

PHY225 The Quantum Universe

Gustavus Adolphus College Spring 2021

Instructor: Dr. Steven Mellema

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Textbook: *Modern Physics for Scientists and Engineers* (2nd Edition), by Taylor, Zafiratos and Dubson

Course Policy and Evaluation:

1. **Class Meetings and Reading Assignments:** The class will meet five days a week from 11:30 am-12:20 pm. Class meetings will be either in person or online via Zoom meeting. Usually, four periods per week will be used for lecture, recitation or homework review. Class periods on the fifth day will be used for group problem-solving sessions or for exams. Attached is a daily calendar of all activities and reading assignments for the course. When reading assignments are made for a class session, the **reading is expected to be completed before coming to the class.**
2. **“Lectures”:** The lectures for this course **will not** be used simply to repeat material covered in the textbook. I will assume that each student is capable of reading and understanding the textbook, which has been chosen for its clarity and completeness of presentation. (Of course, questions about areas that were unclear when you read the textbook are always encouraged during class time!) Class time will be spent exploring in greater depth the concepts introduced in the textbook using demonstrations, discussion, and “Conceptests”. We will also devote time to examining and developing problem-solving techniques through additional worked examples.
3. **Pre-class, Online Reading Quizzes:** On each class day for which a reading assignment is given on the calendar, each student is required to take an online quiz to demonstrate that he/she has read and obtained a basic understanding of the material in the textbooks for the next lecture.

These quizzes will be conducted using the WebAssign program (accessible at webassign.net). The day’s reading quiz may be accessed at least 24 hours in advance, and **must be completed 15 minutes before class starts, i.e. at 11:15 am.**

You will need to purchase a WebAssign code, either from the Book Mark or online at webassign.net. The WebAssign class key for this course is: **gustavus 3923 8227**. (You can use WebAssign for 10 days before purchasing and entering the registration code.)

Each student should self-enroll at webassign.net for the course PHY225-001 using that class key.

4. **Use of Moodle:** The course Moodle site is the main communications platform for this class, and should be accessed several times a week. Students will be held responsible for informing themselves of all announcements/assignments made via Moodle.
5. **Homework:** Homework problems will be due approximately once per week, and written solutions are due at the beginning of class on the assigned date. (See the complete list of homework assignment due dates in the calendar below.) Late homework may be accepted at the discretion of the instructor with a reduction in credit of 20% per week.
6. **Group Problem Solving:** Approximately once per week, students will work in assigned groups of three or four to solve difficult problems in a cooperative-learning setting. These sessions will require each group to submit a solution in a particular format, using the five-step physics problem-solving method previously taught. The entire group will receive one grade for their solution, with the grade depending on adherence to the problem-solving method.
7. **Attendance:** Regular attendance at all class meetings is expected. Students will be held responsible for informing themselves of all announcements/assignments made in class.
8. **Exams:** There will be four one-hour exams and a two-hour final exam. The date for each of the exams is given in the calendar below. Students must arrange in advance to take an exam at other than the scheduled time, and may do so only for a valid health or school-related reason.
9. **Evaluation :**

Homework	25%
Online Reading Quizzes	10%
Group Problem Solutions	10%
Hour Exams	10% each
<u>Final Exam</u>	<u>15%</u>
Total	100%

Assignment of final letter grades will be based upon the following guidelines:

	B+ = 86-90%	C+ = 74-78%	D+ = 62-66%
A = 94-100%	B = 82-86%	C = 70-74%	D = 58-62%
A- = 90-94%	B- = 78-82%	C- = 66-70%	

10. **Incompletes :** A grade of incomplete will only be given for work not completed due to circumstances beyond the control of the student.
11. **Alignment with MN Teacher Education Standards:** This course fulfills some of the requirements for a MN Teaching License. A list of these standards, and the content within this course can be found at <https://gustavus.edu/physics/Syllabi.php>
12. **Academic Honesty:** Having signed and agreed to abide by the College's Honor Code, students thereby pledge that, in all academic exercises and examinations, they shall submit their own work. In the context of this course, students are expected to collaborate and to discuss their out-of-class assignments. However, submitting under one's own name work that is merely copied from another is a violation of the Honor Code. Furthermore, seeking outside assistance during exams is expressly

forbidden. A full description of the Academic Honesty Policy and the Honor Code can be found in the Academic Catalog (online at: www.gustavus.edu/general_catalog/current/acainfo).

