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

SYLLABUS

Instructor: **Dr. Laszlo Takacs**

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Place and Time: PHYS 107, MWF 2:00-2:50 pm

Office hours: To be decided later

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; some applications of nuclear physics in science, medicine, and technology; and the elements of high-energy particle physics. Many of the covered topics – e.g. nuclear energy and medical applications – have direct relevance to everyday life. Others – such as dating methods, material characterization techniques – are of importance to other branches of science.

Course Objectives

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

At the end of the course, you will:

- be familiar with the basic properties and transformations of nuclei,
- understand the principles of many important applications of nuclear physics,
- have some basic understanding of particle physics.

Course Format

PHYS 402 is mostly a traditional lecture course, although individual reading and class discussion will also play an important role. Some subjects will be discussed based on 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, fission and fusion, and some elements of particle physics.

Homework

There will be a homework assignment every week. The solutions will be due on Fridays before the lecture. Most problems will include numerical evaluation.

Student lectures

Some 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%
Studdent 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 you are looking 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 or 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 at least three midterm tests, submitted 10 homework/quiz solutions, 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 first time nuclear physics is offered in at least 30 years and I was not the person who taught it. Thus the course may need adjustments as we go. 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. Post announcements may be necessary, such as canceling a class due to inclement weather, changes of an assignment, etc. Visit the course Blackboard page at least every other day, or if you suspect that guidance should be available in a given situation. I will enter your grades into Bb, thus you can make sure that all your grades are recorded correctly. Make sure to check occasionally.

PHYS 402 NUCLEAR PHYSICS Fall, 2016

TENTATIVE SCHEDULE

Date	Reading	Subject
8.31.	1.1-4	Introduction, basic principles
9.2.	1.5-6	Radioactivity, nuclear reactions
9.5.	2.1-2	Structure of the nucleus: liquid drop model
9.7.	2.3-4(5)	Structure of the nucleus: shell model
9.9.	3.1-2	Gamma transition
9.12.	3.3	Beta emission
9.14.	3.4	Alpha emission
9.16.	4.1-2	Nuclear reaction
9.19.	4.3-4	Direct reaction
9.21.	4.5-6	Compound nucleus reaction
9.23.	5.1-3	Radiation-matter interaction: charged particles
9.26.	5.4-5	Radiation-matter interaction: high-energy photons, neutrons
9.28.	6.1-3	Gas and scintillation detectors
9.30.	6.4-5	Semiconductor detectors, spectrum from a single photon
10.3.		Examples
10.5.		Counting experiments: electronics
10.7.		Counting experiments: statistics, data evaluation
10.10.		Low level counting
10.12.	6.6-7	Neutron detection, identifying particles
10.14.	6.8	Particle accelerators
10.17.	7.1-3	Biological effects of radiation, dose, dosimetry
10.19.	7.4-5	Human exposure
10.21.	7.6	Risk assessment
10.24.		**Midterm**
10.26.		Preparation for student lecture
10.28.	10.1-2	Fission reactors
10.31.	10.3-4	Chain reaction in a nuclear reactor
11.2.	10.5	Reactor operation
11.4.	10.6-7	Practical reactor designs
11.7.		Nuclear weapons based on fission, proliferation
11.9.	11.1-3	Thermonuclear fusion
11.11.	11.4	Progress toward fusion power
11.14.		Fission weapons
11.16.	11.5-7	Nucleosynthesis in the early universe and in stars
11.18.		Isotope ratio studies
11.21.	8	Industrial applications
11.23.	9	Medical applications
11.25.		**Thanksgiving Break**
11.28.	9	Medical applications

11.30.		Student lectures
12.2.		Student lectures
12.5.		Leptons
12.7.		Quarks
12.9.		Hadrons
12.12.		The Higgs boson