Syllabus

Important notes

1. Class will take place at the scheduled day & time and will occur synchronously via a Zoom meeting link to be posted on blackboard. Cameras must be turned on to encourage class participation.
2. Problem sets are still due at the start of class but should be deposited electronically in a shared google drive folder I will share with you via your stonybrook.edu email account.
3. Final exam will be given at the time determined by the registrar and will be given online with links to be shared on blackboard.
4. If you have a physical, psychological, medical or learning disability that may impact your course work, please contact the Student Accessibility Support Center, ECC (Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.
   https://www.stonybrook.edu/commcms/studentaffairs/sasc/facstaff/syllabus.php

1. Course Staff and Office Hours

Instructor: Prof. Matthew D. Eisaman
matthew.eisaman@stonybrook.edu
631-632-8421
Light Engineering, 145

Office Hours: Wednesdays and Fridays, 11:00am to 1:00pm ONLINE via Zoom link to be shared on Blackboard
Other hours by appointment

TAs: To be announced

Office hours and locations may change. Please check Blackboard for most up-to-date information.

2. Course Description

Title: ESE 332 Quantum Mechanics for Engineers

Introductory undergraduate-level first course in quantum mechanics geared towards engineers and applied physicists. Comprehensive introduction to quantum mechanics and its application to real-world problems. Concepts covered will include blackbody radiation, the photoelectric effect, the quantization of the electromagnetic field, wave-particle duality, Heisenberg's uncertainty principle, the electron wave function, superposition, stationary states, the Pauli exclusion principle, many-body systems, tunneling, quantum mechanics in crystalline materials, quantum measurement, wavefunction collapse, entanglement, and teleportation. Applications covered will include lasers, LEDs, solar cells, MOSFETs, flash memory, quantum cryptography, quantum computation, and quantum teleportation, among others.

Prerequisites: Prerequisites: PHY 122/124 or PHY 126 and 127 and 134 or PHY 132/134 or PHY 142/134; MAT 127 or 132 or 142 or 171 or AMS 161. Advisory Corequisite: AMS 261 or MAT 203 or 205 or 307

Credits: 3

3. Textbook

OPTIONAL (NOT REQUIRED) TEXTBOOKS

Peter Deák, *Essential Quantum Mechanics for Electrical Engineers*, Wiley-VCH, 2017. ISBN-13: 978-3527413553.

David A. B.Miller, *Quantum Mechanics for Scientists and Engineers*, Cambridge University Press, 2008. ISBN-13: 978-0521897839.

Leonard Susskind and Art Friedland, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014. ISBN-13: 978-0465062904.

4. Course Learning Objectives

At the end of this course, students will:

1. Know how to solve introductory problems in quantum mechanics
2. Understand quantum mechanical concepts relevant to electronic devices

5. Student Learning Outcomes

	Student Outcomes	% contribution
1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	90%
3	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	
3	an ability to communicate effectively with a range of audiences.	
4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	
6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.	
7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	10%

6. Schedule

Lectures : MW, 2:40pm-4:00pm, Online via Zoom meeting link to be shared on blackboard
Mid-term exams will be given 1.5 hrs. in class (online) during the second lecture period of Week 7. The final examination will be 3 hrs. online with date and time TBD.

