# PHYSICS 320: MODERN PHYSICS, FALL 2016

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Class Discussion: MWF 9:30 – 10:20, Dana 153
Text: *Modern Physics*, Kenneth S. Krane, 3rd edition
Lab: MW 1:30–4:20 in Dana B054

**Office Hours:** Tuesday/Thursday 9:30 – 11:00am, 12:15 – 1:30pm, (and more generally, most other normal working hours when I'm not preparing for or teaching class or lab). Questions naturally arise in the process of learning and doing physics. In fact, the really good questions are what keep physics going. I *expect* you to have lots of questions and I hope that you will come by my office to talk with me about them.

**Course Webpage:** http://www.phy.davidson.edu/FacHome/thg/320-2016.htm
I will post announcements, simulations, assignments, and solutions here.
**Lab Webpage:** http://moodle.davidson.edu/moodle2/course/view.php?id=7631
Laboratory assignments and instructions can be found on Moodle.

**Introduction:** Physicists generally refer to discoveries made from the beginning of the 20th century through today as *Modern Physics*. It has been an exhilarating ride, characterized by an explosion of fascinating new ideas, including special and general relativity, quantum mechanics, and cosmology. We will consider these and other important recent discoveries in this course. Due to the vast range of subfields that have emerged in modern times, we will survey a broad swath of topics. We will start with special relativity and the experiments that foreshadowed quantum theory, then move through quantum mechanics and its application to atomic physics, and finish with a look at semiconductors, statistical mechanics, and cosmology. Some of these topics will be familiar from your introductory physics course, and we will rely on that knowledge as we develop a deeper understanding of the phenomena. While we will use more sophisticated problem-solving techniques, the exotic nature of the underlying concepts should make this an enjoyable experience.

**Learning Objectives:**

- Obtain a deeper conceptual understanding of modern physical phenomena
- Develop more sophisticated analytical problem-solving skills, including advanced calculus
- Conduct laboratory experiments on a variety of quantum mechanical systems and effects
- Apply modern concepts to interpret new and unusual experimental results
- Analyze and model the physics with computational resources like *Origin* and *Mathematica*

**Learning Outcomes** *(successful completion of this course should enable students to)***:**

- Predict the outcomes of observations that require ideas developed in the modern era
- Explain the behavior of modern physical systems
- Solve intermediate-level quantitative problems involving concepts in modern physics
- Demonstrate experimental familiarity with a variety of modern physical phenomena
- Configure and operate modern laboratory instruments, with an emphasis in spectroscopy
- Analyze data in *Origin* and compute theoretical results in *Mathematica*

**Class Discussion and Exercises:** Attendance at and participation in class discussions are critical for learning new physics. Reading the text before class will definitely facilitate this part of the learning process. We will frequently be using *Physlet Quantum Physics* by our very own Belloni, Christian, (and Cox) to explore new ideas in class. *Physlet Quantum Physics* can be accessed on comPADRE via the following URL: http://www.compadre.org/PQP/. Pre-class exercises allow me to gauge your grasp of new material and enable me to use class time effectively. When assigned, they are due 1 hour before class starts. In-class exercises will also be used regularly to give us the opportunity to explore new concepts and problem-solving strategies together. The College's 25% rule on attendance will be in effect.

**Homework:** As you work your way up the physics curriculum, you will encounter problems of increasing complexity, and *Physics 320* begins this journey in earnest. Learning how to handle these problems takes *substantial* time and practice. Hence, I will assign approximately 5 questions / problems / physlets each week to test your understanding and challenge your problem-solving skills. You should start these assignments early to allow time for my assistance. I encourage you to work in groups of 2 – 3 students on the homework sets, but you must participate in the process of obtaining the solution to each problem. When working with a partner, keep in mind that reviews and the final will test your *individual* problem-solving ability. Do not consult solution manuals, solution sets, or another student's work from any previous class. Using any solution, other than those found in your textbook or posted on our website, is an honor code violation. Always show your arguments, realizing that neatness, clarity, correct units, and appropriate significant figures also count. Homework will be collected for grading at the beginning of class on the dates designated and late homework will not be accepted.

**Laboratory:** At the turn of the 20th century, several experimental observations came to light that could not be explained by classical physics. These irregularities led scientists to consider extraordinary new ideas, and the era of modern physics began. We will start our semester with a collection of experiments that demonstrate these foundational problems. Then, equipped with the new ideas that emerged, we will study a variety of phenomena that can only be explained with modern physics concepts.

Laboratory attendance during your schedule lab period is required. If you foresee a conflict with your scheduled lab period, please consult with me and your lab partner to schedule an alternative time to complete the lab. You are required to keep a laboratory notebook in which you will record your day-to-day work. Always begin your entry with the date, time, and name of any lab partners. Dates recorded in the lab book must be the dates on which the entries are made. You are encouraged to work together when taking data and analyzing your results but you may not copy work from one another. If you are not in the laboratory when the data is being taken, you should not include it in your notebook. The main goal of keeping a lab book is to save time by keeping a careful record of what you have already accomplished. Your notebook should always include:

- A diagram of the experimental setup if it is not shown on the lab webpage.
- Instrument settings
- Sketches of oscilloscope traces and other important visual results
- Data and analysis, including documentation of any associated computer files
- Sample calculations
- Interpretation of your results

**Seminar Attendance:** Seminars broaden your scientific perspective and show you how physics is being used in the world beyond Davidson. Attendance at all physics seminars is required. *Ask questions!*

**Reviews and Final Exam:** We will have 2 closed-book, closed-notes take-home reviews, tentatively scheduled for collection on 9/30 and 11/22. When taking these reviews, you should ensure that all relevant resources are stowed beyond reach. Consulting reviews from any previous offering of Physics 320 is an honor code violation. The comprehensive final exam will be take-home and open-book, to be completed during the self-scheduled exam period.

**Grading:**

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| Homework, Exercises, and Seminar Attendance | 25% |
| Laboratory (Experiments and Physlets) | 25% |
| 2 Reviews | 30% |
| Final Exam | 20% |