13. **Requesting Accommodations:** Gustavus Adolphus College is committed to ensuring equitable and inclusive learning environments for all students. If you have a disability and anticipate or experience barriers to equal access, please speak with the accessibility resources staff about your needs. A disability may include mental health, attentional, learning, chronic health, sensory, physical, and/or short-term conditions. Students with a documented elevated risk of COVID-19 may also request academic accommodations. Accommodations cannot be made retroactively; therefore, to maximize your academic success at Gustavus, please contact them as early as possible. Accessibility resources staff are located in the Academic Support Center (<https://gustavus.edu/asc/accessibility/>) (x7138). Accessibility Resources Coordinator, Corrie Odland, (codland@gustavus.edu), can provide further information.
14. **Social Distancing:** I expect that students will comply with “social distancing” rules regarding acceptable distance (no less than six feet) from other students and the instructor, as well as with rules regarding staged entering and exiting classrooms and passing through hallways, as an expectation of the College and this class. As your faculty instructor, I will not create activities or conditions that will require you to be within 6 feet of another, except during “pass-by” or “transitional movement” occurrences. Although we will be conducting small group work in this class, I expect that you will meet with your group remotely OR in a location where every group member can abide by social distancing guidelines.
15. **Food and Beverages in Classrooms and Laboratories:** No food will be permitted in classrooms during the spring 2021 semester unless there is a medical accommodation. These restrictions are based on the risk that happens when removing a face covering to eat and drink.
16. **Copyright and Recording:** Recordings and videos of the class, produced as part of class instruction, are not to be posted or distributed in any format or on any platform without the written consent of the instructor. Posting any class recordings or materials (including excerpts and clips) to external sites or to social media will be considered a violation of this policy.

Some class materials may be copyrighted. Access to these materials is restricted to students registered for the class. These materials may not be reproduced, shared, or distributed by students, and are made available only to those currently enrolled in this class. If a tutor needs access to these materials in order to provide you with academic support, please ask your instructor for assistance.

17. **Help for Multilingual Students:** Some Gusties may have grown up speaking a language (or languages) other than English at home. If so, we refer to you as “multilingual.” Your multilingual background is an incredible resource for you, and for our campus, but it can come with some challenges. You can find support through the Center for International and Cultural Education’s (<https://gustavus.edu/cice/>) Multilingual and Intercultural Program Coordinator (MIPC), Pam Pearson (ppearson@gustavus.edu). Pam can meet individually for tutoring in writing, consulting about specific assignments, and helping students connect with the College’s support systems. If you want help with a specific task (for example, reading word problems on an exam quickly enough or revising grammar in essays), let your professor and Pam know as soon as possible. In addition, the Writing Center (<https://gustavus.edu/writingcenter/>) offers tutoring from peers (some of whom are themselves multilingual) who can help you do your best writing.

FEBRUARY 2021

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
1 WEEK	1 Classes begin; Syllabus and Introduction	2 Time Dilation	3 Length Contraction	4 Velocity Addition	5 Group Problem: Relativistic Kinematics	6/7
	Read: Sections 1.1-1.6	Sections 1.7-1.9	Sections 1.10-1.12	Sections 1.13-1.14		
2 WEEK	8 Relativistic Momentum Chapter 1 Homework due	9 Relativistic Mass-Energy	10 Classical Limits	11 General Relativity	12 Group Problem: Relativistic Dynamics	13/14
	Read: Sections 2.1-2.4	Sections 2.5-2.7	Sections 2.8-2.9	Sections 2.10-2.11		
3 WEEK	15 <i>World Within World</i> Chapter 2 Homework due	16 Atomic Theory	17 Experimental Confirmation	18 The Nuclear Atom	19 Hour Exam #1 (Chapters 1-2)	20/21
	Read: Sections 3.1-3.5	Sections 3.6-3.9	Sections 3.10-3.11	Sections 3.12-3.13		
4 WEEK	22 Quantization Chapter 3 Homework due	23 Wave-Particle Duality	24 Atomic Spectra	25 Other Evidence for Quantization	26 Group Problem: Quantization	27/28
	Read: Sections 4.1-4.5	Sections 4.6-4.7	Sections 5.1-5.6	Sections 5.7-5.10		

