CONTACT INFORMATION:

- Dr Robert W. Hill, PHY248
- email: robhill@uwaterloo.ca
- Office hours: by appointment
- Please contact via email and expect a reply within 24hrs.

COURSE DESCRIPTION:


LEARNING OBJECTIVES:

- Background: understanding why we need a quantum theory
- Learning the building blocks of a quantum theory: state vectors and operators
- Learning how to use quantum mechanics to compute probabilities for outcomes of measurements
- Learning how to use quantum physics for technological applications

RESOURCES:

- Textbook (required): CUSTOM VERSION OF “Quantum Mechanics” by David H. McIntyre
- Clickers will be used in class (see below)
- SPINS software can be obtained using links from the following url: http://www.physics.oregonstate.edu/qmactivities
- LEARN Website: We will be using the LEARN website to make material for the lectures available, including assignments and handwritten lecture notes. Announcements will be made via the LEARN system as online notification, but also as emails. Please remember to initialize the forwarding mechanism in LEARN so that all email notifications reach you even if you are not logged into the system
### COURSE OUTLINE:

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture Material</th>
<th>Tutorial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>May 4th</td>
<td>Introduction and History, Math (Vectors and Matrices)</td>
<td>No tutorial</td>
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<tr>
<td>2</td>
<td>May 11th</td>
<td>Stern-Gerlach experiments (1-4), Quantum State Vectors</td>
<td>Eigenvalues, eigenvectors</td>
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<td>3</td>
<td>May 18th</td>
<td>Basis definition, Matrix Notation, General Quantum Systems</td>
<td>No tutorial</td>
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<tr>
<td>4</td>
<td>May 25th</td>
<td>Operators, eigenstates and eigenvalues, Expectation values</td>
<td>Quantum State tomography</td>
</tr>
<tr>
<td>5</td>
<td>June 1st</td>
<td>Mixed State, Density Operator, Projection operators, Commutators and Uncertainty</td>
<td>Expectation values</td>
</tr>
<tr>
<td>6</td>
<td>June 8th</td>
<td>Time dependence, Schrodinger Equation, Dynamics for time indep. Hamiltonian</td>
<td>Midterm Review</td>
</tr>
<tr>
<td>7</td>
<td>June 15th</td>
<td>Examples (Lamour Precession), Energy eigenstates as stationary states</td>
<td>Midterm Week (no tutorial)</td>
</tr>
<tr>
<td>8</td>
<td>June 22nd</td>
<td>Continuous Observables in QM, Wavefunctions and wave mechanics</td>
<td>Dynamics and Schrod. Equation</td>
</tr>
<tr>
<td>9</td>
<td>June 29th</td>
<td>Infinite Potential Well, Harmonic oscillator</td>
<td>Finite Potential well</td>
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<tr>
<td>10</td>
<td>July 6th</td>
<td>Free Particle, Uncertainty principle, Scattering from potential step</td>
<td>Superposition states</td>
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<tr>
<td>11</td>
<td>July 13th</td>
<td>Scattering from potential barrier, Quantum mechanical tunnelling</td>
<td>Potential Well expansion</td>
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<tr>
<td>12</td>
<td>July 20th</td>
<td>STM and other applications</td>
<td>Course review</td>
</tr>
<tr>
<td>13</td>
<td>July 27th</td>
<td>Course review</td>
<td>Course review</td>
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</tbody>
</table>

The course lecture plan and the schedule of due dates given above will be followed as closely as possible, but some changes may occur. Any changes in assignment due dates or test dates will be discussed and announced in class and posted on the course webpage. However, the grading scheme (below) will remain the same.

### TUTORIALS:

- Tutorials are held on Mon 09.30-10.20 (QNC 2501), Mon 15.30-16.20 (PHY 313), Thurs 08.30-09.20 (DWE 3519), Thurs 15.30-16.20 (DWE 3519).
- Tutorial work will be problem solving, performed in small groups guided by a TA.
- Marks (5%) are awarded for attendance and participation in the tutorial.
ASSIGNMENTS:

• Assignment questions will be issued weekly. These will be available in .PDF format on LEARN on Fridays at 5.00pm.
• Completed assignments are due the following Friday and should be handed in during class on that day.
• Graded assignments will be available 1 week after they have been handed in. They will be available for collection during class on Friday. Uncollected assignments will be held by the instructor, in his office, until the end of the semester. After that time, they will be securely destroyed.
• Assignment Solutions: Solutions will be available on LEARN on Friday at 5.00 pm.
• Please Note: No late assignments will be accepted for credit without prior consultation with the course instructor.

QUIZ QUESTION:

• One quiz question, based on material in the previous weeks assignment, will be completed in class on Friday.

