Physics 181 Quantum Mechanics for Everyone
(Fall 2017); CRN: 14985
Class Meetings: T, Th 1:00-2:50 am, Room 107 Klamath Hall

Instructor: Michael Raymer (Professor of Physics)
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Grader: Spencer Alexander (Physics PhD student)
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Office visits can also be arranged any time by appointment (best to use email).

Course Home Page: Canvas system, https://canvas.uoregon.edu
Log-in should be the same as for your email account.
Canvas will be used in this course as an online resource for the syllabus, lecture slides (posted after each lecture), pre-class exercises, and homework assignments. Please check Canvas frequently in order to stay up to date on the course materials that are posted from class to class. Important announcements will also be sent via email, so it is best to get into the habit of checking your email daily.

Course Description: A non-science major's introduction to the most important ideas of Quantum Mechanics, using only basic algebra and geometry. Students will learn about the experiments that led to the creation of Quantum Mechanics, explore the theoretical ideas of Quantum Mechanics, and learn about modern applications in technology such as quantum cryptography, quantum computing, quantum teleportation, and quantum sensing. See the document *Course Purpose* in Canvas.

Course Learning Goals:
While exploring these topics, we will stress, "How do we know?" "What historical process led to the discoveries?"
1. Be able to identify the main objects and relations between the objects comprising quantum theory (electron, photon, state, measurement...)
2. Be able to explain the difference between measurement in a classical-physics context and in a quantum-physics context.
3. Be able to differentiate between a classical-physics and a quantum-physics worldview and to recognize where each worldview is appropriate.
4. Be able to identify the quantum physics basis of various technologies.
5. Be able to use classical probability methods for predicting probabilities of measurement outcomes in a

classical context.

6. Be able to manipulate diagrammatic methods for predicting probabilities of measurement outcomes in a quantum context.

Use of Math: You will need to employ some basic math skills—fractions, geometry, exponents and scientific notation, how to use a calculator, and how to draw and interpret graphs, but no detailed algebra will be used. Some new math concepts will be introduced. If you encounter some math you don't understand, please seek us out for help.

Prerequisites: No formal requirements.

Needed Materials:

• Calculator: You will occasionally need a scientific calculator for this course, and you must bring it (or a cell phone equivalent) to all classes. At minimum, it should be able to calculate using scientific notation for large and small numbers. If you have a stand-alone calculator, please bring to all exams.

• i>clicker: **You need to purchase an i>clicker** and **register it prior to the second week of classes**. (from the UO bookstore: $50 new, with $19 resale value: the bookstore makes no profit from iclickers. If you buy a used one-not recommended-it will cost about $28 at the bookstore plus $10 registration fee at the iclicker company's website). You will use the clicker to respond to class polls and to take in-class reading quizzes (see the grades section below). You must bring your clicker to every class. You need to register your clicker following instructions on Canvas in the *iClicker* section for this course. (NOT on the commercial iClicker website.)

• Text: The required text is the paperback book written by the professor, M. Raymer, *Quantum Physics: What Everyone Needs to Know*, first published in 2017. Other readings will be provided online.

• We will post lecture notes for the course (the slides we show in class) on the Canvas site. Usually these notes will be available within a couple of days after the material is covered in class. You should still plan to take your own detailed notes during class, since research shows that taking notes is an important step in learning and retaining new concepts.

Grading: Grades for the course will be based on:

   * Daily Classroom Participation (i>clicker-based Polls and in-class writing: 10%)
   * At-home On-Line Reading Pre-Class Questions: 15% (for correct and/or thoughtful answers)
   * Homework: 30% (due weekly usually Thursday, including Week 10)
   * Mini exam (Tues. Oct. 11): 5% [one double sided 8.5 x 11 in. page of notes permitted]
   * Midterm exam (Tues. Nov. 7.): 15% [one double sided 8.5 x 11 in. page of notes permitted]
   * Final Exam and Final Essay: combined 25% (Tues. Dec. 5, 12:30 pm) [two double sided 8.5 x 11 in. pages of notes permitted](The weighting between the two parts will be decided upon in consultation with students in the class and will reflect individual preferences.)

Exam Format: The in-class portion of midterm and final exams will consist of some multiple choice and some short-answer questions. At least 50% will be taken from homework, in-class examples, on-line Pre-Class Questions, or previous exams in this term. There will also be take-home essays, an example of

which from a prior year will be posted in advance on Canvas prior to or early in the term.

Grading Scale: The expected grading scale for this course is:
100-85 = A(+/-), 85-75 = B(+/-), 75-65 = C(+/-), 65-50 = D, <50 : in danger of F.
If necessary, we may apply a curve to achieve a higher average final grade. However, you are guaranteed at least the grade listed here based on your course average. Pass/fail grading option: A passing grade requires at least the equivalent of a C- grade.

• Clicker Polls: Classes will involve poll questions, which will be answered with your clicker. Points earned does not depend on whether or not you get these questions right, as long as you give some answer. Your responses are known only to you and to the Instructors.

• Attendance: You will need to attend class to earn participation points through clicker polls. **With prior approval** you may miss up to two classes with no loss of attendance points. You can also miss up to one day (or have a nonworking clicker) without prior notification with no loss of attendance points.

• On-Line Pre-Class Questions: Several days before each class there will be posted a brief set of graded questions to answer on Canvas, to assist you in understanding the assigned readings. They will be due at 12 noon before the relevant class.

• Homework: Weekly homework sets will be assigned on Canvas. We encourage you to work together in solving homework problems, but you must write up the solutions on your own, in your own words. See the document *How to Study for Science Courses* provided on Canvas. We will try to post solutions to each homework assignment within one day after it is due. Homework is due at the **start of class** on the due date, normally Thursdays. We will accept late homework *no more than 24 hours late* (1:00 pm the day after the due date). Up to 24-hour-late homework will have 20% deducted. Put these into the Late Homework In-Box outside Prof. Raymer's office Wil 276. Homework may be turned in late with no penalty under extenuating circumstances only by prearrangement with at least 24 hours notice before the normal deadline.

Amount of time to spend per week on this course
For a 4 credit course, the University's expectation is that you'll spend about 10 hours per week outside of class on coursework.

Makeup exams (NONE): The exams are pre-scheduled (see above and below) so you can avoid scheduling conflicts. **Thus, there will be no makeup exams for this course, so please check the dates now.** If you have a *serious and documented* reason for missing a Midterm Exam (death in the family, serious illness), your final-exam score will count in place of the missed midterm exam score. That is, your final-exam score will count for more than it would otherwise.

Final Exam: The final exam will be Tues. Dec. 5, at 12:30 pm. Please verify this on the UO calendar of exams. **You must take the exam at the official time**. (No exceptions, except for medical reasons.) If you have a calculator please bring it to the final.

Suggestion Box: If you have suggestions for improving anything about how the course is going, please

drop a note (can be unsigned) in the Late-Homework box outside Prof. Raymer's office or in the designated **Suggestion In-Box** on Canvas in the Quizzes Section.

Accessible Education: From UO website: *The University of Oregon works to create inclusive learning environments. Please notify us if aspects of the instruction or course design result in barriers to your participation. You are also encouraged to contact* Accessible Education Center *in 164 Oregon Hall at 346-1155.* If you have a documented need for accommodations in this course, please meet with either of the instructors soon. Co-Instructor *Saul Propp* has experience with course accommodations. Also please request that the Accessible Education Center send a letter verifying your documented needs for accommodations. http://aec.uoregon.edu