

**EE 3325 - 13353**  
**Applied Quantum Mechanics for Electrical Engineers**  
**Course Syllabus – Fall 2019**

Instructor: Aryzbe Najera, Ph.D.  
[adiaz6@utep.edu](mailto:adiaz6@utep.edu)  
Lecture: LART 108  
Office: E327 and Office Hours:  
Tues. & Thurs. 10:30am – 12:00pm

**Course Description:** An introductory course designed to provide students with a fundamental understanding of (1) electron energy, electron/photon interaction, and electron energy transitions; (2) electromagnetic wave theory and quantization of photon energy; (3) laser theory and operation; and (4) advanced applications such as quantum dots, zener diodes and resonant tunneling diodes. This includes applying boundary conditions to solve the time-independent Schrödinger's equation, normalization of the wave function, and applying fundamental solutions such as the infinite potential well (particle-in-a-box) and finite potential well to laser, quantum dot and tunneling applications.

**Pre-requisites for Course:** PHYS 2421, EE 2350, MATH 2326 and MATH 1312, with grade of "C" or better.

**Textbook:** Class notes, equation sheets, homework problems and corresponding power point presentations for each lecture were specifically designed for this course.

**Course Topics:**

- I. Electrons and Semiconductors
- II. Electromagnetic Waves
- III. Schrödinger Equations and Quantum Applications
- IV. Advanced Applications of Schrödinger Equations: Quantum Dots, Tunneling, Zener Diodes, Resonant Tunneling Diodes

**Course Grade:**

Quizzes	20%
Homework/In-Class Assignments	20%
Midterm Exam	30%
Final Exam	30%

**Dates:**

**NO MAKE-UPS.**

**No late work accepted.**

**Midterm Exam (Parts I and II) – Thurs., Oct. 17<sup>th</sup>, 2019. No make-ups.**

**Final Exam (Comprehensive) – \*\*Thurs., Dec. 5, 2019, 9:00 am - 12:00 pm**

**Learning Outcomes:**

- A. Understand basic fundamental concepts associated with quantum mechanics such as:
  - a. Wave-particle duality
  - b. Quantization of electromagnetic spectrum
  - c. Blackbody radiation
  - d. Planck's constant
  - e. Photoelectric effect
  - f. de Broglie's Relations
  - g. Compton Effect
  - h. 2-slit Experiment
  - i. Wave Packets
  - j. Heisenberg's Uncertainty Principle
  - k. Discrete Energy Values
  - l. Eigenfunctions and Eigenvalues
  - m. Electron orbitals
- B. Understand the wave nature of quantum mechanics as it applies to electromagnetic waves and electrons by being able to:
  - a. calculate the energy, momentum, frequency and wavelength of electromagnetic waves.
  - b. understand constructive and destructive interference.
  - c. recall the wave equation.
  - d. derive the 2<sup>nd</sup> order differential harmonic equation from the wave equation.
  - e. use solutions from the 2-slit experiment to model the interference pattern.

**Grade Scale:**

**A = 90 – 100**

**B = 80 – 89**

**C = 70 – 79**

**D = 60 – 69**

**F = 0 - 59**

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- C. Understand the probabilistic nature of electrons and be able to:
  - a. analyze the 2-slit experiment.
  - b. solve for eigenfunctions from the time-dependent Schrödinger equation
- D. Be able to solve quantum mechanical problems associated with photon-electron interactions such as:
  - a. Electron Energy Transitions
  - b. Compton Effect
  - c. X-Ray Production
  - d. Uncertainty Principle
- E. Be able to use boundary conditions and the time-independent Schrödinger equation to solve quantum mechanical problems such as:
  - a. Infinite Potential Well (Particle-in-a-box)
  - b. Finite Potential Well
  - c. Tunneling Probability
  - d. Particle Confinement
- F. Be able to design and simulate electronic devices using simulation tools located on the nanoHUB.org website such as:
  - a. PN Junctions
  - b. Quantum Dots
  - c. Resonant Tunneling Diodes

**Lecture:**

This course will be taught using active student learning activities to include student-student discussions, group problem solving, and feedback from the instructor. Students are asked to come to class prepared by completing the designated reading assignment for that day. The reading assignments will be correlated with a short lecture which will be used to introduce problem solving methods and reinforce critical concepts. Short lectures (10-15 min) will be linked to team problem solving sessions, and team assignments will be picked up on a daily basis. The lecture is designed to include at least one team activity per lecture. Occasionally, extra credit sessions or quizzes will be based on the reading assignment, and some but not all are listed in the course schedule. Visual teaching tools will be used to reinforce and clarify critical concepts. Several visual tools will come from the [nanoHUB.org website](http://nanoHUB.org) and students are encouraged to register and explore this website during the first week of class. This educational website is supported by the National Science Foundation and is free to all users.

