PHYS252-Spring 2025

Quantum Physics and Applications

"Our goals can only be reached through the vehicle of a plan. There is no other route to success."
- Pablo Picasso

Course & Instructor Information

Instructor: **Irene D. Guerinot**
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E-mail: iguerino@utk.edu ***To help me keep track of email messages, please include "PHYS252" in the subject line of any email message you sent to me.***
Office Hours: Virtual (Zoom) by appointment-check my schedule here: https://calendly.com/iguerino
If the listed times are not convenient, get in touch with proposed dates and we will schedule a meeting. Please don't hesitate to email me with updates, questions, or concerns. I will typically respond within 24 hours during the week and 48 hours on the weekend. I will notify you if I will be out of town and if connection issues may delay a response. Please don't hesitate to email me with updates, questions, or concerns. I will typically respond within 24 hours during the week and 48 hours on the weekend. I will notify you if I will be out of town and if connection issues may delay a response.

Lab Teaching Assistant(s)-The lab instructor(s) will announce their office hours on Canvas. There are also in-person tutors available in the Department of Physics tutoring center - Physics Tutorial Center (Nielsen-512). Experienced Physics students (graduate and undergraduate) provide personal attention and assistance. You are more than welcome to use the tutorial center to get help on the learning materials, HW assignments, laboratory work, exams, and so on. For details, please check the link: https://physics.utk.edu/undergraduate/

Course Description

PHYS252 explores the fundamentals of quantum physics and applications to solid state physics, nuclear physics, particle physics, and cosmology. Topics covered include: The nature of photons; Wave particle duality; Application of the Schrödinger Equation to simple steps and barriers; and Models of single- and multi-electron atoms. This course includes a laboratory component that may be incorporated into the class time in a studio physics modality. Basic scientific computing will be incorporated into the course.
Prerequisites: PHYS 231 or 251 with a C or better and MATH 142 with a C or better.
Value Proposition: This course covers the basics relating to the nature of quantum systems, with some applications, presented at a level appropriate for sophomore-level physics and engineering students. The purpose of the course is both to introduce students broadly to concepts related to quantum physics, and to prepare them for PHYS 411 "Introduction to Quantum Mechanics I", PHYS 341 "Introduction to Nuclear Physics", PHYS 342 "Structure of Matter", and PHYS 461 "Modern Physics Laboratory".

Course Format

Learning Environment: This is a fully (asynchronous) online course (lectures & laboratories), which means to complete this course you are not required to travel to campus. You will participate in this course (asynchronously) using Canvas, the University of Tennessee's Learning Management System. The class material is divided into 6 modules. Each week will have assigned readings, supplementary materials (e.g., recorded short video introducing the topic we are studying), and activities (e.g., homework assignments, lab reports, reading summaries, extra credit opportunities, and discussion forums). **Assignments will be due weekly (typically twice a week)**. It depends on the module. Use the Snapshot file (on the Canvas Home Page and on this syllabus) as well as the Calendar function of Canvas to see the big picture!!

Time Commitment: An online course requires discipline, self-motivation, collaboration, and organization. It also requires the same credit hours of work as a face-to-face course. Although there is greater flexibility for "when" you may complete coursework online, there are required due dates (many!). Class participation is required and expected. You should expect to spend between 12 and 16 hours per week working and learning in the course. Please plan your time accordingly. Work is expected to be completed on time. Late assignments are not accepted.

