– 20% Assignments, 5% Additional Tasks, 20% Midterm test, 55% Final Exam
Note: At least 5 Assignments must be completed to receive a passing grade

Important Dates (Fall 2009):
Sept 12th - Lectures begin
Sept 30th  - Drop, no penalty period ends
Oct 10th – Thanksgiving Day
Nov 1st  – tentative date for midterm
Nov 18th - Drop, penalty 1 period ends
Dec 5th - Lectures end
Dec 7th - Drop, penalty 2 period ends
Dec 8th – 22nd - Examination Period

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department’s administrative assistant who will provide further assistance.

**Discipline:** A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

**Appeals:** A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

**Note for Students with Disabilities:** The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.
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Provisional Course Outline:

Week 1
L1 Orientation and Motivation
L2 Historical Background 1: Photo-electric effect, Compton effect
L3 Mathematical Background 1: Vector Space, Inner product

Week 2
L4 Historical Background 2: de Broglie Hypothesis, Davisson and Germer experiment
L5 Historical Background 3: Double slit experiment
L6 Mathematical Background 2: Matrices

Week 3
L7 Stern Gerlach Experiments: Classical expectation, actual results.
L8 Mathematisation 1: 2D matrix mechanics
L9 Mathematisation 2: probability amplitudes and probabilities

Week 4
L10 Examples: Quantum State Tomography and Quantum Zeno Effect
L11 Bra-ket Notation and decomposition
L12 Pauli Matrices, 2D operators

Week 5
L13 Eigenvalues and Eigenvectors
L14 Expectation Values, Trace
L15 Statistical Operator

Week 6
L16 Bloch Vector; Generalised Stern Gerlach
L17 Photons 1: Polarisation as quantum states
L18 Photons 2: Quantum mechanics of Polarisation

Week 7
L19 Summary and Generalisation Beyond 2D
L20 Dynamics: Heisenberg and Schrödinger Pictures
L21 Time evolution of Probability Amplitudes - Schrödinger Equation

Week 8
L22 Introduction to Infinite Dimensions: Mapping quantum mechanical structure from finite to infinite dimensions
L23 Position Operator and wavefunctions in position basis
L24 Momentum Operator in position basis
Week 9
L25 Uncertainty principle
L26 Time independent Schrödinger Equation
L27 Infinite Potential Well

Week 10
L28 Finite Potential Well
L29 Bound states in general: orthogonality and completeness of solutions, zero point energy, etc.
L30 Harmonic Oscillator 1 (ladder operator method)

Week 11
L31 Harmonic Oscillator 2 (ladder operator method)
L32 Wavepackets and scattering: why use stationary states for scattering?
L33 Scattering: potential step

Week 12
L34 Scattering: potential barrier
L35 STM and band structure
L36 Summary