MARCH 2021

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
WEEK 5	1 Matter Waves Chapters 4-5 Homework due Read: Sections 6.1-6.3	2 Wave Functions Sections 6.4-6.6	3 Wave Packets and Uncertainty Sections 6.7-6.8	4 Velocity of a Wave Packet Sections 6.9-6.10	5 Group Problem: Matter Waves	6/7
WEEK 6	8 No Class: First Quarter Break Read:	9 No Class: First Quarter Break	10 Schrödinger Equation Chapter 6 Homework due Sections 7.1-7.5	11 One-Dimensional Examples Sections 7.6-7.7	12 Harmonic Oscillator Sections 7.8-7.9	13/14
WEEK 7	15 Hour Exam #2 (Chapters 3-6) Read:	16 Quantum Tunneling Sections 7.10-7.11	17 Three Dimensions Chapter 7 Homework due Sections 8.1-8.3	18 Central Force Problem in Three Dimensions Sections 8.4-8.5	19 The Hydrogen Atom Sections 8.6-8.8	20/21
WEEK 8	22 Atomic Shells Read: Sections 8.9-8.10	23 Group Problem: Schrödinger Equation	24 Electron Spin Chapter 8 Homework due Sections 9.1-9.5	25 The Zeeman Effect Sections 9.6-9.8	26 Multielectron Atoms Sections 10.1-10.5	27/28
WEEK 9	29 The Periodic Table Read: Sections 10.6-10.9	30 Group Problem: Atomic Physics	31 Atomic Transitions Chapters 9-10 Homework due Sections 11.1-11.4			

APRIL 2021

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
9 WEEK				1 Time-Dependent Perturbation Theory	2 No Class: Easter Break	3/4
	Read:			Section 11.5		
10 WEEK	5 Selection Rules	6 Lasers	7 Molecules Chapter 11 Homework due	8 Semi-conductors	9 Super-conductors	10/11
	Read Sections 11.6-11.8	Sections 11.9-11.10	Sections 12.1-12.5	Sections 14.1-14.4	Sections 14.7-14.8	
11 WEEK	12 Hour Exam #3 (Chapters 7-11)	13 <i>Knowledge or Certainty</i>	14 Nuclear Properties Chapters 12-14 Homework due	15 The Liquid Drop Model	16 The Shell Model	17/18
	Read		Sections 16.1-16.4	Sections 16.5-16.7	Sections 16.8-16.9	
12 WEEK	19 Radioactivity	20 Nuclear Reactions Chapter 16 Homework due	21 Fission and Fusion	22 <i>The Manhattan Project</i>	23 Radiation Safety	24/25
	Read Sections 17.1-17.4	Sections 17.5-17.6	Sections 17.7-17.9	Sections 17.10-17.11	Sections 17.12-17.13	
13 WEEK	26 Group Problem: Nuclear Physics	27 Elementary Particles Chapter 17 Homework due	28 Fundamental Forces (MayDay Schedule)	29 Quantum Exchange Models	30 Particle Accelerators	
	Read	Sections 18.1-18.3	Sections 18.4-18.7	Sections 18.8-18.9	Sections 18.10-18.11	

MAY2021

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
						1/2
Read						
14	3 Hour Exam #4 (Chap. 12-17)	4 Looking Back: The Cosmic Universe Chapter 18 Homework due	5 Looking Forward: Supersymmetry?	6 Final Exam Review	7 No Class: Reading Day	8/9 Final Exam: 1:00-3:00 PM
WEEK						
	10	11	12	13	14	15/16