

# PHYS 471F Advanced Topics in Physics I: Nuclear and Particle Physics (2019)

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Class meets:	MWF 1:00 PM - 2:00 PM (November 1 to December 14, 2019)
Classrooms	Reichardt 207
Office hours:	MWF 9:30 AM - 11:25 AM, Th. 8:30 to 11:30 AM, or by appointment
Credits:	1 credit: 3 hours/week of lecture.
Textbook:	No textbook purchase is required. References are listed below.
Prerequisites:	PHYS F220; PHYS F301; or permission of instructor

## I. Course Description

The UAF Catalog listing for PHYS 471F: "Application topics provide expanded exposure to subjects in physics. Three topics are offered within the fall and spring semesters of each academic year as compressed 14-lecture, one-credit courses. Prerequisites: PHYS F220; PHYS F301; or permission of instructor. (1+0)"

This course will introduce some basic nuclear and particle physics. At the end of this syllabus is a tentative schedule which lists topics we plan to cover in more details. This is subject to change.

## II. Course Goals

The main goal of this course is to introduce you to the fundamental concepts, phenomena, and theories of nuclear and particle physics, at the upper undergraduate level.

## III. Student Learning Outcomes

- Know how to solve basic problems related to topics covered in the course, especially at the GRE/physics level.
- Have basic understanding of various aspects of nuclear and particle physics.
- Obtain good understandings on useful concepts, as well as theoretical and mathematical tools that can help students to conduct research in any area of physics.

## IV. Textbook, Reading Assignments, and References

Since this is a one-credit course lasting one month, you are not required to buy a textbook. However, topics will be mainly based on some selected sections from the following references, mostly Martin 2006, that you can possibly download based on the subscription by UAF.

1. (Martin) Martin, B. R., 2006, Nuclear and Particle Physics, John Wiley & Sons, Ltd. ISBN: 0-470-01999-9.
2. (Wong) Wong, S. S. M., 1998, Introductory Nuclear Physics, 2nd Ed., John Wiley & Sons, Ltd. ISBN-10: 0-471-23973-9.

## V. Instructional method

The class is one credit over a month, and so there are 3 hours per week for lectures. Based on the reading schedule listed below, you should have read the materials in references before coming to each day's lecture. You are also expected to contribute to discussion in class about physical concepts and mathematical derivations. I will not have time to read through all the materials, but will only highlight those points that are important or difficult. You must cover the rest by reading and ask for help if you encounter difficulties.

Note: some lecture notes will be available for download via the BlackBoard site.

## VI. Homework

There will be approximately one homework set assigned per week. You should work on your homework as early as possible before a deadline so that you can have time to ask for help if you encounter difficulties in solving these problems. Late homework will not be accepted.

To emphasize the importance of doing homework, homework grade will count towards 50% of the total grade of the course.

Your submission of any homework problem cannot simply be a one-line statement of the answer. You need to show steps of how you used the method leading to that answer. I will grade the homework based on the method used, as well as the answer. Therefore, you should submit your partially finished work. This will help you getting partial credit, and let me identify your difficulties. Also, your work should be clean and clear enough for me to understand.

While it is good for you to have discussion with classmates or search the Internet for additional information, your submitted homework should be of your own, but not a direct copy from another source. Keep in mind that you will be required to do similar questions on your own during exams. In addition, it is against the UAF Honor Code to misrepresent work which is not your own. Plagiarism on homework or on an exam will result in a failing grade.

Solutions to the homework problems will be posted on BlackBoard after the due date. Therefore, late homework will not be accepted. The homework assignments will be posted on BlackBoard.

## VII. Examinations

There will be one one-hour in-class final exam on the last day of class, Wednesday November 1st. It will be a closed book exam. Calculators, computers, and communication devices are also not allowed. However, special or unusual formula or integrals essential to a particular question will be written down for that question. The final exam counts towards 50% of the total grade. ***You must not miss the Final Exam (except for documented illness or family emergency).***

Some questions in the exam will be similar to those you have seen in homework. This is to make sure that you don't just copy homework answers without truly understanding how to answer on your own. Thus, it is important to review homework sets and solutions before the exams. Exam questions will be graded based on the method used, as well as the answer. Therefore, you should write down explicitly and clearly step by step how you come up with your answers. This will help you getting partial credit.

