PHYS 402 **NUCLEAR PHYSICS** **Fall, 2018**

SYLLABUS

Instructor: **Dr. Laszlo Takacs**

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Place and Time: Sondheim 114, MWF 2:00-2:50 pm

Office hours: TBA

Text: Nuclear Physics, Principles and Applications
by John Lilley
John Wiley and Sons, Ltd. ISBN 0-471-97936-8 (paper)

Content

The subjects of this course are the structure, properties, and transformations of the nucleus and the applications of nuclear physics in medicine, energy production, science and technology. Many of the covered applications – e.g. nuclear energy and medical imaging – have direct relevance to everyday life. Others – such as dating methods and materials characterization techniques – are of importance to other branches of science.

Course Objectives

This course will provide an overview of the main subjects in nuclear physics and technology.

At the end of the course, you will:

- be familiar with the basic properties and transformations of nuclei and
- understand the principles of many important applications of nuclear physics,

Course Format

PHYS 402 is essentially a traditional lecture course, with a substantial individual learning component and regular class discussions. Some subjects will be covered in student lectures. A tentative schedule is attached to this Syllabus. The details may change, but the course will surely start with general subjects followed by a midterm on Oct. 24 (or 26). The second half of the semester will be dedicated to applications.

Homework

There will be a homework assignment every week. The solutions will be due on Mondays before the lecture.

Some problems will be directly from the book. Although they have hints/solutions in the back of the book, what is found there is not a complete solution and cannot be accepted as such. Your

solution should include the details skipped in the book, so that it is clear that you understood the calculation not only copied it from the book.

From every homework, I will select two problems for detailed grading (about 5 points max), the rest will be graded to 1 point – about correct (1), good effort with errors or incomplete (0.5), missing or useless (0).

Student lectures

Some subject, mostly on applications, will be covered in the form of student lectures. The topics will be decided early to give you sufficient time to research the subject. The lectures themselves will be given after the Thanksgiving break.

Grades will be determined according to the following distribution:

Midterm test	20%
Final exam	40%
Homeworks (~10)	20%
Student lecture	20%

The tests will be open source (book, notes, etc.) but be aware that you will not have enough time to learn the material during tests. You can look up a fact or an equation quickly, but you need to know what to look for and approximately where to find it.

I will show detailed grade statistics after the midterm test. It will tell you the grade you would receive, if I had to assign it at that moment. It will also show how far you are from obtaining a better grade (and from slipping.) If at any moment you are uncertain about your standing, ask. In particular, do not drop or withdraw from the course for fear of a bad grade without consulting me first. I understand that grades are important for you, they are important for me also. Let's talk before you act.

"Incomplete" is given only in exceptional cases. To be considered for an "I", you must have taken the midterm test, submitted at least 6 homework, and have C or better standing at the time of incapacitation.

Academic Integrity

"By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating on a test could result in disciplinary action that may include, but is not limited to, suspension or dismissal." More on the requirements of academic integrity can be found at http://www.umbc.edu/gradschool/procedures/integrity.html

Applied to this course, a proven case of misconduct during a test or a blatant copy or plagiarism of a homework solution "earns" zero on the assignment in question. A second offence will result in failing the course.

On my end, I promise well-prepared lectures, careful and timely grading and openness.

Questions and Comments

This is the second time nuclear physics is offered after a 30-year break. Thus the course may need adjustments as we go both in content and in presentation. Therefore, if you have any question, concern, or suggestion during the semester, do not hesitate to talk to me.

Blackboard

Assignments and sample solutions will be posted on Blackboard. There will also be additional material on subjects not covered in the book. Posting announcements may be necessary, such as canceling a class due to inclement weather, changes of an assignment, etc. Visit the course Blackboard page, if you suspect that guidance should be available in a given situation. On very important urgent matters I will also email you. Check your grades in Bb to make sure that all of them are recorded correctly.

PHYS 402 **NUCLEAR PHYSICS** **Fall, 2016**

TENTATIVE SCHEDULE

Date	Reading	Subject
8.29.	1.1-2	Introduction, history, basic principles
8.31.	1.3-4	Basic facts, spin, magnetic moment, parity, energy levels
9.3.		**Labor Day**
9.5.	1.5.3, 3.2	Radioactivity, gamma radiation
9.7.	1.5.1, 3.4	Radioactivity, alpha
9.10.	1.5.2, 3.3	Radioactivity, beta
9.12.	1.5.4-7	The kinetics of radioactive decay, dating
9.14.	2.2.1-3	Structure of the nucleus: liquid drop model, semi-empirical formula
9.17.		Problems
9.19.	2.3	Structure of the nucleus: shell model
9.21.	1.6	Nuclear collisions, reactions
9.24.	4.1-2	Nucleus reaction
9.26.	4.3-4	Elastic scattering, direct reactions
9.28.	4.5-6	Compound nucleus reactions, heavy ion interactions
10.1.	5.1-3	Radiation-matter interaction: charged particles
10.3.	5.4-5	Radiation-matter interaction: photons and neutron
10.5.	6.1-3	Gas filled and scintillation detectors
10.8.	6.4-7	Semiconductor detectors, photon and neutron detection
10.10.		Counting experiments, statistical analysis
10.12.	6.8	Particle accelerators
10.15.		Review
10.17.		**Midterm**
10.19.	7.1-3	Biological effects of radiation, dose, dosimetry
10.22.	7.4-6	Human exposure, risk assessment
10.24.	8.1-2	Industrial applications
10.26.	8.3	Neutron activation analysis, isotope production
10.29.	8.5-6	PIXE, mass spectrometry
10.31.		Applications in geology, archaeology and art: age determination
11.2.		Applications in archaeology and art: determining provenance
11.5.	9.1-3	Medical imaging: X-rays, CAT scan
11.7.	9.4-5	Medical imaging: PET, MRI
11.9.	9.6	Radiation therapy
11.12.		Reserve
11.14.	10.1-2	Fission
11.16.	10.3-5	Chain reaction in a nuclear reactor
11.19.	10.6-7	Practical reactor designs
11.21.		Reactor safety and accidents
11.23.		**Thanksgiving Break**
11.26.	11.1-4	Fusion, progress toward fusion power

11.28.	11.5-7	Nucleosynthesis in the early universe and in stars
11.30.		Student lectures
12.3.		Student lectures
12.5.		Nuclear weapons based on fission
12.7.		Fusion bombs, proliferation
12.10.		Reserve