**Homework:**

Two types of homework activities will be assigned and will be worth 20% of the final grade. The first type is team in-class assignments and the second type is homework problems assigned at the end of a section and due the following week.

**Type 1:** Team class assignments: All team members work on an assignment which will be picked up from one random individual per group, and all students present will earn the same grade. Students should work together during these sessions to make sure that all students agree on the method and solution for each problem. Points for in class work will vary depending on the complexity of the assignment. The points for each assignment are included in the class schedule, and are subject to change prior to the date of the assignment.

**Type 2:** Homework activity: Homework will be assigned and will be used to design a learning activity during the following lecture. During the first five minutes of the class period, each group will be assigned roles similar to those listed below and will be given 5 minutes to prepare for their activity. Some examples of group homework activities are listed below.

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- Activity A: Group work (all members turn in work for a grade)  
Activity B: One homework problem (all students have a role)  
Activity C: Similar homework problem or concept (all students have a role)  
Activity D: Students design a problem (all students have a role)

All homework should follow the standard engineering homework format. Homework that does not follow this format will not be accepted. Students should use the front side of the paper only and include no more than 2 problems per page except when indicated otherwise by the instructor.

- Homework Format:
1. Include EE3325, Name, Date
  2. Statement of the problem with each solution
  3. Neat solutions with legible handwriting

All problem solving activities are considered homework assignments and will be worth 20% of the final grade.

**Exams:** The midterm exam is worth 30% of the course grade. The final exam is comprehensive and is worth 30% of the final grade. The final exam will count as a make-up exam for a missed midterm exam, for documented and approved absences only. An equation sheet will be provided for each exam.

**Attendance:** Attendance is mandatory. When absent, the student is responsible for obtaining notes, handouts, and assignments and for meeting the same deadlines as the rest of the class. Excused absences are limited to documented medical emergencies, religious holidays and UTEP sponsored and/or required activities.

**Course Drop Deadline:** The deadline to drop this course with an automatic W is **Nov. 1<sup>st</sup>**.

**Cell Phone and Laptop Policy:** Cell phones are not permitted during the lecture. Laptops may be used during assignments as specified by instructor. Students are required to turn off cell phones before entering the classroom. Cell phones should be placed out of sight (like in a purse or backpack). Students should NOT receive or make any calls/text messages during class. Students using cell phones during class will be asked to leave and will receive a zero for attendance and on all group assignments completed that day.

**Scholastic Integrity:** As an entity of The University of Texas at El Paso, the Department of Electrical and Computer Engineering is committed to the development of its students and to the promotion of personal integrity and self-responsibility. The assumption that a student's work is a fair representation of the student's ability to perform forms the basis for departmental and institutional quality. All students within the Department are expected to observe appropriate standards of conduct. Acts of scholastic dishonesty such as cheating, plagiarism, collusion, the submission for credit of any work or material that are attributable in the whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student, or the attempt to commit such acts will not be tolerated. Any case involving academic dishonesty will be referred to the Engineering Dean's Office and the Office of the Dean of Students. The Dean of Students will assign a Student Judicial Affairs Coordinator who will investigate the charge and alert the student as to its disposition. Consequences of academic dishonesty may be as severe as dismissal from the University. See the Office of the Dean of Students' home page at [www.utep.edu/dos/acadintg.htm](http://www.utep.edu/dos/acadintg.htm) for more information.

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I acknowledge that I have received the syllabus for EE 3325 for the **Fall 2019** semester, and that I understand all attendance and homework requirements.

I also acknowledge that work and absences does not excuse any missed assignments and graded work.

The student is responsible for any missed work.

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**Print Name**

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**Student Signature**

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**Date**