Course Learning Outcomes

Upon completion of this course the students will be able to:

- Understand the nature of photons
- Explore particle-wave duality
- Apply the Schrödinger Equation
- Analyze atomic models
- Examine hydrogen atom structure
- Understand many-electron atoms
- Study statistical physics frameworks
- Investigate solid-state physics fundamentals
- Comprehend nuclear structure & reactions
- Grasp elementary particles & cosmology basics
- Communicate effectively with diverse, scientific and non-scientific audiences

Required Textbooks & Other Resources

- The textbook for this course is *Modern Physics* by Kenneth Krane, published by Wiley. The specific chapters per module, as suggested in the course snapshot found later in the syllabus, correspond to editions 2 and 4—any edition is acceptable!
- Much of the material is covered in the OpenStax University Physics Book Volume 3 at a slightly lower level. Volumes 1 and 2 may be useful to review material related to waves, optics, and special relativity. These books are available in paper copy, or digitally: https://openstax.org/details/books/university-physics-volume-1
- https://openstax.org/details/books/university-physics-volume-2
- https://openstax.org/details/books/university-physics-volume-3
- You must have a computer with a functional webcam, reliable connectivity, and you will need a calculator.

For technical issues, contact the OIT HelpDesk by phone at (865) 974-9900 or at the Walk-in HelpDesk,. For IT and Computing issues, use the online Contact Form. Also: Getting Started with Zoom, Online@UT Canvas, the UT Library, the UT Library's Information for Distance Education, and UT Research Guides and Subject Librarians.

Course Evaluation and Requirements

Homework Assignments (100 points (20% of your grade)): Assignments are designed to reinforce concepts from the online materials and should be submitted via Canvas. You'll have the opportunity to resubmit assignments up to three times for a better score, with your highest submission being the one that counts. Deadlines are typically set for 11:59 PM on the specified date, and please note that late submissions will not be accommodated.

Laboratories (100 points (20% of your grade)): You can find our lab syllabus for Spring 2025 under the Syllabus tab on Canvas. This document outlines our grading policy and what we expect in your lab reports. **Keep in mind that you must secure at least a 60% grade in labs to pass the overall course.**

Class Participation(50 points (10% of your grade)): Engagement in online discussions is essential for participation credit. Active involvement prior to the second homework due date of each module—including labs and extra credit—will ensure full participation points for that module. Feel free to ask questions, provide answers, offer hints, or start discussions on new topics.

Reading Notes (50 points (10% of your grade)): For reading assignments, you'll engage with sections from our textbook or other assigned readings. Take detailed notes on these materials and upload them onto Canvas as

part of your coursework. More information is available on Canvas under the module specific reading notes assignments.

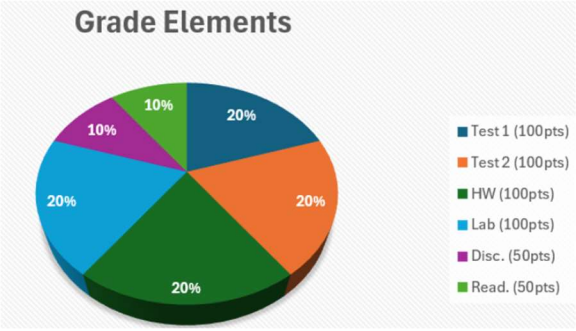
Exams/Tests (100 points per test(20% of your grade each test)): Tests are 90-minute online exams. Test 1 (March 11) questions are about material covered in modules 1 – 3a, and test 2 (May 9) questions are about material covered in modules 3b - 5. You will take the tests online using the Chrome browser with the Proctorio plug-in. Familiarize yourself with this setup by utilizing the Extra Credit Proctorio assignment before exam 1.

Extra Credit Assignments (20+ points - optional but highly encouraged!): These optional tasks are diverse — ranging from computational exercises, research projects, analytical derivations, to creating short podcasts — and I highly encourage you to take advantage of them! Extra credit points will bolster your overall score. Extra credit points are added to your total score from exams, homework, discussion, reading, and lab work.

No late work will be accepted. Remember that each component of this course is structured to enhance your understanding and mastery of physics. Should you have any questions or need further clarification about these requirements or procedures, please do not hesitate to reach out.

