EEE434/591: Quantum Mechanics

Instructor: Dragica Vasileska

*This course will be taught by **Professor Dragica Vasileska** from Arizona State University, Tempe, AZ. Professor Vasileska received a Ph.D. Degree from Arizona State University in 1995. From 1995 until 1997 she held a Faculty Research Associate position within the Center of Solid-State Electronics Research at Arizona State University. In the Fall of 1997, she joined the faculty of Electrical Engineering at Arizona State University. Her research interests include semiconductor device physics and semiconductor device modeling, with strong emphasis on quantum transport and Monte Carlo device simulations. She is a Fellow of IEEE. Dr. Vasileska has published more than 200 journal publications, over 250 conference proceedings refereed papers, dozens of books and book chapters, and has given numerous invited talks. She is a recipient of 1998 NSF CAREER Award and is an IEEE Fellow.*

Purpose of the Course

The purpose of this course is to deepen students' understanding of Quantum Mechanics. The course will give a brief historical overview and introduce the quantum mechanical wave function and its probabilistic interpretation, using the example of wave packets. The Schrödinger wave equation will be introduced, and solutions will be discussed that are relevant to modern electronic devices. One of the phenomena that will receive special attention is the Tunneling Effect, which allows electrons to "cross" barriers. The course also introduces potentials which electrons experience in ultra-small devices as well as centrally symmetric potentials that help to explain the atomic orbitals of the hydrogen atom. The course will also introduce techniques to approximate solutions of the Schrödinger wave equation as well as the perturbation theory, which helps to find solutions to the wave equation in case of a small disturbance of a well-known potential.

Prerequisites

EEE 241: *Fundamentals of Electromagnetics*; EEE 352 *Properties of Electronic Materials*.

Textbook

D. K. Ferry, *Quantum Mechanics: An Introduction for Device Physicists and Electrical Engineers*, 2nd Edition, Taylor and Francis, New York, NY, 2001. ISBN: 978-0750307253

Grading

Grades will reflect your performance on the homework assignments (30%), two midterms (25% each) and the final exam (25%)

Course Delivery Formats

This is a course with an **online** and a **hybrid** section. Lectures and worked-out problems are web-delivered on **Canvas for both sections**. There are also **weekly Zoom meetings** for the students in both sections.

Weekly Course Topics

Module 1: Radiation and Photoelectric Effect
Module 2: Particles and Waves
Module 3: The Wave Function
Module 4: Operators and Observables
Module 5: The Infinite Well
Module 6: Finite Well Potentials
Module 7: Tunneling Effect
Module 8: The WKB Approximation
Module 9: Hilbert Space and Dirac Notation
Module 10: Harmonic Oscillator
Module 11: The Radial Hamiltonian
Module 12: The Angular Hamiltonian
Module 13: Perturbation Theory, Variational Principle
Module 14: Spin and Entanglement
Module 15: Review

Course Time Commitment

This three-credit course requires approximately 135 hours of work. Please expect to spend around 9 hours each week preparing for and actively participating in this course.