

PHY225 The Quantum Universe

Gustavus Adolphus College Spring 2022

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 2730 1906**. (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. **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.
15. **Departmental Expectations:** As is expected in any course in the physics department, each student is asked to work, along with the instructor and their student peers, to develop a culture of cooperation and inclusion within our department. The physics major can be challenging, and we all need the respect and support of others. While it would be unreasonable to assume that every single person will develop a close working relationship with every other, it is expected that each individual will be supportive of, and a positive influence on, every member of the departmental community that they encounter..

FEBRUARY 2022

subject

QUANTUM UNIVERSE

period

4

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

MARCH 2022

subject

QUANTUM UNIVERSE

period

4

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

APRIL 2022

subject

QUANTUM UNIVERSE period

4

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
WEEK 8					1 The Periodic Table	2/3
					Sections 10.6-10.9	
WEEK 9	4 Atomic Transitions Chapters 9-10 Homework due	5 Time-Dependent Perturbation Theory	6 Selection Rules	7 Lasers	8 Molecules Chapter 11 Homework due	9/10
	Sections 11.1-11.4	Section 11.5	Sections 11.6-11.8	Sections 11.9-11.10	Sections 12.1-12.5	
WEEK 10	11 Semi-conductors	12 Super-conductors	13 Hour Exam #3 (Chap. 8-11)	14 <i>Knowledge or Certainty</i>	15 No Class: Easter Recess	16/17
	Sections 14.1-14.4	Sections 14.7-14.8				
WEEK 11	18 Nuclear Properties Chapters 12-14 Homework due	19 The Liquid Drop Model	20 The Shell Model	21 Group Problem: Nuclear Structure	22 Radioactivity	23/24
	Sections 16.1-16.4	Sections 16.5-16.7	Sections 16.8-16.9		Sections 17.1-17.4	
WEEK 12	25 Nuclear Reactions Chapter 16 Homework due	26 Fission and Fusion	27 <i>The Manhattan Project</i> MayDay! Schedule	28 Radiation Safety	29 Group Problem: Nuclear Reactions	30
	Sections 17.5-17.6	Sections 17.7-17.9	Sections 17.10-17.11	Sections 17.12-17.13		

MAY2022

subject

QUANTUM UNIVERSE period

4

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
						1
	Read					
13	2 Elementary Particles Chapter 17 Homework due	3 Fundamental Forces	4 Quantum Exchange Models	5 Particle Accelerators	6 Group Problem: Elementary Particles	7/8
WEEK	Read Sections 18.1-18.3	Sections 18.4-18.7	Sections 18.8-18.9	Sections 18.10-18.11		
14	9 Looking Back: The Cosmic Universe Chapter 18 Homework due	10 Looking Forward: Supersymmetry?	11 Hour Exam #4 (Chap. 12-18)	12 Final Exam Review	13 No Class: Reading Day	14/15
WEEK						
	16 8:00-10:00 am: Final Exam (Comprehensive)	17	18	19	20	21/22
	23	24	25	26	27	28/29