

PHY225 The Quantum Universe

Gustavus Adolphus College Spring 2020

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 10:30-11:20 am. 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 10:15 am.**

When you registered at webassign.net for the Cosmic Universe course, you used the multi-term access code that came bundled with your Serway textbook. That code should still be valid, along the class key for this course: **gustavus 9928 7508**

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

4. **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.
5. **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 technique (adherence to the problem-solving method) as well as the answer.
6. **Attendance:** Regular attendance at all class meetings is expected. Students will be held responsible for informing themselves of all announcements/assignments made in class.
7. **Use of Electronic Devices in Class:** The use of cellular phones, tablets, and laptop computers during the lectures is prohibited. Exceptions may be made to accommodate student accessibility.
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, examinations, papers, and reports, they shall submit their own work. Footnotes, or some other acceptable form of citation must accompany any use of another's words or ideas. 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. (Full

descriptions of the Academic Honesty Policy and the Honor Code can be found in the Academic Catalog, online at https://gustavus.edu/general_catalog/current/acainfo. For more information about the Honor Code, contact Dean Valerie Banschbach (vbanschbach@gustavus.edu or x7541).

13. **Accessibility Resources:** 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. When appropriate, staff will guide students and professors in making accommodations to ensure equal access. 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/care/accessibility/>). Accessibility Resources Coordinator, Katy Clay, (clayk@gustavus.edu) (x7227), 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), Carly Overfelt (overfelt@gustavus.edu). Carly 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 Carly 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 2020

SUBJECT The Quantum Universe PERIOD 3

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
						1/2
	3 No Class – Touring Week	4 No Class – Touring Week	5 No Class – Touring Week	6 No Class – Touring Week	7 No Class – Touring Week	8/9
1 WEEK	10 Classes begin; Syllabus and Introduction Sections 1.1-1.6	11 Time Dilation Sections 1.7-1.9	12 Length Contraction Sections 1.10-1.12	13 Velocity Addition Sections 1.13-1.14	14 Group Problem: Relativistic Kinematics	15/16
2 WEEK	17 Relativistic Momentum Chapter 1 Homework due Sections 2.1-2.4	18 Relativistic Mass-Energy Sections 2.5-2.7	19 Classical Limits Sections 2.8-2.9	20 General Relativity Sections 2.10- 2.11	21 Group Problem: Relativistic Dynamics	22/23
3 WEEK	24 Chapter 2 Homework due <i>World Within World</i> Sections 3.1-3.5	25 Atomic Theory Sections 3.6-3.9	26 Experimental Confirmation Sections 3.10- 3.11	27 The Nuclear Atom Sections 3.12- 3.13	28 Hour Exam #1 (Chapters 1-2)	29

MARCH 2020

SUBJECT The Quantum Universe PERIOD 3

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
						1
WEEK 4	2 Quantization Chapter 3 Homework due	3 Wave-Particle Duality	4 Atomic Spectra	5 Other Evidence for Quantization	6 Group Problem: Quantization	7/8
	Sections 4.1-4.5	Sections 4.6-4.7	Sections 5.1-5.6	Sections 5.7-5.10		
WEEK 5	9 Matter Waves Chapters 4-5 Homework due	10 Wave Functions	11 Wave Packets and Uncertainty	12 Velocity of a Wave Packet	13 Group Problem: Matter Waves	14/15
	Sections 6.1-6.3	Sections 6.4-6.6	Sections 6.7-6.8	Sections 6.9-6.10		
WEEK 6	16 Schrödinger Equation Chapter 6 Homework due	17 One- Dimensional Examples	18 Harmonic Oscillator	19 Quantum Tunneling	20 Hour Exam #2 (Chapters 3-6)	21/22
	Sections 7.1-7.5	Sections 7.6-7.7	Sections 7.8-7.9	Sections 7.10-7.11		
WEEK 7	23 Three Dimensions Chapter 7 Homework due	24 Central Force Problem in Three Dimensions	25 The Hydrogen Atom	26 Atomic Shells	27 Group Problem: Schrödinger Equation	28/29
	Sections 8.1-8.3	Sections 8.4-8.5	Sections 8.6-8.8	Sections 8.9-8.10		
WEEK 8	30 Electron Spin Chapter 8 Homework due	31 The Zeeman Effect				
	Sections 9.1-9.5	Sections 9.6-9.8				

APRIL 2020

SUBJECT The Quantum Universe PERIOD 3

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
WEEK 8			1 Multielectron Atoms Sections 10.1-10.5	2 The Periodic Table Sections 10.6-10.9	3 Group Problem: Atomic Physics	4/5
WEEK 9	6 No Class – Spring Break	7 No Class – Spring Break	8 No Class – Spring Break	9 No Class – Spring Break	10 No Class – Spring Break	11/12
WEEK 10	13 No Class – Spring Break	14 Atomic Transitions Chapters 9-10 Homework due Sections 11.1-11.4	15 Time-Dependent Perturbation Theory Section 11.5	16 Selection Rules Sections 11.6-11.8	17 Lasers Sections 11.9-11.10	18/19
WEEK 11	20 Molecules Chapter 11 Homework due Sections 12.1-12.4	21 Semi-conductors Sections 14.1-14.4	22 Super-conductors Sections 14.7-14.8	23 Group Problem: Atoms, Molecules and Solids	24 Hour Exam #3 (Chapters 7-11)	25/26
WEEK 12	27 Knowledge or Certainty Chapters 12-14 Homework due	28 Nuclear Properties Sections 16.1-16.4	29 The Liquid Drop Model (Mayday Schedule) Sections 16.5-16.7	30 The Shell Model Sections 16.8-16.9		

MAY 2020

SUBJECT The Quantum Universe PERIOD 3

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN
WEEK 11					1 Radioactivity	2/3
					Sections 17.1-17.4	
WEEK 12	4 Nuclear Reactions Chapter 16 Homework due	5 Fission and Fusion	6 <i>The Manhattan Project</i>	7 Radiation Safety	8 Group Problem: Nuclear Physics	9/10
	Sections 17.5-17.6	Sections 17.7-17.9	Sections 17.10-17.11	Sections 17.12-17.13		
WEEK 13	11 Elementary Particles Chapter 17 Homework due	12 The Fundamental Forces	13 Quantum Exchange Models	14 Particle Accelerators	15 Hour Exam #4 (Chap. 12-17)	16/17
	Sections 18.1-18.3	Sections 18.4-18.7	Sections 18.8-18.9	Sections 18.10-18.11		
WEEK 14	18 Chapter 18 Homework due Looking Back: The Cosmic Universe	19 Looking Forward: Supersymmetry?	20 Final Exam Review	21 No Class - Reading Day	22	23/24
	25 Final Exam 1:00-3:00 PM	26	27	28	29	30/31