

## Physics 354 Modern Physics Fall 2017 (tentative)

**Instructor:** Dr. Arlette Baljon

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Office Hours\*: Mon & Wed 10:00-11:00  
and by appointment

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**TA:** ....., room P331: Office hours (for HW help) Tue 2-3pm.

**Class Schedule:** Mon & Wed, 2:00 – 3:15 in AH1112

**Course management:** Blackboard (Bb). All Readings, Quizzes, Activities, Homework, and their Solutions will be posted on Bb. Grades (points) will be kept updated their as well

**Enforced Prerequisites:** Math 150, 151, 252, and Physics 195, 196, 197 *all with a C or higher*. **Corequisite:** Math 342A.

**Space:** AH1112 is a Learning Research Studio. You will sit in groups and work together during class-time. The groups will be posted on the first day.

**Text:** **Modern Physics for Scientist and Engineers** by Thornton and Rex, 4<sup>th</sup> edition (Cengage Learning). A copy of the textbook and the student solution manual is on course reserve at the library. A new textbook is quite expensive, however the bookstore and Amazon sell second hand books. A used copy is fine since you do not need access to the online content. An e-book is available from Cengage (<http://www.cengagebrain.com/>). Finally, you might be able to use the international or older editions as long as you make sure you double check its content against that of the official textbook, that is on reserve in the library.

**Course Goal:** You will study the topics that in the early 20<sup>th</sup> century revolutionized physics and society: special relativity and quantum theory. Applications of these new thoughts to the structure of atoms and molecules, lasers, semiconductors, coupled waveguides, medical imaging techniques, nuclear and particle physics, and space travel will help you understand the impact that these theories had on the subsequent developments in research and on our daily lives.

This course will prepare you for a rigorous study of quantum mechanics in your senior year. Although the solution to the Schrodinger equation will be derived mathematically for a particle in an infinitely high potential 1d well, its solution in other more realistic potential fields will be stated and then investigated and interpreted. Moreover, time will be devoted to mind-bugging and philosophical issues such as wave/particle duality, probability waves, the uncertainty principle, hidden variables, and quantum entanglement. After successfully finishing this course, you will have a conceptual understanding of these revolutionary thoughts and how physicist construct theories and experiments in order to better understand and describe nature's laws. You will start to think as a physicist!

## Course Learning Outcomes:

- 1) Know and understand basic concepts of modern physics both conceptually and mathematically. A detailed list of concepts you will be tested on is posted on Blackboard.
- 2) Identify what equations are needed to analyze a physical question. In some cases this might imply integrating several components of the course to analyze a question for a new situation, thereby transferring knowledge and skills to new contexts.
- 3) Recognize the connection between topics discussed and methods used in this Modern Physics class and other classes taken as part of the curriculum.
- 4) Carry out computer-based animations and investigate quantum phenomena by responding to a range of questions related to these animations.
- 5) Create a short video clip demonstrating one way in which modern physics theory has impacted modern society and reflecting on how what you learned in this course relates to your experiences, values, and/or goals.
- 6) Cultivate creative, imaginative, and innovative thinking skills by developing traits as curiosity, confidence, and courage.
- 7) Feel the excitement that comes with learning that stretches the mind and with co-creation of knowledge, ultimately fostering a love for life-long learning.

Note that these align with the degree learning outcomes of the physics degree, which are 1: Relevant knowledge and skills; 2: Problem solving; 3: Experimenting; 4: Oral communication; 5: Traits; 6: Motivation; 7: Written communication: use of standard English; 8: Independent research.

**Topics covered:** wave properties, electromagnetic waves, superposition, interference, Rutherford model, Bohr model, energy quantization, atomic structure, atomic spectra, selection rules, black-body radiation, x-rays, photoelectric effect, fundamental quantum concepts, uncertainty principle, solutions of the Schrödinger equation (including square wells, harmonic oscillators, and hydrogen atoms), angular momentum, spin, atoms in magnetic fields, band theory of solids, lasers, alpha and beta decay, the atomic nucleus, neutrinos, quarks, particle physics, the standard model, grand unifying theories, relativity (introductory concepts, time dilation, length contraction, simultaneity, energy and momentum, four-vectors and Lorentz transformation, velocity addition, space-time diagrams, black holes)

**Class structure:** The format of this class is flipped. This will leave more class time for discussion. During 45 min or so of class, I will give 2 or 3 short (10 min max) lectures that are alternated with group discussions and tasks. We will use plickers as an alternative to the clickers you might know from lower division classes (this is free software). The remainder of the time you will work with your group on a computational-based animation (see below), relevant mathematical problem, or reflection on material.

