

Course Syllabus

Course Information

<i>Course Number/Section</i>	PHYS4352.001.23F
<i>Course Title</i>	Concepts of Modern Physics
<i>Credits</i>	3
<i>Term</i>	Fall 2023
<i>Days and times:</i>	Mon/Wed 10:00 am – 11:15 am
<i>Location:</i>	SLC 2.304

Professor Contact Information

<i>Professor</i>	Xiaoyan Shi
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<i>Office Location</i>	SCI B.134
<i>Online Office Hours</i>	Wednesdays 1-2 pm, and by appointment via email/ MS Teams

Teaching Assistant Contact Information

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<i>Office Location</i>	SCI 3.257
<i>Online Office Hours</i>	Mondays 1-2 pm, and by appointment via email/ MS Teams

Course Pre-requisites, Co-requisites, and/or Other Restrictions

Pre-requisite: PHYS 4302 (Quantum Mechanics II). If a course equivalent to PHYS 4302 has not yet been taken or is being taken concurrently, please ask the professor for permission to take PHYS 4352.

Course Description

A 3 credit hour course applying basic principles of quantum mechanics, statistical physics, and special relativity to modern topics in physics, such as atomic & molecular physics, solid-state physics, quantum optics, nuclear physics, and elementary particle physics. Topics may vary according to student interest.

Student Learning Objectives/Outcomes

Upon completing this course, students will develop an understanding of:

1. Quantum statistical mechanics and applications to photons, lasers, and properties of crystals
2. Fundamental theory of electrical conduction in semiconductors and metals
3. Macroscopic quantum phases such as superconductivity
4. Special relativity and principle of invariance
5. General principles of symmetry in physics
6. Basic principles of quantum field theoretical methods

Required Textbooks and Materials

UTD library reserved textbooks

We have online or physical access to both textbooks (including required and suggested ones listed below) on UTD library. For physical books, only one user can use them at a time. All students in this class have access to ebook and a scanned chapter of the physical book. The link to the reserved book(s) is listed on “eLearning” website >>Phys4352 course page >> Library reserved materials.

Required Texts

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2nd edition) by Eisberg and Resnick (John Wiley & Sons, ISBN 978-0-471-87373-0)

(Chapter 11 of this book is available in the library reservation, see link above)

Required Materials

calculator with trigonometry functions, but without web access capability

Suggested Readings/Texts

The Feynman Lectures on Physics (on reserve at McDermott Library)

Textbooks and some other bookstore materials can be ordered online or purchased at the [UT Dallas Bookstore](#).

Technical Requirements

In addition to a confident level of computer and Internet literacy, certain minimum technical requirements must be met to enable a successful learning experience. Please review the important technical requirements on the [Getting Started with eLearning](#) webpage.

Academic Calendar

- Calendar is listed below (tentative schedule. 3-1, 3-2 et al. are the sections of the recommended textbook)
- Topics and time may change as we go along to match student interests

Date	Lecture	Reading Guide
08/21	Course description, Review of Quantum Mechanics	3-1, 3-2, 3-4
08/23	Uncertainty Principle, Two Identical Particles	3-3, 3-5, 9-1, 9-2, 11-1, 11-2
08/28	Many Identical Particles: Planck Distribution	11-7 to 11-9
08/30	Bosons	11-3 to 11-6, 11-8 to 11-10
09/04	Labor day (no class)	
09/06	Lasers: General Theory	11-7
09/11	Lasers: Practical	
09/13	Fermions and the Exclusion Principle	9-3, 9-4
09/18	Ground State of Many Identical Fermions	11-11
09/20	Electrons in Crystals: Bloch Waves	13-1, 13-2, 13-6
09/25	Electrical Conduction in Metals	13-4, 13-5
09/27	Electron Energy Bands in Crystals	13-3, 13-7
10/02	Semiconductors	13-9, 13-10
10/04	Superconductivity (phenomena)	14-1
10/09	Superconductivity (theory)	

10/11	Midterm exam (75 minutes)	
10/16	Transformations, Invariance, and Symmetry	
10/18	Symmetry Breaking	
10/23	Symmetry Breaking and Phase Transitions	
10/25	Special Relativity: Lorentz Transformations & Symmetry	A-1 to A-9
10/30	Space-Time and Relativistic 4-vectors	A-9 to A-17
11/01	Relativistic Momentum and Energy	
11/06	Fancy Notation: Covariance and Contravariance	
11/08	Gauge Transformations and U(1) Symmetry	18-3, 18-4, 18-6
11/13	Simple Relativistic Quantum Mechanics	17-4
11/15	Quantum Fields and Particles: 2nd Quantization	
11/27	Student presentations	
11/29	Student presentations	
12/04	Student presentations	
12/06	Student presentations	

Grading Policy

35% Homework; 15% Midterm Exam; 10% Class Participation & Attendance; 40% Term Paper and Presentation. Final grade is a sum of aforementioned items.