ASSESSMENT:

• Final Course Grades will be assigned according to the following combination of marks using whichever leads to the highest overall grade:

  10% Assignments, 15% In-class Quiz, 5% Clicker Participation, 5% Tutorial Participation, 25% Midterm, 40% Final

  OR

  10% Assignments, 15% In-class Quiz, 5% Clicker Participation, 5% Tutorial Participation, 10% Midterm, 55% Final

• Examinations
  o Midterm Exam: 7.00-8.30 pm, June 17th, 2015, MC4021 and MC4061
  o Final Exam is scheduled by Registrars Office. Further details will be provided closer to date.

  Please Note: Student travel plans are not considered acceptable grounds for granting an alternative examination time  http://www.registrar.uwaterloo.ca/exams/finalexams.html

• If any graded elements are missed and appropriate documentation is forthcoming (e.g. VIF for illness), the student should discuss with the instructor how accommodate the missed element. Typically, the grade for that component will be renormalized to reflect the missing element(s).
• Students are reminded that it is their responsibility to check appropriate uWaterloo websites for details concerning various dates (e.g., final examination, drop deadlines, etc)
CLICKERS:

- The lectures will make use of clickers, so each student is required to have an i-clicker in his/her possession. Participation in the use of clicker questions will count towards the final grade (5%).
- Clicker points are based on at least one use per lecture involving clicker questions (irrespective of whether the answer is correct or not). In order to avoid issues with absences and misplaced clickers, the clicker participation will be calculated based on 90% of the lecturers using clicker events.
- Clickers need to be registered for this course. Please use LEARN to register your clicker for this class (Table of Contents > Syllabus > iClicker Registration)
- **IMPORTANT NOTE:** It is in violation of academic integrity to activate a clicker during lecturers that is registered to a different student, especially if that student is not present.

COMMITMENT EXPECTATIONS:

- Students are expected to spend 3-5 hrs per week on assignment problems and reading textbooks and notes outside of class and tutorials.
- Attendance at lectures is strongly recommended. The course material is conceptually challenging and students are encouraged to ask questions about the material in class.

VERIFICATION OF ILLNESS:

- Verification of Illness: In order to request accommodation due to illness, students will have to file a Verification of Illness form with the Science Undergraduate office. Based on this filing, and an explicit request from the student, the Lecturer will decide how and if an accommodation will be made.
- Science students should be aware that starting with the Winter 2013 term, the only Verification of Illness forms (VIFs) that instructors will accept for accommodation for missed assessments (labs, quizzes, midterms, final exams, etc.) will be those issued by the University of Waterloo, Health Services, when this service is open. VIFs issued by walk-in clinics will not be accepted, except when obtaining a VIF from Health Services is not possible.
- If a student is sick on a weekend, during off-hours, while out of town or receiving ongoing care from a family physician or specialist, it is acceptable to provide documentation from other health service providers. Information should include (1) date of the physician assessment, (2) dates of illness, (3) level of incapacitation and (4) whether the diagnosis was made by the physician or based on description by the student.
- Keeping the playing field level for all of our students is a priority. Students are reminded that obtaining a VIF under false pretenses is an academic offense. For tests and exams, a student found guilty of misrepresentation will receive a failing grade in the course and be suspended.
- Any questions concerning this policy can be directed to an undergraduate advisor in the Science Undergraduate Office. ESC 253 (Monday: 9:30 am - 12:00 pm, 1:00 pm to 4:15 pm Tuesday- Friday: 8:30 am - 12:00 pm, 1:00 pm to 4:15 pm Email: current@science.uwaterloo.ca, Phone: 519-888-4567 extension 35244, Web: https://uwaterloo.ca/science/current-undergraduate-students

ACADEMIC INTEGRITY:

- **Office of Academic Integrity** provides relevant information for students, faculty and staff.
  - **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.
Grievance: Students, who believe that a decision affecting some aspect of their university life has been unfair or unreasonable, may have grounds for initiating a grievance. Students should read Policy #70, Student Petitions and Grievances, Section 4. When in doubt, students must contact the department’s/school’s administrative assistant who will provide further assistance.

Discipline: Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about ‘rules’ for group work/collaboration should seek guidance from the course instructor, academic advisor, or the Associate Dean of Science for Undergraduate Studies. For information on categories of offenses and types of penalties, students should refer to Policy #71, Student Discipline. For information on typical penalties, students should check Guidelines for the Assessment of Penalties.

Appeals: A decision or penalty imposed under Policy 33 (Ethical Behavior), Policy #70 (Student Petitions and Grievances) or Policy #71 (Student Discipline) may be appealed, if there is a ground. Students, who believe they have a ground for an appeal, should refer to Policy #72 (Student Appeals).

STUDENTS WITH DISABILITIES:

- **AccessAbility Services**, 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 students require academic accommodations to lessen the impact of their disability, they should register with AccessAbility Services at the beginning of each academic term.