**Reading and Quizzes:** As a professional physicist you will have to keep up with developments in your field. In physics most information is shared by means of printed media (even in this digital age). Hence in order to keep learning throughout your life it is important you are able to study textbooks. Hence you are expected to read the appropriate section of the text *before* class. After you study the material you have to take a quiz on Bb. This way I have to spend less time going over the material in class and instead time will be spend on group problem solving and activities. Quizzes will be open for at least 36 hours (either Thurs 8pm till Mon 8am or Mon 8pm till Wed 8 am). Don't use scientific notation. Answer in a numeric form and use the units specified in the question. A total of 5 points can be earned for each quiz.

**Trivia Game:** As an additional motivation we will play a trivia game during the semester. Groups will compete with each other for Starbucks gift cards.

**Computer-based Animations:** during 10 class sessions you will work on computational activities. The activities are posted on Bb and most can be found on either <http://www.standrews.ac.uk/physics/quvis> or <http://phet.colorado.edu/en/simulations/category/new>.

While working on an activity you have to answer a list of questions. You will have to upload your answers to Bb (note Saturday due dates) after which they are peer graded (you will grade your own work and that of two other students). Even though you work in a group during class, the answers to the questions have to be uploaded individually. The calendar below lists the due date of the activities and the dates by which you need to finish the peer grading. Solutions will be available on Bb after the due date to assist with the peer grading. A total of 10 points can be earned in each activity.

Those that don't do the activity should not participate in the grading and receive no points. If you only do the activity but don't finish the grading you get half of the points.

Rubric for grading the activities:

10 points	8 points	6 points	4 points	2 points
All questions are answered. There are only a few (1-2) minor errors.	All questions are answered. However there are several errors in calculations and/or some concepts are not yet well understood.	All questions are answered. However many calculations are way off and the student clearly lacks conceptual understanding.	Most but not all questions are answered. However many calculations are way off and the student clearly lacks conceptual understanding.	Some effort is made.

**Icebreaker:** Please go to the following link <https://padlet.com/abaljon/x6q2i51ajg25> Open a new box by double clicking on the canvas. Then enter your name in the title field. Introduce yourself. Then reflect on the values that brought you to college and tell us what your goals are.

The padlet gives many options to upload info, choose whatever you like best: text, videos, links.....Return to the padlet later and read the introductions of your classmates. In order to get credit for this icebreaker activity your entry should post by Sept 6 2pm.

**Padlet activities:** There are 4 padlet activities throughout the semester (including the icebreaker mentioned above). They are worth 7 points each

The links to the padlets are:

Padlet 1 (Icebreaker) <https://padlet.com/abaljon/x6q2i51ajg25>

Padlet 2 (Einstein and friends) <https://padlet.com/abaljon/aeqvwo7syxx9>

Padlet 3 (.....) <https://padlet.com/abaljon/qbnqu7kd8t5x>

Padlet 4 (I see) <https://padlet.com/abaljon/cwj0hd2p9mpe>

**Homework:** There are 10 HW sets. Each is worth 20 points. HW will be posted on Bb. Due dates are listed below. HW is collected at the beginning of class. Late HW will be accepted till midnight on the day the HW is due by email (4 points subtracted). After that, solutions will be posted and no work accepted.

**Tests:** There are 2 tests: **Oct 16** and **Dec 11**. For each test a study guide and taped review of the material is posted on Bb. The formula sheet that is handed out with each test can be found there as well. In addition you are allowed to bring a 3 by 5 inch index card with notes written on both sides Please bring a simple calculator (with sin/cos/etc. functions) as well. The first tests covers material up to Oct 9 and the second test the remainder. Tests will also cover activities and homework questions. Both tests are 75 min long.

**Video Project:** You will have to do a project. The topic has to be related to the class material. You are encouraged to make a connection to your own experiences (in or out school). The project has to be delivered in the form of a clip (YouTube or any other media). You are encouraged to work with a partner. Due Dec 9 at 8am. Late videos are accepted till Dec 15 8am, however you will lose 10 points and there is no guarantee that your video will be shown in class. Clips should be 3-6 min long (6-12 min when you work with a partner). Please upload your project to YouTube and then embed the YouTube in Bb (under Discussions/Project). A short video on how to do this and some guidelines and suggestions are posted on Bb (under Syllabus). Videos are worth 100 points. Most will be watched on Dec 13 and 15 by the entire class (I will select which ones by lottery). Attendance is mandatory and failure to show up will result in a reduction of points.