## VIII. Grading

The final grade will be composed of:

Final exam:	50 %

Homework	50 %
Total:	100 %

The course will be graded approximately on the following scale:

> 90 %	A
87 % -- 90 %	A-
83 % -- 87 %	B+
80 % -- 83 %	B
77 % -- 80 %	B-
73 % -- 77 %	C+
70 % -- 73 %	C
67 % -- 70 %	C-
63 % -- 67 %	D+
60 % -- 63 %	D
57 % -- 60 %	D-
< 57 %	F

## IX. Getting Help

I will be at Reichardt 108 during my office hours posted above. Canceled office hours will be announced in class or by email. If you need to see me outside these office hours, please set up a time by appointment to come to my office at Elvey 706E. These are hours set aside especially to help you - do not feel like you are imposing or cheating by coming in. If you have problems that need immediate attention, please send me an e-mail or give me a call at my office phone number.

## X. Disabilities Services

The Physics Department will work with the Office of Disabilities Services (<http://www.uaf.edu/disability/>) to provide reasonable accommodation to students with disabilities.

## XI. Tentative Schedule

Below is a tentative schedule (subject to change). You should read the sections of the reference book before coming to the class for that day.

Date		Topics (from Martin 2006)	homework due
11/1	F	1.6 Observable quantities: cross sections and decay rates Appendix C: Rutherford Scattering 2.2 Nuclear shapes and sizes 1.7 Units: length, mass and energy	
11/4	M	2.1 Mass spectroscopy and binding energies 2.3 Nuclear instability 2.4 Radioactive decay 2.5 Semi-empirical mass formula: the liquid drop model	
11/6	W	7.1 The nucleon – nucleon potential 7.2 Fermi gas model 7.3 Shell model	

		7.4 Non-spherical nuclei 7.5 Summary of nuclear structure models	
11/8	F	7.6 alpha-decay 2.6 beta-decay phenomenology 7.7 beta-decay --- neutrino	
11/11	M	2.7 Fission 2.8 gamma-decays 2.9 Nuclear reactions 7.8 gamma-emission and internal conversion 8.1 Fission	
11/13	W	8.2 Fusion 4.3 Particle interactions with matter 8.3 Biomedical applications	HW1
11/15	F	4.2 Accelerators and beams 4.4 Particle detectors 4.5 Layered detectors	
11/18	M	1.2 Relativity and antiparticles 1.3 Symmetries and conservation laws 1.4 Interactions and Feynman diagrams 1.5 Particle exchange: forces and potentials	
11/20	W	3.1 Leptons 3.2 Quarks	HW2
11/22	F	3.3 Hadrons 9.1.3 Supersymmetry	
11/25	M	5 Quark Dynamics: the Strong Interaction 5.1 Colour 5.2 Quantum chromodynamics (QCD) 5.3 Heavy quark bound states 5.4 The strong coupling constant and asymptotic freedom 5.5 Jets and gluons 5.6 Colour counting 5.7 Deep inelastic scattering and nucleon structure	
11/27	W	6.1 Charged and neutral currents 6.2 Symmetries of the weak interaction	HW3
12/2	M	6.3 Spin structure of the weak interactions 6.4 $W^\pm$ and $Z_0$ bosons	
12/4	W	6.5 Weak interactions of hadrons 6.6 Neutral meson decays	HW4
12/6	F	6.7 Neutral currents and the unified theory 9.1.1 The Higgs boson 9.1.2 Grand unification	
12/13	F	Final exam 1-3 PM	
12/16	M	This is absolutely the last day for submitting any missed work to me, as well as discussing with me about your grades.	
12/18	W	Final grades will be submitted by noon. They will also be posted on Blackboard.	

STUDENT PROTECTIONS AND SERVICES STATEMENT:

Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc. to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: [www.uaf.edu/handbook/](http://www.uaf.edu/handbook/).

UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: <https://alaska.edu/nondiscrimination/>.

Your instructor follows the University of Alaska Fairbanks Incomplete Grade Policy: “The letter “I” (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) the majority of work in a course but for personal reasons beyond the student’s control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an “I” grade.”

Effective communication: Students who have difficulties with oral presentations and/or writing are strongly encouraged to get help from the UAF Department of Communication’s Speaking Center (907-474-5470, [speak@uaf.edu](mailto:speak@uaf.edu)) and the UAF English’s Department’s Writing Center (907-474-5314, Gruening 8th floor), and/or CTC’s Learning Center (604 Barnette Street, 907-455- 2860).