Total Points = Test 1% + Test 2% + HW% + Lab% + 0.5*Disc.% + 0.5*Read.% + extra credit points
No grades will be dropped. The final letter grade will be determined using the following breakdown:

Points	Letter Grade
450 and above	A
435-449	A-
415-434	B+
400-414	B
385-399	B-
365-384	C+
350-364	C
335-349	C-
315-334	D+
300-314	D
285-299	D-



How to Be Successful in This Course

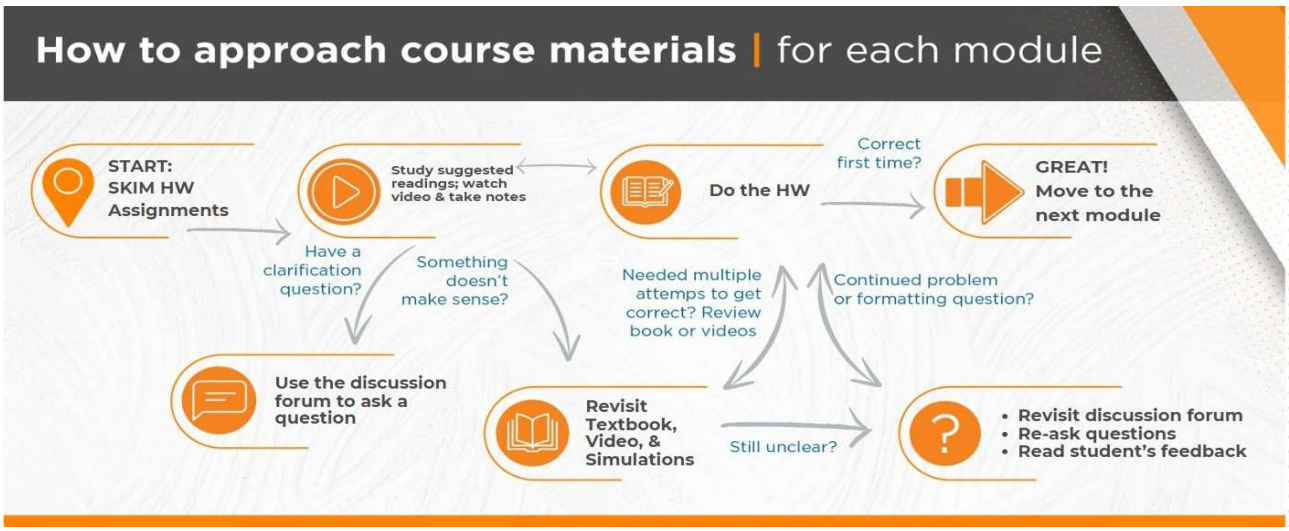
This is an intensive online course. Assignments will typically be due twice a week. Each week will have assigned readings, supplementary materials (e.g., recorded lecture), and activities (e.g., weekly discussion, lab reports, and homework assignments-solving problems). Work is expected to be completed on time. Late assignments are not accepted. So, get organized and manage your time wisely.

- There is some math in this course. Quite a bit actually---but that's good.
- This could be a challenging course if you do not keep up with the material.
- Math is never more than simple algebra and calculus---if you find yourself doing a page of calculations, you are way off the path.
- The hardness is conceptual---and with applying logic.
- When confronted with a problem, recognize the concepts needed for a solution, and then you should know or be able to find the right equation (and then do the algebra in usually just a couple lines).
- Do your homework (yourself)!
- Do the homework in groups!
- Make sure you understand both “why” and “why not.”
- Note all the course graded assignments and exams on your **personal calendar**.
- Read (carefully and take notes) the **textbook and other assigned reading material**!
- **Nail the early material!** Every concept builds on the previous, so it is imperative to get the early material down.
- **Don't get behind!** A Physics course is never a "crammable" course. We will cover a lot of information in a short amount of time. It is impossible to learn this material right before an exam.
- **Check your UT email and Canvas** site every day. Set Canvas notifications.
- I am trying to convince you NOT to take the seemingly easy path of just trying to memorize a trick for every problem you see.

