PHYS 214 - University Physics, Quantum Physics

Instructors:
Prof. Kwiat teaches this course often; he is a great guy. He is one of those professors that students will remember after they graduate. Other professors include Bryce Gadway and James Eckstein. The lab and discussion sections are taught by a myriad of different TAs, all of them graduate students.

Prerequisites:
Phys 212 (and indirectly Math 241) are the prerequisites for this course. The concepts learned in Phys 212 that carry over are mostly wave behavior related. Understanding solutions to differential equations (linear, 2nd order) will benefit understanding of the course, though students can get by without taking a differential equations class such as Math 286 beforehand (or concurrently).

When To Take It:
PHYS 214 is taken either as a freshman or a sophomore, although there are rare cases where people have put it off until senior year. The latter case is highly not recommended, though, since the concepts taught in the course will be extensively used in upper level ECE courses. PHYS 214 is most often taken (and recommended to be taken) in the same semester as PHYS 213 (University Physics, Thermal Physics), since they are both 8-week courses (PHYS 214 is taken in the first 8 weeks, and PHYS 213 is taken in the last 8 weeks of a semester). Some may find it a bit intense though, since 214 and 213 are both full physics courses condensed into 8 weeks - each is like having a 4 credit hour course that only lasts half of the semester. Occasionally students take the classes in different semesters, but this isn't very common.

Class Content:
PHYS 214 begins by introducing waves and wave behavior mathematically and demonstrates how phenomena such as diffraction and interference come about. These topics will be reviewed in more intricate detail in the courses ECE 329 and ECE 350 (Fields and Waves I/II). Wave-particle duality is introduced, which leads into quantum mechanics concepts such as the Uncertainty Principle. Schroedinger's Equation is solved for both the infinite and finite potential well, which should be an easy concept to grasp when MATH 286 (Introduction to Differential Equations) is taken concurrently with this course. Schroedinger's Eq. will be used to show how quantum tunneling occurs, and then a shallow exploration of 3D potentials (particle in a box was 1D) and the hydrogen atom will ensue. How quantum numbers \( m, n, l, \) and \( s \) (from CHE M 102 (General Chemistry I)) arise as a result of the quantum nature of matter and energy is covered last.

Work:
PHYS 214 currently uses ByteShelf (similar to FlipItPhysics) to attempt to parallel the structures of PHYS 211 and PHYS 212 and includes Prelectures, Online Quizzes and “Ask the Profs.” Note that because this course is condensed into an 8-wk course, it has a higher pace and more work than 211 & 212. In addition, the number of assignment grade drops is less forgiving than the predecessors. The workload now looks like this:

- **Lecture** – show up, stay awake, click a few times for points. Three times a week, one hour each. During the summer this is condensed to four lectures per week each lasting 1 hour and 20 minutes. Professor's will work through easier/similar/harder versions of questions in your homeworks and exams.
- **SmartPhysics**:
  - Prelectures – a series of short lectures consisting of narrated graphical animations that gives you a primer on the following lecture's material due at 8AM on the day of lecture. While they are helpful and thus recommended, you can also click through to rack up the points at 7:59, and watch them again after lecture. Usually three per week.
  - Online Quizzes – a short quiz accompanying each Prelecture. These are a mixture of short answer and multiple-choice questions, usually no more than four per quiz. These check for understanding of the material presented in the corresponding Prelecture – so watch the Prelectures!
  - Homework – you can expect to spend anywhere from 2-6 hours on each week's homework set, depending on your aptitude with the course material. Each student receives different variables for their problem set, so matching answers is no longer viable, but learning the procedures during office hours is not as bad as it sounds – just find a nice TA.
- **Lab** – same drill as PHYS 211 and PHYS 212. Pre-lab is worth 5 points, quick and easy, turn it in at the start of lab. The labs work in PHYS 214 is manageable, be diligent and you will be fine. Lab reports are due at the end of each 2 hour lab. Four labs total - one of them is a computer based exercise where you work with a simulation of quantum wells in the Loomis Computer Lab. Make absolutely sure that you study for that lab, or you will either a) spend a lot more time than you would like, or b) get a low score for that lab.
- **Discussion** – as for PHYS 211 and PHYS 212, don't show up late, or you don't get the 20 point quiz at the end of each discussion. One 2 hour discussion each week. Quiz covers material similar to discussion problems. Good TAs will make sure you know which problems matter.
- **Exams** – one midterm and one final. The midterm usually catches students off guard, if they didn't learn from PHYS 214 already. Study hard for the midterm, and even harder for the final because the final is worth more than a third of the grade. Prof. Budakian mentioned in Fall ’15 that the midterms come directly from past exams questions but different numbers or concepts, so study those mainly. They will photograph the room and run statistical analyses on your bubble sheets - cheating is for idiots.

Life After:
Both EEs and CompEs will see the concepts in PHYS 214 in their core and advanced courses. While not explicitly discussed, concepts from this course are used in the study of semiconductor devices and students are expected to have knowledge of this material for ECE 340. Students who find this information interesting should consider taking upper level quantum courses such as PHYS 485 or PHYS 486 (Quantum Physics I) and PHYS 487 (Quantum Physics II). Those looking for a more device oriented course may want to take ECE 485 (MEMS Devices & Systems).