Grades: A (90 and above), B (80-89.9), C (70-79.9), D (60-69.9), F (below 60). Each grade (except F), for example grade A, has three finer grades: A- (90-93.2), A (93.3-96.5), A+ (96.6 and above).

Course Policies

Homework

1. There will usually be one homework assignment each week, handed out and due on Wednesdays, except for the week preceding an exam. Homework assignments and solutions will be posted on the eLearning website for this course. Students may work together on homework assignments, but what you turn in should be an honest reflection of your own understanding.
2. Homework is due on the date specified.
3. Please upload your homework onto elearning.
4. Homework can be in Word, Latex, PDF, or JPG format. If you use phone or scanner to scan your work, please make sure it is clear and legible.
5. Late homework will be accepted with reasonable explanation before solutions are posted on eLearning. NOT accepted for any reason after solutions are posted on eLearning.

Online Exam

1. There will be one online exam, tentatively scheduled on **10/11/2023**. The test score will be reported as mid-term score.
2. Make-up Exam will be allowed only in emergency cases beyond the student's control. Proof must be supplied to document the emergency.
3. Calculators will be necessary for exam. Any calculators that have internet access will not be allowed in the exams. A scientific calculator that has trig functions should be sufficient for the exam.
4. You must show all work for exam problems (excluding multiple choice questions) to receive partial credits.
5. Exams will cover both in-class examples and homework.

6. You will be allowed to bring one 8.5" x 11" piece of paper with whatever you wish written on both sides to the Exam. This paper is the only information you may bring to the exam.
7. Except the computer used for online exam, no phones of any kind or any devices with internet access are allowed to be used during exams.

Term Paper and Presentation

1. Instead of a final exam, there will be a required term paper, due on **12/06/2023**, and an accompanying in-class (online) presentation, to be given during the last few classes. Each student must do his/her own term paper and presentation. The topic of the term paper and presentation will be on the physics of any Nobel Prize in Physics awarded since 1960 to present year. No two students may choose the same Nobel Prize; choice will be first-come, first-served. Details of the term paper and presentation requirements will be posted on the eLearning site for this class.
2. Late term paper will not be accepted.
3. In-class (online) presentation is required on the date scheduled. No make-ups.

Class Participation and Attendance

1. Attendance and interactions (questions, discussions) are strongly encouraged during lectures, and especially at the student presentations. Please be aware that it is highly unlikely that you do well in the class without regular attendance at lectures.
2. Attendance is REQUIRED during the student presentations, whether or not you are scheduled to present in that class. These will be the only classes where the instructor will take attendance. Participation in questions and discussions during student presentations will count towards grade.

Class Notes

1. You can go to the course under eLearning and download lecture notes that form part (but NOT ALL) of the lectures. Lecture notes are generally available by the day after the lecture has been given. Be careful these lectures are not complete and will not be enough to pass the class.
2. The reading assignment includes the relevant sections from the chapters given above and the lecture notes available on eLearning. Therefore, it is best if you do the **reading before the lecture**.

Comet Creed

This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

“As a Comet, I pledge honesty, integrity, and service in all that I do.”

Academic Support Resources

The information contained in the following link lists the University's academic support resources for all students.

Please go to [Academic Support Resources](#) webpage for these policies.

UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus.

Please go to [UT Dallas Syllabus Policies](#) webpage for these policies.

Classroom Conduct Requirements Related to Public Health Measures

UT Dallas will follow the public health and safety guidelines put forth by the Centers for Disease Control and Prevention (CDC), the Texas Department of State Health Services (DSHS), and local public health agencies that are in effect at that time during the Fall 2021 semester to the extent allowed by state governance. Texas Governor Greg Abbott's Executive Order [GA-38](#) prohibits us from mandating vaccines and face coverings for UT Dallas employees, students, and members of the public on campus. However, we strongly encourage all Comets to get vaccinated and wear face coverings as recommended by the CDC. Check the [Comets United: Latest Updates webpage](#) for the latest guidance on the University's public health measures. Comets are expected to carry out [Student Safety](#) protocols in adherence to the Comet Commitment. Unvaccinated Comets will be expected to complete the [Required Daily Health Screening](#). Those students who do not comply will be referred to the Office of Community Standards and Conduct for disciplinary action under the [Student Code of Conduct – UTSP5003](#).

COVID-19 Resources

[Comets United webpage](#): check frequently

[FAQ](#): check out the FAQs and reach out to your instructor or academic advisor if answers are not included

[Student Resources](#): a variety of resources are available to help students to obtain counseling, health care, and academic support.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.