**Evaluation and feedback:** A questionnaire will be posted on Bb and handed out on Dec 13 and is due back Dec 15 in class. Don't put your name on it, but I will cross you off a list when you hand it in, so I know who to give points (7 points total)

**Calendar: Quiz, Activities and their grading are done on Bb. HW is handed in at the beginning of class. Padlets uploaded using the links above.**

Day	Reading for Quiz	Quiz and Grading Time due (8 am)	HW and Padlets Time due (2 pm)
Aug 30	Chap 1	Quiz 1	
Sept 6	Chap 3.1, 3.2, 3.3 and listen to posted mp4 on “quantum koans”	Quiz 2	Padlet 1
Sept 9		Act 1	
Sept 11	Chap 3.4, 3.5, 3.6	Quiz 3	
Sept 12	Chap 3.7, 3.8, 3.9, 4.1	Quiz 4	HW1 (in class)
Sept 15		Act 2, Grade Act 1	
Sept 18	Chap 4.3, 4.4, 4.5, 4.7	Quiz 5	
Sept 20	Chap 5.1, 5.2, 5.3, 5.4	Quiz 6	HW2(in class)
Sept 23		Act 3, Grade Act 2	
Sept 25	Chap 5.5, 5.6	Quiz 7	
Sept 27	Chap 5.7, and read “100 years of quantum mysteries	Quiz 8	HW3 (in class)
Sept 30		Act 4, Grade Act 3	
Oct 2	Chap 5.8, 6.1, and 6.2	Quiz 9	
Oct 4	Chap 6.3, 6.4	Quiz 10	HW4 (in class)
Oct 7		Act 5, Grade Act 4	
Oct 9	Chap 6.7	Quiz 11	
Oct 11	REVIEW		HW5 (in class)
Oct 14		Grade Act 5	
Oct 16	TEST 1 (2 pm)		
Oct 18	Chap 6.5 and 7.1,7.2	Quiz 12	
Oct 21		Act 6	
Oct 23	Chap 7.3, 7.4, 7.5, 7.6	Quiz 13	
Oct 25	Chap 8.1	Quiz 14	
Oct 28		Act 7, Grade Act 6	
Oct 30	Read “A Quantum Threat to Special Relativity, “Quantum Teleportation”, and listen to posted mp4 on entanglement.	Quiz 15	
Nov 1	Chap 10.1-10.2	Quiz 16	HW6 (in class)
Nov 4		Act 8, Grade Act 7	Padlet 2
Nov 6	Chap 8.2	Quiz 17	
Nov 8	Chap 2.1, 2.3, 2.4, 2.5	Quiz 18	HW7 (in class)
Nov 11			
Nov 13	Chap 2.6, 2.7, 2.8, 2.9	Quiz 19	
Nov 15	Chap 2.10, 2.11, 2.12, 15.1	Quiz 20	HW8 (in class)
Nov 18		Act 9, Grade Act 8	
Nov 20	Chap 15.2, 15.4 and listen to posted mp4.	Quiz 21	
Nov	THANKSGIVING		
Nov 27	9.5, 9.6 (only classical theory till end of page 317), 11.1,11.2 (till example 11.3)	Quiz 22	
Nov 29	Chap 14.1, 14.2, 14.3, 14.4, 14.6, 14.7	Quiz 23	HW9 (in class)
Dec 2		Act 10, Grade Act 9	
Dec 4	No class		
Dec 6	REVIEW		HW10 (in class)
Dec 9		Grade Act 10, Video Project due	
Dec 11	TEST 2		
Dec 13	VIDEOS		
Dec 15	VIDEOS (3:30-5:30)		
Dec 16			Padlets 3 and 4

Please note that the dates in this syllabus overwrite all other due dates!!!! If there is a discrepancy between the dates above and those in Bb, something went wrong while setting dates in Bb. Please let me know it by email when you notice this, so I can correct it. There is no class on Dec 4 so you can work on the video project.

**Grades:** All grades are based on your individual performance, except for the video project, where you can choose to work in pairs. The grading scale is based on 1000 points. 500 points can be earned in the tests: 250 points in each. The other 500 points for online quizzes, computational-activities, homework, padlet activities, and video-project combined. That is 5 points per quiz, 10 for each of the animation activities, 20 for each of the homeworks, 7 each for padlet activities, 7 for end of semester questionnaire, 100 for the video project. Please note that the total number of points that can be earned in the second category add up to more than 500, so you can miss a few activities or quizzes without being penalized. The maximum number of points earned in this category is 500 though. The other 500 points can only be earned in the tests.

Scale: A>870, A->840, B+>800, B >770, B- >740, C+>700, C>670, C->630, D+>600, D>570, D->540 F below 540.

**Disability:** If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Disability Services. Your cooperation is appreciated.