Week	Dates	Topics	Text
1	2/1,2/3	**Intro:** Classical physics, a brief history of quantum mechanics, wave-particle duality, Heisenberg Uncertainty Principle, quantization, photoelectric effect, overview of how quantum mechanics is essential to modern technology / engineering	1-3
2	2/8, 2/10	**Mathematics review:** Linear algebra, Fourier transforms	notes
3	2/15, 2/17	**Concepts:** Quantum information **Applications:** Quantum cryptography, Quantum key distribution, Quantum Computation	18
4	2/22, 2/24	**Concepts:** Tunneling **Applications:** Moore's Law and MOSFETs in classical computing, flash memory, tunnel diodes	16-17
5	3/1, 3/3	**Concepts:** Quantum confinement, periodic potentials, quantum numbers, spin **Applications:** Quantum dots, semiconductors, periodic table	8-9
6	3/8, 3/10	**Concepts:** The postulates of quantum mechanics, matrix representation, spin matrices, expectation values **Applications:** Quantum mechanical calculations	4-5
7	3/15, 3/17	**Concepts:** Interaction of spin and magnetic fields, Larmor precession **Applications:** NMR, MRI, quantum computation	notes, 9
8	3/22, 3/24	First half of class: **REVIEW** **Second half of class: MIDTERM**	
9	3/29, 3/31	**Concepts:** Fermi Level, semiconductor doping, pn junctions **Applications:** solar cells, photodetectors, LEDs	8
10	4/5, 4/7	**Concepts:** Blackbody radiation, absorption and emission **Applications:** solar cells, lasers, LEDs	15
11	4/12, 4/14	**Concepts:** Finite square well potential **Applications:** LEDs, quantum well	16-17
12	4/19, 4/21	**Concepts:** Atomic states **Applications:** atomic clocks, GPS	notes
13	4/26, 4/28	**Concepts:** Quantum Information, Part II, specific quantum algorithms, physical implementations of quantum information systems **Applications:** Quantum cryptography, Quantum key distribution, Quantum Computation	notes
14	5/3, 5/5	**Concepts:** Quantum Information, Part II continued **Applications:** Quantum cryptography, Quantum key distribution, Quantum Computation	notes
	TBD	**FINAL EXAM**	

7. Assignments

Problem sets

There will be weekly problem sets. Problem sets will be distributed at the end of each lecture and will be **due the following lecture at the start of class**. Late problem sets **will not be accepted - no exceptions**. Please turn in what you have at the start of class. You must submit the problem set by depositing an electronic copy in the shared google drive folder I will share with you on Blackboard.

Exams

The midterm exam will be based on all information presented up through Week 6 and will be designed to take 1.5 hours. The final exam will include all material presented in all lectures and will be designed to take 3 hours. Both will be given online.

7. Grading

The course grade will be based on the following components:

Item	Percent
Problem Sets	45
Midterm exam	20
Final exam	35

Grades are based on the following scale:

A = 93-100, A- = 90-92
B+ = 88-89, B = 83-87, B- = 80-82
C+ = 78-79, C = 73-77, C- = 70-72
D+ = 68-69, D = 63-67, F <63

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Class Protocol

All electronic devices are to be turned off during class unless advance permission is given by the instructor. No recording of lectures of any kind (including audio and video) is allowed.

Class resources

Blackboard (http://blackboard.stonybrook.edu) will be used as the primary means of distribution for readings from the primary literature and submission of assignments.

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Students who require assistance during emergency evacuation are encouraged to discuss their

needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Academic Honesty

Any academic dishonesty on a written homework or lab will result in a zero grade for the assignment for all parties involved.

All exam work must be entirely your own with no collaboration or outside materials/information. Any academic dishonesty on the midterm exams or the final exam will result in failing the course. The case will be submitted to the College of Engineering's Committee on Academic Standing and Appeals.

Electronic Communication Statement

Email and especially email sent via Blackboard (http://blackboard.stonybrook.edu) is one of the ways the faculty officially communicates with you for this course. It is your responsibility to make sure that you read your email in your official University email account. For most students that is Google Apps for Education (http://www.stonybrook.edu/mycloud), but you may verify your official Electronic Post Office (EPO) address at http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo.

If you choose to forward your official University email to another off-campus account, faculty are not responsible for any undeliverable messages to your alternative personal accounts. You can set up Google Mail forwarding using these DoIT-provided instructions found at http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail.

If you need technical assistance, please contact Client Support at (631) 632-9800 or supportteam@stonybrook.edu.

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Critical Incident Management Statement

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