Bulletin Course Description:
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.

Course Title: Quantum Mechanics for Engineers

Contribution of course to meeting the Professional Component: Engineering Science 50%, Laboratory Experience 0%, Mathematics 20%, Basic Science 20%, General Education 10%, Design Experience 0%

Spring 2020
Stony Brook University
Department of Electrical & Computer Engineering
College of Engineering and Applied Sciences
Course Title: Quantum Mechanics for Engineers
Course Instructor: Prof. Matthew D. Eisaman

Instructor and TA contact information:
Prof. Matthew D. Eisaman
Email: matthew.eisaman@stonybrook.edu
Work Phone: 631-632-8421
Office Location: Light Engineering, 145
Office Hours: Wednesdays 11:00am - 1:00pm, and by appointment, if needed

Course Pre/co-requisites
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

LEARNING OBJECTIVES (satisfies SBC's Understand Technology (TECH) learning objective)
At the end of this course, students will (LO = Learning Outcomes for "Understand Technology"):
1. Know how to solve introductory problems in quantum mechanics (LO1)
2. Understand quantum mechanical concepts relevant to electronic devices (LO2)

COURSE REQUIREMENTS
Attendance and Make Up Policy
Late work will not be accepted. Attendance at all exams is mandatory. In the case of: 1) Verifiable illness, 2) Verifiable family emergency, 3) University-sanctioned religious holiday, or 4) Participation in official University-sponsored events (for documented student athletes only), excuse must be documented on official letterhead (as appropriate) and will be verified by the instructor.

Description and schedule of Required Readings and/or Assignments.
REQUIRED TEXTBOOKS
- Peter Deák, *Essential Quantum Mechanics for Electrical Engineers*, Wiley-VCH, 2017. ISBN-13: 978-3527413553.

OPTIONAL (NOT REQUIRED) TEXTBOOKS

- 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.

SYLLABUS

Week	Dates	Topics	Text Readings
Week 1	1/27,1/29	**Intro:** Classical physics, A Brief History of Quantum Mechanics, Overview of how quantum mechanics is essential to modern technology / engineering	Deák, Ch. 1
Week 2	2/3, 2/5	**Concepts:** Blackbody radiation **Applications:** Incandescent lamps, pyrometers, solar spectrum for photovoltaics	Deák, Ch. 2
Week 3	2/10, 2/12	**Concepts:** The Photoelectric Effect, the Compton Effect, and the quantization of the electromagnetic field (photons) **Applications:** Lasers, LEDs, Photovoltaics	Deák, Ch. 3
Week 4	2/17, 2/19	**Concepts:** Energy quantization (Franck-Hertz experiment) and wave-particle duality of the electron (Davisson-Germer experiment) **Applications:** Discharge Lamps	Deák, Ch. 4
Week 5	2/24, 2/26	**Concepts:** Wave nature of the electron and Heisenberg's Uncertainty Principle **Applications:** Electron behavior in semiconductors (negative differential resistance)	Deák, Ch. 5
Week 6	3/3, 3/5	**Concepts:** The electron wave function, the postulates of quantum mechanics, measurements and observables **Applications:** Quantum communication and quantum key distribution	Deák, Chs. 6,7
Week 7	3/10, 3/12	First half of class: **MIDTERM** Second half of class: The role of measurements and operators in quantum communication and quantum computation	Blackboard postings
SPRING BREAK	3/17, 3/19	**SPRING BREAK**	**SPRING BREAK**
Week 8	3/24, 3/26	**Concepts:** Eigenstates of position, momentum, and energy; Stationary states in a quantum well. **Applications:** Quantum-well LEDs	Deák, Chs. 8,9
Week 9	3/31, 4/2	**Concepts:** Tunneling **Applications:** Field emission, MOSFETs, Zener diodes, resonant tunneling, quantum FETs, quantum cascade lasers, flash memory	Deák, Ch. 10
Week 10	4/7, 4/9	**Concepts:** Hydrogen atom, quantum numbers, electron angular momentum and spin **Applications:** The use of spin and quantum numbers in quantum information processing	Deák, Ch. 11
Week 11	4/14, 4/16	**Concepts:** Many-body systems, the Pauli Principle, chemical properties of atoms **Applications:** Applications of superposition states to future electronics and quantum information processing	Deák, Ch. 12

Week 12	4/21, 4/23	**Concepts:** Quantum mechanics in crystalline materials **Applications:** Electron behavior in semiconductors	Miller, Ch. 8
Week 13	4/30, 5/2	**Concepts:** Quantum measurement and wavefunction collapse, entanglement, teleportation **Applications:** Quantum Information technology: Quantum cryptography, quantum computation, quantum teleportation	Miller, Ch. 18
Week 14	5/5, 5/7	Interpretation of quantum mechanics and its application to real-world device design	Miller, Ch. 19
FINAL EXAM	**TBD**	**FINAL EXAM**	**All topics covered in course**

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.

Comprehension quizzes

At the end of every lecture, we will have a comprehension quiz on the material presented in the lecture. These quizzes are designed to require less than 5 minutes to complete, and are meant to provide feedback to the student and instructor on student comprehension.

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.

GRADING

The course grade will be based on the following components:

Item	Percent
Problem Sets	40
Midterm exam	20
Final exam	30
Comprehension quizzes	10

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

MEETING SCHEDULE

MW 2:30pm - 3:50pm, Frey 226
Mid-term exam: In class, week 7
Final exam: TBD

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.

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, 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.

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.