- I am trying to convince you to understand the general approach---that's the way to prepare to deal with problems you've never seen before.
- Ask for help. You might also want to check out the following: How to be Successful in an Online Course.
- Check your UT email and Canvas site regularly.

AI Policy: Permitted in this Course with Attribution

In this course, students are allowed and *infrequently encouraged* to use Generative AI Tools like ChatGPT to support their work. To maintain academic integrity, students must disclose any AI-generated material they use and properly attribute it, including in-text citations, quotations, and references.
A student should include the following statement in assignments to indicate use of a Generative AI Tool: "The author(s) would like to acknowledge the use of [Generative AI Tool Name], a language model developed by [Generative AI Tool Provider], in the preparation of this assignment. The [Generative AI Tool Name] was used in the following way(s) in this assignment [e.g., brainstorming, grammatical correction, citation, which portion of the assignment]."



Course Communication Policy

Netiquette
Please communicate respectfully and clearly with your peers and your instructors on discussion boards, in chats, groups, email, and any other online interactions. Familiarize yourself with UT's Principles of Civility and Community.

Announcements and Email
I will use canvas announcements and email to communicate with the class. Activate your Canvas notification settings and check your UT email regularly (at least once a day) for any communications about the class! I will typically respond within 24 hours during the week and 48 hours on the weekend. I will notify you if I will be out of town and if connection issues may delay a response.

Academic Honesty/Student Conduct
Students are expected to complete their own work. Student work completed for a former class or by someone other than the student could result in disciplinary action.
Students shall not:
- Cheat.
- Plagiarize.
- Collaborate with others on an assignment unless the student is assigned by the instructor to complete group work.
- Allow another student to access your Canvas account using your NetID.

*Please note: The instructor reserves the right to revise, alter or amend this syllabus as necessary. Students will be notified in writing/email of any such changes.

SPRING 2025 PHYS252 – ONLINE

Tentative - Subject to change This syllabus is intended to give the student guidance in what may be covered during the semester and will be followed as closely as possible. However, the professor reserves the right to modify, supplement and make changes as the course needs arise.
Please, see me early on if you have any difficulty.

Timeframe	Module	Topics	Textbook Chapters See Canvas Modules for additional resources		Homework Assignments (A&H), Lab Reports, Discussion, and Extra Credit schedule	Due Date 11:59pm for most) *(Canvas is the ONLY acceptable portal for assignment submission)*
Jan. 21 to Feb. 7	1	Photoelectric effect, Compton scattering. Blackbody radiation, De Broglie hypothesis, Heisenberg uncertainty principle, wave packets. The Schrodinger Equation: boundaries, potential wells, the simple harmonic oscillator.	Krane: 3,4,5 Open: 6, 7		Reading 1, Disc. 1.1	24-Jan
					HW1.1	29-Jan
					HW1.2	5-Feb
					Lab 1, EC1, Disc. 1.2	7-Feb
Feb. 7 to Feb. 21	2	Scattering atoms, Thomson model, Rutherford atom, Bohr model. 1-D atom, wave functions of the H atom, intrinsic spin, spectroscopic notation. Pauli exclusion principle, electronic states, outer electrons, inner electrons.	Krane: 6, 7, 8, 9 Open: 8, 9		Reading 2	12-Feb
					HW2.1	19-Feb
					HW2.2, Lab 2, Disc. 2	21-Feb
Feb. 21 to Mar. 7	3a	Statistical Physics: Classical, Fermi-Dirac, and Bose-Einstein statistics.	Krane: 10		Reading 3a	28-Feb
					HW3.1	5-Mar
					Lab 3, Disc. 3.1	7-Mar
Review-TBD-Your GTA(s) will be in touch **Proctorio Extra Credit (2pts) to make sure Proctorio is working correctly on your computer - available between 2/23 midnight and 3/11 7AM** **Test 1 Discussion Forum (EC assignment-2pts) available between 2/23 midnight and 3/11 7AM / Test 1 ONLINE Proctorio - March 11th / 7am-11:30pm / 90 minutes**						
SPRING BREAK – NO CLASSES – March 17-21						
Mar. 7 to Mar. 28	3b	Solid State Physics: Crystals, band theory, superconductivity, semiconductors.	Krane: 11 Open: 9		Reading 3b, HW3.2	26-Mar
					EC3, Disc. 3.2	28-Mar
Mar. 28 to Apr.16	4	Nuclear history, nuclear structure: gross properties of nuclei, nuclear force, radioactive decay. Fission, fusion, nucleosynthesis.	Krane: 12, 13 Open: 10		Reading 4	2-Apr
					HW4.1	4-Apr
					HW4.2, Lab 4.1	11-Apr
					Lab 4.2, EC4, Disc. 4	16-Apr
Apr. 16 to May 2	5	Forces of nature, the standard model. Expansion of the Universe, the cosmic microwave background, black holes. **No classes Apr. 17 & 18**	Krane: 14, 15, 16 Open: 11		Reading 5	23-Apr
					HW5.1	23-Apr
					HW5.2	23-Apr
					Lab 5, EC5, Disc. 5	2-May
Review-TBD-Your GTA(s) will be in touch May 8=Study Day **Test 2 Discussion Forum (EC assignment-2pts) available between 4/21 midnight and 5/9 7AM** **Test 2 ONLINE Proctorio - May 9th / 7am-11:30pm / 90 minutes**						

