Physics 2710: Introductory Modern Physics

Term: Fall 2020

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Syllabus

What Introductory Modern Physics is About

The so-called "modern world" began to emerge around the turn of the 20th century, propelled, in large part, by revolutionary developments in physics. In culture and society, "modern" includes such things as the introduction of nonrepresentational abstraction in art and music, the reevaluation of the role of the observer in esthetic activity and in social science, and a careful reappraisal of what we know and what we can know. In physics, the word "modern" continues (despite its roughly 100-year old roots) to distinguish between the macroscopic, everyday, commonsense universe, and the almost nonsensical realm of molecules, atoms, and subatomic particles.

Modern physics is about physical reality that cannot be directly sensed and about phenomena for which the observer is an inextricable part. In this realm, time and space are mixed together and reckoned differently by different observers. In this realm, "waves" and "particles" are inseparable and there is no intrinsic reality until an observer observes it.

While all of this might sound preposterous and fantastical, there are profoundly important practical consequences—nuclear energy, laser technology, semiconductors and superconductors, and limits to computation, to name a few. In fact, ***it is estimated that roughly 1/3 of the economy of the developed world is directly due to quantum mechanics***. In this course, we will examine both the philosophical implications of modern physics as well as how its ideas are used in practical applications.

Student Outcomes of Physics 2710 Will Include

- Be able to state how quantum mechanics represents an intellectual revolution that requires completely different ways of thinking from "classical" physics

- Be able to state some of the practical consequences of quantum mechanics
- Be able to state the magnitudes of quantities associated with the microscopic world
- Be able to state, at least qualitatively, the microscopic structure of matter and why bulk matter is stable

- Be able to state, at least qualitatively, examples of how the microscopic structure of matter determines macroscopic properties of matter
- Demonstrate an ability to analyze and solve quantitative problems; in particular, be able to execute some of the calculational methods of quantum mechanics
- Demonstrate an ability to express qualitative understanding of physics

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Course Structure

Textbook and web information: The "text" consists of free course notes accessible by going to the Fall 2020 Physics 2710 Canvas website. Please check often for new stuff. Please find below a list of other texts and electronic tutorials.

Grading: Total points = 1000: (a) Homework quizzes = 200 points; (b) Hourly exams = 2x200 = 400 points; (c) Final exam = 400 points. The following indicates the number of points required to attain each passing grade level:

A ≥ 925, A- ≥ 900, B+ ≥ 875, B ≥ 825, B- ≥ 800, C+ ≥ 775, C ≥ 725, C- ≥ 700, D+ ≥ 675, D ≥ 600.

Homework problems and quizzes: On the dates indicated on the following page, there will be a 15-minute quiz on one of the problems assigned up to that date. Each quiz will be worth 25 points. I strongly encourage you to work on problems in teams (if you can) well before the quiz date so you can ask questions in class or by email. If you have no questions I will assume you are masters of the material.

Examinations: Examinations will consist primarily of qualitative questions designed to allow you to demonstrate your mastery of the course concepts. The final exam will be cumulative. A missed exam may be made up only if you have a written medical or similar excuse.

Office hours (SER240): I will be available MW 9:30-11:00 AM to chat via Zoom. Please send me an email to ask questions or arrange for a Zoom meeting at some other time.

USU welcomes students with disabilities. If you have, or suspect you may have, a physical, mental health, or learning disability that may require accommodations in this course, please contact the Disability Resource Center (DRC) as early in the semester as possible (University Inn # 101, 435-797-2444, drc@usu.edu). All disability related accommodations must be approved by the DRC. Once approved, the DRC will coordinate with faculty to provide accommodations.

The last day to add this class or drop **without a W** is September 16. The last day to drop **with a W** is October 28.

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Topical Clusters, Quizzes, & Exams

Day	Notes	Topic
M 8/31	Fn1: double slit	
W 9/2	Fn1: double slit; the holes	
F 9/4	Fn2: electrons & photons	
W 9/9	Fn2: de Broglie wave, duality	
F 9/11	Fn3: photons, probability	**QUIZ 1**
M 9/14	Fn3: elements of QM	
W 9/16	Sc1: Schrödinger Equation	
F 9/18	Sc1: infinite well	**QUIZ 2**
M 9/21	Sc1: expectation values, HUP	
W 9/23	Sc2: finite well	
F 9/25	Sc2: barriers, tunneling	
M 9/28	Review	**QUIZ 3**
W 9/30	**EXAM I**	
F 10/2	Sc3: rectangular quantum dots	
M 10/5	Sc3: hydrogen 1	
W 10/7	Sc4: hydrogen 2	
F 10/9	Sc4: hydrogen 3	
M 10/12	Sc5: transitions	**QUIZ 4**
W 10/14	Sc: spin	
F 10/16	Mn1: bosons & fermions	
M 10/19	Mn1: bosons & fermions	
W 10/21	Mn2: atoms 1	
F 10/23	Mn2: atoms 2	
M 10/26	Review	**QUIZ 5**
W 10/28	**EXAM II**	

F 10/30 Mn3: stat mech 1

M 11/2 Mn3: stat mech 2

W 11/4 Mn4: stat mech 3

F 11/6 Mn4: stat mech 4

M 11/9 Mn5: stat mech 5 **QUIZ 6**

W 11/11 Mn5: stat mech 6

F 11/13 Mn6: stat mech 7

M 11/16 Mn7: solids intro

W 11/18 Mn8: resistivity

F 11/20 Mn9: superconductivity **QUIZ 7**

M 11/30 Mn9: superconductivity

W 12/2 Mn10: semiconductivity

F 12/4 Mn10: semiconductivity. **QUIZ 8**

M 12/7 Mn10: semiconductivity

W 12/9 Mn11: quantum information

F 12/11 Review

W 12/16 FINAL EXAM

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Students occasionally ask for alternative readings. Some widely used sophomore-level texts include:

- *Concepts of Modern Physics*, Arthur Beiser, ISBN 0072448482
- *Modern Physics*, Paul Tipler & Ralph Llewellyn, ISBN 0716775506
- *Modern Physics*, Raymond Serway, et al., ISBN 0534493394
- *Modern Physics*, Kenneth Krane, ISBN 0534493394
- *Modern Physics for Scientists and Engineers*, John Taylor, et al., ISBN 013805715X

These books are pretty expensive and quite similar to one another in their emphasis on the historical surprises of early 20th century experiments. Beware: readers' reviews tend to be mixed.

Highly recommended electronic tutorials can be found at:

http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html http://web.phys.ksu.edu/vqm/
http://phet.colorado.edu/en/simulations/category/physics/quantum-phenomena