



**EE 471 Applied Quantum Mechanics for Engineers**

**Units: 4**

**2x/week, each lecture 1 hour 50 minutes**

**Location: TBD**

**Instructor: Prof. Martin Gundersen**

**Office: SSC 421**

**Office Hours: Tu, Thurs 9 am**

**Contact Info: 213 740 4396, [mag@usc.edu](mailto:mag@usc.edu).** Emails and phone messages will be typically answered within 48 hours.

**Teaching Assistant:**

**Office:**

**Office Hours:**

**Contact Info:**

## Course Description

This course is typically taken as an upper-division elective by undergraduates majoring in electrical engineering. The purpose of Applied Quantum Mechanics is to develop an understanding of the principles of quantum mechanics (QM), and to learn how these are applied in practical devices. The course includes an introduction to quantum mechanics, an understanding of basic quantum mechanics, and linkage between quantum theory and the devices that are based on quantum mechanics. This subject is generally very challenging on first encounter, however, based on experience with this course, an understanding of the basics can definitely be achieved. QM, which has a very strong theoretical component, also has many experimental aspects, foundations, and applications. QM has become a basis for practical and important devices—and QM has very interesting intellectual elements as well!

## Learning Objectives and Outcomes

After completing this course, a student will be able to:

- Understand the electron wavefunction and the Schrödinger equation
- Understand the Pauli exclusion principle and its application to the periodic table
- Understand the quantum mechanical approach to emission and absorption of light
- Understand basics of laser operation

**Prerequisite:** EE 470

## Required Readings and Supplementary Materials

Required textbook:

D. J. Griffiths and D. F. Shroeter, "Introduction to Quantum Mechanics," 3<sup>rd</sup> edition. Cambridge. ISBN 978-1107189638.

Recommended (available free on web)

R. P. Feynman, "The Feynman Lectures in Physics, Vol. III." Addison-Wesley. ISBN 978-0201021189.

## Description and Assessment of Assignments

Written homework will be assigned each week.

## Grading Breakdown

Assignment	% of Grade
Homework	35
Midterm Exam	25
Final Exam	35
Extra credit	5
<b>TOTAL</b>	<b>100</b>

### Assignment Submission Policy

Each assignment will be due in one week after assignment and is to be handed in at the beginning of lecture. Late homework will not be accepted and will not be graded.

### Grading Timeline

Homeworks will be graded roughly two weeks after the due date.

### Additional Policies

Homework must reflect your own work and study. It is permissible and appropriate to discuss homework with others, but homework assignments are to be your work, not the work of others.

## Course Schedule: A Weekly Breakdown

Homework will be assigned each week and will be due the following week, for a total of 14 homework assignments.

	Topics/Daily Activities	Readings
<b>Week 1</b>	Wave nature of electron. Free motion of electrons. Schrödinger equation	Reading Ch 1 Griffiths
<b>Week 2</b>	Mathematical review: Complex numbers, series expansions of basic functions, binomial theorem. Differential equations. Wave equations as solutions of Maxwell's equations. Fourier series	
<b>Week 3</b>	Basic example: Infinite square well. Spatial wave functions and energy levels. Fourier sine series.	Reading Chapter 2 Griffiths (infinite well)
<b>Week 4</b>	More basic examples: Rigid rotor. Harmonic oscillator.	Reading Chapter 2 Griffiths and notes
<b>Week 5</b>	Vibrations and rotations of diatomic molecules. Barriers: contacts, tunneling, emission.	
<b>Week 6</b>	Mathematics of quantum mechanics: Operators, eigenfunctions (eifs), eigenvalues. Bra-ket notation. Dirac delta function.	Chapter 3 Griffiths and notes
<b>Week 7</b>	Amplitude and probability. Hermitian operators. Orthogonal eifs and real eigenvalues. Uncertainty principle.	Reading from notes
<b>Week 8</b>	Time dependence of amplitudes and eigenstates. Transitions between states. Wavefunctions and energy levels for coupled states. Elementary model of electronic band structure of ammonia.	Reading and HW from notes and Griffiths and Feynman Ch 9
<b>Week 9</b>	Ladder operator solutions of harmonic oscillator. Orbital angular momentum operator and wave equation. MIDTERM EXAM.	Reading Ch 4 Griffiths
<b>Week 10</b>	Spin angular momentum. Pauli principle. Hydrogen atom.	
<b>Week 11</b>	Periodic table construction. Valence bonding. Symmetry: Identical particles, two-particle system, Slater determinant. Reading	Ch 4 Griffiths
<b>Week 12</b>	Emission of light from an atom. Einstein $A$ and $B$ coefficient. Lasers.	Notes, Ch 11.1 to 11.3 Griffiths
<b>Week 13</b>	Density of states. Fermi distribution. Carrier concentration.	Ch 5.3 Griffiths
<b>Week 14</b>	Time-independent perturbation theory. Hydrogen ion and hydrogen molecule. Variational method. Degenerate and non-degenerate perturbation theory.	Ch 7 Griffiths
<b>Week 15</b>	Zeeman effect. Hyperfine splitting. Review.	Ch 7 Griffiths finish
<b>FINAL</b>	Date: For the date and time of the final for this class, consult the USC Schedule of Classes at <a href="http://classes.usc.edu/">classes.usc.edu/</a> .	

## Statement on Academic Conduct and Support Systems

### Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” [policy.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

### Support Systems:

*Student Health Counseling Services - (213) 740-7711 – 24/7 on call*  
[engemannshc.usc.edu/counseling](http://engemannshc.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call*  
[suicidepreventionlifeline.org](http://suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call*  
[engemannshc.usc.edu/rsvp](http://engemannshc.usc.edu/rsvp)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED) | Title IX - (213) 740-5086*  
[equity.usc.edu](http://equity.usc.edu), [titleix.usc.edu](http://titleix.usc.edu)

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

*Bias Assessment Response and Support - (213) 740-2421*  
[studentaffairs.usc.edu/bias-assessment-response-support](http://studentaffairs.usc.edu/bias-assessment-response-support)

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

*The Office of Disability Services and Programs - (213) 740-0776*  
[dsp.usc.edu](http://dsp.usc.edu)

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

*USC Support and Advocacy - (213) 821-4710*  
[studentaffairs.usc.edu/ssa](http://studentaffairs.usc.edu/ssa)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity at USC - (213) 740-2101*

[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

*USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

*USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.