Additional Student Resources

Open Records Act
This course adheres to the University's policy regarding the use and release of student records that are governed by Public Law 93-380, the Family Educational Rights and Privacy Act and the Tennessee Public Records Act, which charges the University and its employees with protecting the confidentiality of the educational records or its prospective, current and former students. One way this affects you is that the professor cannot share or discuss grades via email.

Students with Disabilities
Students with documented disabilities should notify the instructor immediately to discuss requests for special provisions. Students who have a disability that requires accommodations should make an appointment with the Office of Disability Services, 2227 Dunford Hall, (974-6087) to discuss specific needs and get official documentation of the disability.

College of Arts & Sciences Diversity Statement
"The College of Arts and Sciences at the University of Tennessee believes in the value of diversity…. We are committed to creating a vibrant multicultural, multi-ethnic community where diverse students, faculty, and staff are recruited and retained and where diversity scholarship is respected…"

UT ODS Disability Statement
"Any student who feels he or she may need accommodation based on the impact of a disability should contact the Office of Disability Services (ODS) at 865-974-6087 in 100 Dunford Hall to document their eligibility for services. ODS will work with students and faculty to coordinate reasonable accommodations for students with documented disabilities."

University Civility Statement
Civility is genuine respect and regard for others: politeness, consideration, tact, good manners, graciousness, cordiality, affability, amiability, and courteousness. Civility enhances academic freedom and integrity and is a prerequisite to the free exchange of ideas and knowledge in the learning community. Our community consists of students, faculty, staff, alumni, and campus visitors. Community members affect each other's being and have a shared interest in creating and sustaining an environment where all community members and their points of view are valued and respected. Affirming the value of each member of the university community, the campus asks that all its members adhere to the principles of civility and community adopted by the campus: http://civility.utk.edu/.

Academic Integrity
"An essential feature of Tennessee, Knoxville, is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student at the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity."

Academic Dishonesty
This course adheres to the university's Academic Standards of Conduct and Honor Statement, as presented in the student handbook Hilltopics. All students are expected to be honorable and to observe standards of conduct appropriate to a community of students and scholars. All work in this course should be **the original work of the student**. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course, dismissal from the program and dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. Scholastic dishonesty includes **plagiarism**, which according to Webster is: "to take (ideas, writings, etc.) from (another) and pass them off as one's own." Therefore, handing in work that contains material written by someone else, whether it is a current or former student, or a secondary source and presenting it as your own efforts is a clear example of plagiarism.

Please review the Campus Syllabus for information that is common across all courses at UT.