

Syllabus

Physics 926 Introduction to Nuclear and Particle Physics Spring Semester 2024

Instructor: Ilya Kravchenko
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Office Hours: Wednesday 13:00-15:00

Prerequisites: PHYS 914 (E&M II) and PHYS 917 (QM II),
or permission from the instructor

Lecture:
Tuesday, Thursday 12:30-13:45, Jorgensen 145

Course Description

In this course, we will review the present state of particle physics. We will focus on the standard model of elementary particles, both on the theoretical and experimental side. The first half of the semester will be spent on building up the foundation and reviewing relevant material, including symmetries, Lagrangian formalism, quark model, introduction to Feynman diagrams, and basic QED. The second half of the semester will be the review of EWK and QCD components of the standard model as well as its neutrino sector. Physics beyond the standard model will be briefly discussed at the end. A variety of most recent experimental results from the Large Hadron Collider and other particle physics facilities and experiments will be presented in depth.

Textbooks

Required: *Introduction to Elementary Particles*, D. Griffiths, Edition second, revised (2008).

Recommended: *Quarks and Leptons: An Introductory Course in Modern Particle Physics*, F. Halzen, A.D. Martin (1984).

Online reference: Particle Data Group website <http://pdg.lbl.gov> is a useful summary of knowledge of particle properties, composition of hadrons, particle decays, as well as reviews of numerous aspects of particle physics.

Lectures

Lectures will primarily consist of explanations of the material by the instructor with an occasional short quiz. The attendance will not be checked, however it is strongly recommended not to miss the lectures. Sometimes, there will be surprise quizzes. The material of this course is sufficiently challenging, and students should not rely on the textbooks alone. For the best results, students are recommended to familiarize themselves with the appropriate portions of the textbook(s) before each lecture. The textbook-to-lecture correspondence will be announced in advance.

Assignments

Homeworks. There will be homeworks offered roughly every week or two weeks. The homeworks will consist of problems mostly at the level of Griffiths end-of-chapter. Collaboration in solving homework is permitted and encouraged. However, you must describe your solutions independently. Copying from your classmates or Internet sources is strictly prohibited.

Quizzes. Occasionally, quizzes will be offered in the beginning of the lectures, with several relatively simple questions that are expected to take 5-15 min. Some of the material covered in this course is not appropriate for homework, such as historical facts, or general/qualitative concepts, as these are very easy to answer at home with a textbook in front. The quizzes will test on that type of material. The quizzes will be closed book, and the use of notes normally won't be allowed. Some reference material will be provided for the quizzes when necessary.

Projects. There will be one "project" assignment in the second half of the semester. The nature of the project will be announced later in the semester. It could be an assignment to write a review of a journal paper. One of the learning outcomes of this course is expected to be the ability of students to read and understand a typical experimental paper on particle physics of the level of papers published by LHC experiments. Throughout this course there will be several lectures devoted to experimental topics. Papers will be assigned once we cover those topics, in the second half of the semester. Each student will get their own individual paper to review. The guidelines for writing a review (typically an essay of ~3 pages) will be provided separately. An alternative project selection may be possible, of the type involving computing: writing a simple program of particle physics interaction simulation or simple analysis of provided data accompanied by a three-page or so report of predefined format.

If an assignment is missed for a good reason (in the case of sickness a doctor's note will be needed), the instructor should be warned before the deadline.

Examinations

There will be one midterm exam in the middle of the semester. The exam will last 75 minutes and will happen at a regular lecture slot. There will also be a final exam during the Finals week, which will last for two hours and will be offered at a time that will be announced separately. All exams will be closed book and no notes will be allowed. Make-up exams will be possible only if the exam is missed because of a very good reason, and the instructor has to be notified before an exam is missed.

Grading

The following weights will be used in assigning the grades:

Homeworks	50%
Project or paper review	10%
Quizzes	15%
Midterm exam	10%
Final exam	15%

Any discussion of a grade on a homework, quiz, etc must be made within 2 weeks after the graded work is available to the student.

The grades will be determined from your final score using the table below. The table shows the lower cutoff for a grade (total 100%). For example, if your score is greater or equal to 80% but less than 83% you will get a B.

95 %	A ⁺
90 %	A
87 %	A ⁻
83 %	B ⁺
80 %	B
77 %	B ⁻
73 %	C ⁺
70 %	C
67 %	C ⁻
63 %	D ⁺
60 %	D
50 %	D ⁻
less than 50 %	F

AI tools

In this course, it is recommended that you avoid using tools like ChatGPT for assistance with your homeworks. Better discuss homework problems, if you have to, with your classmates. If you are assigned an essay or paper review project in this course, you may use these tools to proofread your essay, improve grammar or style, reduce text size and such (i.e. editorial help), but do not use them to actually write the content. Note also that while the output of those systems may sound convincing, it could be rather off in subtle ways for highly specialized fields such as fundamental particle physics (I had a laugh once reading what it had to say when I asked it to comment on the Data Acquisition System of the Askaryan Radio Array neutrino experiment that I am working on).

Academic Integrity

Refer to the Student Code of Conduct and Academic Integrity, which can be found at the Student Judicial Affairs Web site and in the back of the Undergraduate Bulletin. The first violation of the code will result in at least a failing grade for the assignment and notification of university officials. Further action may be taken. Subsequent violations will result in failure for the course, along with notification of university officials. To avoid situations of cheating, plagiarism or academic dishonesty, start your work early and contact the instructor in advance if something is unclear.

For Students with Disabilities

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the [Services for Students with Disabilities](#) (SSD)

office, 132 Canfield Administration, 472-3787 voice or TTY.

Instruction continuity

If in-person classes are canceled (for example, due to weather), you will be notified of the instructional continuity plan for this class by a class-wide email through Canvas. Under certain circumstances, a lecture or a recitation section may be conducted online via Zoom at the regular class time slot, and a recording would be made available as well.

UNL-wide policies

UNL has several the University-wide policies that are not repeated here but can be found on the following web site:

<https://executivevc.unl.edu/academic-excellence/teaching-resources/course-policies>

Please refer to that web site as needed. These policies include: University-wide Attendance Policy, Academic Honesty Policy , Accommodations for Students with Disabilities Policy, Resources for students seeking mental health help, Final Exam Week Schedule, Emergency Procedures, Diversity and Inclusiveness, Title IX Policy.