Location and time: Tu/Th 10:00–11:45 am, Physical Sciences 110.

Instructor: Robert Johnson
Office: 323 Natural Sciences II; Office phone 459-2125
E-mail: rjohnson@scipp.ucsc.edu
Office hours: M,W 10:00–11:00; T, Th 12:00–1:00, or by appointment.
Course Web site: http://scipp.ucsc.edu/~johnson/phys139a/phys139a.htm
eCommons site: https://ecommons.ucsc.edu/xsl-portal

TA: Auditya Sharma
Office: ISB 288
Phone: 459-4106
E-mail: sharma@physics.ucsc.edu
Discussion Section: ISB 235 at 4:00 PM on Wednesdays.
Office hours: 4:00–5:00 pm on Tuesdays.


The two textbooks are available as a bundle in the Bay Tree Bookstore. However, they can also be obtained separately online, new or used.

### Syllabus

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<th>Week</th>
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<th>Reading Belloni</th>
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<td>Mar. 30 April 1</td>
<td>Schrödinger eqn. &amp; statistical interpretation. Stationary states.</td>
<td>1.1–1.6</td>
<td>Ch 1, Ch 6, 2.1</td>
<td>7.1, 7.6</td>
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<td>2</td>
<td>April 6 April 8</td>
<td>Infinite Square well. Harmonic oscillator.</td>
<td>2.2 2.3</td>
<td>Ch 10 12.1–12.4, 7.2–7.4</td>
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<td>3</td>
<td>April 13 April 15</td>
<td>Free particle. Delta-ftn potential. Finite square well.</td>
<td>2.4 2.5 2.6 2.7</td>
<td>Ch 8, 11.1–11.3 9.6–9.9</td>
<td>#2 HW #1</td>
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<td>4</td>
<td>April 20 April 22</td>
<td>Linear algebra. Uncertainty principle.</td>
<td>3.1–3.4 3.5</td>
<td>7.8 5.10</td>
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<td>5</td>
<td>April 27 April 29</td>
<td>Dirac notation. QM in 3-D: S.H.O. and square well</td>
<td>4.1, 4.2 3.6</td>
<td>13.1–13.6 13.7, 13.8</td>
<td>#4 HW #2,3</td>
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<td>Hydrogen atom Angular momentum, Spin</td>
<td>4.2 4.3, 4.4</td>
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<td>7</td>
<td>May 11 May 13</td>
<td>Spin Two-particle system</td>
<td>4.4 5.1</td>
<td>#6 HW #4,5</td>
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<td>8</td>
<td>May 18 May 20</td>
<td>Bosons and Fermions Atoms and the periodic table, Solids</td>
<td>5.2 5.3</td>
<td>14.1, 14.2</td>
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<td>9</td>
<td>May 25 May 27</td>
<td>Solids Quantum statistical mechanics</td>
<td>5.3, 5.4</td>
<td>11.4–11.7 15.1–15.4</td>
<td>#8 HW #6,7</td>
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<td>10</td>
<td>June 1 June 3</td>
<td>Black body spectrum EPR, Bell’s theorem, and decoherence</td>
<td>5.4 12.1–12.5</td>
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<td>11</td>
<td>June 7 June 8</td>
<td>Final homework due by 5pm Comprehensive Final examination</td>
<td></td>
<td>8–11 AM</td>
<td>#9</td>
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This course covers physics that should be familiar from Physics 101A and 101B. We will not spend much time on the historical development of quantum physics, as that should have been stressed in Physics 101A. Instead, we will study the formal theory, including simple applications, following Griffith’s textbook closely. The Physlet Quantum Physics textbook is also required. Note that it really is only at the Physics 101A level mathematically. Therefore it can provide some review, but more importantly, it adds visual and interactive reinforcement of the concepts discussed in Griffiths by way of rather formal mathematics.

The course is math intensive. Its prerequisites include two quarters of Multivariable Calculus plus three quarters of Math Methods, which should be sufficient. In particular, I will expect you to be familiar with the following: vectors in 3-D (e.g. dot products and cross products); partial derivatives, total differentials, and the chain rule; vector differential calculus (e.g. gradient, divergence, curl); coordinate transformations (e.g. rotation matrices) and basic linear algebra (eigenvalues and eigenvectors); Cartesian, cylindrical and spherical coordinate systems; line, surface and volume integrals; Taylor series; first-order ordinary differential equations, second-order linear ordinary differential equations and partial differential equations (especially separation of variables in Cartesian, cylindrical, and spherical coordinates); Fourier series and Fourier transforms. However, some topics in differential equations and Fourier transforms will be reviewed and developed in the lectures.

