PHYSICS 3250 (Spring 2017)

Applied Nuclear Physics

Syllabus

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The focus of PHYS3250 will be on applications of nuclear physics. At least half of the lectures will be devoted to topics on how nuclear physics tranforms our lives in the present society, including medical imaging, radiation therapy, forensics, national security, nuclear fission and fusion, and space travel and survival. For some topics, we will discuss not only their scientific basis, but also their economic factors and impact on the environment. Lectures will be held every Tuesday and Thursday from 12:30-1:45pm.

Textbook and Material

The **textbook** for the course is "Nuclear Physics: Principles and Applications", by J.S. Lilley, ISBN 978-0-471-97936-4, published June 2001 by John Wiley & Sons, Inc. This book will be available from the UVa bookstore. An electronic version can be purchased at http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118723325.html. We will also read excerpts (that I will provide) from other relevant books and journals.

Problem sets and reading assignments will be posted every week on Collab. You are required to complete the problem sets and to read the reading assignments. There will be up to 8 problems in each assignment and at least one problem will be based on the reading materials. Homework problems are not supposed to be heavy on algebra, but you need a good understanding of the physics concept and in-class examples in order to complete the homework with ease. Some problems may require the use of computer spreadsheets for calculation purposes. For those problems you may print out your spreadsheets and attach them to your solution paper. Hard copies of problem set solutions will be provided in-class but not posted online.

Grading

The **grading** will be based on: Homework 20%; An in-class Midterm 30%; Final Exam 40%; and a Term paper due on the day of the final exam 10%. I will provide a list of topics that could be used for the term paper, but you are free to choose your own topic. *Electronic submission of the term paper is required.* In the past, I had always encouraged turning in the term paper early so that I could provide suggestions for revisions in order to boost the grade, similar to how I would treat research papers.

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Important Dates

- first lecture: Thursday Jan. 19th;
- Add deadline (College of Arts&Science): Feb. 1st;
- Drop deadline (College of Arts&Science): Feb. 2nd;
- no lecture on March 7th and 9th (spring recess);
- Withdrawal deadline (College of Arts&Science): March 15th;
- midterm exam is typically held on the Thursday after the spring recess. For this semester, it will be on Thursday March 16th;
- last lecture: Tuesday May 2nd;
- final exam: TBA

Class Outline

A detailed course calendar will be provided during the first lecture and be updated/posted on Collab for snow dates and other cancellations.

1. Introduction: particles and forces, quantum mechanics applied to the nucleus, $E = mc^2$;
2. Nuclear structure: shell model, semi-empirical mass formula, nuclear binding energy;
3. Radioactivity;
4. Passage of radiation through matter;
5. Radiation creation and detection: particle detectors, particle accelerators, X-ray generators;
6. Biological effects of radiation;
7. Industrial applications of radiation;
8. Nuclear medicine: imaging, radio-therapy, MRI;
9. Nuclear energy – introduction;
10. Nuclear fission: neutron cycle, moderators, reactor basics, fuel cycle, waste management, reactor safety;
11. Nuclear fusion: fission vs. fusion, thermo-nuclear fusion, progress towards fusion power, ITER;
12. Fusion in stars: fusion in the early universe, stellar burning, nucleosynthesis.