Syllabus: Elements of Modern Physics

Instructor:	Hunter King	**Email:**	h.king@rutgers.edu
Time:	M 12:30 – 3:30pm	**Place:**	CNS-213

Course Information

Course Description:

In the history of physics up to the 20th century (and in your progress through a physics education up to this point) a comprehensive and extremely self-consistent world view had (should have) emerged to make sense of seemingly all the physical phenomena around us. It turns out, there were a few holes in this 'classical' world view, particularly involving light, and phenomena at the extremely small and extremely large scales. Attempts to resolve them ultimately required radical concessions to the classical view, and distinguished a set of 'modern' physical principles. This course will review the modern principles, including special relativity and quantum mechanics, lead to improved understanding of atomic, nuclear and molecular structure and behaviors, as well as that of statistical mechanics and cosmology.

Learning goals are to provide:

- a solid, working understanding of basic principles of special relativity and quantum mechanics to serve as foundation for more rigorous study in related graduate courses
- exposure to the larger scope of topics in modern physics as preview of potential future educational paths

Prerequisite: 50:750:132 Elements of Physics

Corequisite: 50:640:221 Calculus 3 -AND- 50:750:238 Lab

Textbook: *Modern Physics*, 4th edition, by Kenneth Krane. Wiley 2019

Office hours / review sessions: By request, online.

Class policies:
– Please make every effort to attend class in-person and on-time.
– Please put completely away mobile phones for the extent of class time.

Topic outline:

Week	Topic
9/12	Introductions. Classical physics context and preconceptions
	Light causing trouble
9/19	Reconciling light speed issue: Special Relativity
9/26	Light as particles
10/3	Particles as waves (!)
10/10	(Sort of) Reconciliation: Schrodinger Eq.
due 10/17	Midterm I
	Atoms
10/17	Basic atomic models
10/24	Hydrogen atom
10/31	Many electron atoms
	Molecules and ensembles
11/7	Bonds and degrees of freedom
due 11/14	Midterm II
11/14	Quantum Statistical Mechanics
11/21	Solid state: crystals
	Even smaller and way bigger
11/28	Nuclear structure and reactions
12/5	Elementary particles
12/12	The whole universe, really briefly
Finals week	Final exam

Breakdown of final grade:

1. **Weekly homework assignments** (40%):
   We will be covering roughly one chapter per week. To manage this pace, we will need to keep up with critical reading of the text. Problem sets will be assigned weekly and will need to be reviewed together in the class in which they are due, which means I **can't accept late assignments**. You are strongly encouraged to work on the problems together.

2. **In-class assignments** (10%):
   Brief in-class assignments will given each week. Students will work in pairs to grapple with one or two conceptual problems. These assignments will be primarily be used to stimulate discussion and aid digestion of lecture material, but will also be crudely evaluated for a grade.

3. **Midterm exams** (30%):
   At the end of class in week 5 and week 9, a take-home exam will be given to evaluate understanding of the content so far. They will cover material since the beginning of class, and since the first midterm, respectively (will not be cumulative). Unlike weekly homework assignments, these exams will be completed individually.

4. **Final exam** (20%):
   A traditional exam will be given during the assigned time during finals week. The content will cover content from the entire course (with somewhat greater weight placed on the more recent material that had not appeared in the previous midterms).