Please at least read the relevant sections of the textbooks before coming to lecture. Before or after the lecture be sure to work through on paper the non-obvious derivations in Griffiths, as that will be more valuable to you than watching me do it. Also, read the relevant sections of Physlet Quantum Physics and, most importantly, play with the interactive material on the CD. I think that both textbooks are very readable, with good explanations. If I don’t have to recite to you everything in the text, then that leaves more time for me to work through examples, go over conceptual questions in more depth, and demonstrate concepts using computer calculations. To encourage these good habits, you will find on eCommons for most lectures a short multiple-choice “reading quiz,” to be completed prior to the beginning of the lecture. The reading quizzes will sometimes include interactions with online programs and “Physlets” that illustrate conceptual aspects of quantum mechanics.

A set of homework problems will be given out each week, for a total of nine assignments. The problems will mostly be taken from textbooks but will also include some derivations and maybe some short-answer conceptual questions. Due to departmental limitations, only a fraction (probably half) of your homework solutions will be graded. Solutions will be posted online shortly after the due date. You are welcome to collaborate on the homework, but be sure that in the end you know how to work out each assigned problem by yourself. You are also encouraged to seek help on the homework, whenever necessary, from myself and the teaching assistant. While my office hours are the most convenient time for me to meet with you, if you have a conflict with those times or have an urgent question that cannot wait, you are welcome to look for me at other times, make an appointment to see me, or else send questions to me via e-mail. During most weeks I am on campus all day Monday through Friday.

The homework will include some numerical calculations to be done with spread sheets (Open Office or Excel) as well as MathCad or Mathematica. The software is available to you in various campus computer labs (see http://ic.ucsc.edu/services/computer_labs/software.php). I will provide detailed examples, templates, and instructions, so no prior experience with these programs or with computer programming will be necessary. Generally you can complete the problem by a few small edits to the template that I provide, followed by observation of and discussion of the results. If you prefer to use Matlab instead of Mathcad or Mathematica, that is fine, but I probably won’t be able to provide any support for it. Homework will also include interactive exercises from the Physlet Quantum Physics book.

Mathematica, Mathcad and some other programs are also very powerful in doing symbolic calculations. You can use them as an aid for that purpose, but you still have to show the mathematical work by hand in your homework solution. In general you must show your work, and computer printout will not be accepted in place of hand calculations.

Instead of a midterm exam, we will have a 30-minute quiz every other Thursday, as noted on the syllabus, that will be based on the two previous homework assignments. Your lowest quiz score will be dropped from your average when calculating your final grade.
Grades and evaluations will be determined according to the following approximate weights:

- Graded homework: 15%
- Reading quizzes (lecture preparation exercises): 10%
- Quizzes: 30%
- Final exam: 45%

The final exam will include short-answer conceptual questions as well as problem solving. While physics is not especially memory intensive, it nevertheless is crucial for a physicist to carry a “toolkit” of fundamental definitions and relations. If your memory is blank, then you will not be capable of even starting to think about a problem, even with a library at your disposal. Therefore, my quizzes and exams will be closed book, with no notes allowed. If values of physics constants are needed, then I will supply them. I will also supply esoteric or lengthy equations and integration formulas if they are needed.

In addition to the textbooks, the following texts are on reserve for reference:

- S. Brandt, H.D. Dahmen, T. Stroh, *Interactive Quantum Mechanics*. This book comes with a CD containing software for doing various numerical calculations that illustrate phenomena in quantum mechanics. I will use it during lectures for illustration, but you can also load the program onto your computer and use it to gain deeper insights into the physics. It is at a higher level than the Physlet book.
- Richard L. Liboff, *Introductory Quantum Mechanics*, another excellent introductory level textbook. It is more-or-less at the same level as Griffiths but lengthier and more complete.
- Shankar, *Principles of Quantum Mechanics*. This is a much thicker and more in-depth textbook. It is at a bit higher level than Griffiths, such that it can be suitable for use in first-year graduate-school courses. It can be used as a reference on particular topics that you would like to see in more detail. It also includes topics that we will not cover, such as the Feynman path-integral formulation of quantum mechanics.
- Dirac, P.A.M., *The Principles of Quantum Mechanics*, a classic, formal introduction to quantum mechanics, which uses extensively Dirac’s bra-ket notation.
- Feynman, Leighton, and Sands, *The Feynman Lectures on Physics*, Volume 3, on reserve. Highly recommended reading, either during or following this course.
Helpful eCommons Information for Students

Instructors, please feel free to copy and paste all or part of this text into your syllabus or other class handout.

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Once you have your CruzID Gold password, you can log into eCommons by visiting this site: http://ecommons.ucsc.edu/

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- Online: http://itrequest.ucsc.edu/
- Phone: (831) 459-HELP
- Email: help@ucsc.edu
- In-Person: Kerr Hall
  o Kerr Hall Rm. 54 - M-F 8am to 5pm

60-Minute Inactivity Timeout

After 60 continuous minutes of inactivity, you will be automatically logged out of eCommons. This means any tasks or changes you were working on will not be saved beyond when you last saved them yourself. As an example, if you were in the middle of editing your calendar and left the room for 60 minutes without saving your work or logging out of eCommons, your calendar changes would be lost. The best practice is to save your work and log yourself out of eCommons when you are no longer actively working in it, especially when editing the site or completing coursework.

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