Syllabus

Physics 926
Introduction to Nuclear and Particle Physics
Fall Semester 2015

Instructor: Ilya Kravchenko
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Office Hours: Wednesday 14:00-15:30

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

Lecture:
Tuesday, Thursday 12:30-13:45, Jorgensen 247

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 Tevatron and Large Hadron Collider 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 quiz in the beginning of the lecture. 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.

Paper reviews. There will be one or several short paper reviews to write. 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 Tevatron or LHC experiments. Throughout this course there will be several lectures devoted to experimental topics. Papers will be assigned at the times of those lectures. Each student will get his/her own individual paper to review. The guidelines of writing a review (typically an essay of ~3 pages) will be provided separately.

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 and papers	50%
Quizzes	25%
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.

Physics 926 Fall 2015 Class Schedule

Note: the lecture sequence may change as semester progresses. Changes will be announced over email and at the lectures.

Date		Topic
Aug 25	Tue	Introduction, fermions and bosons of the standard model
Aug 27	Thu	Qualitative standard model: interactions, Feynman diagrams
Sep 1	Tue	Symmetries, group theory review
Sep 3	Thu	Symmetries: SU(2) applications to spin, isospin, flavor
Sep 8	Tue	Symmetries: SU(3) flavor and color, discrete symmetries
Sep 10	Thu	Special relativity and kinematics of particle interactions
Sep 15	Tue	Review of Lagrangian formalism
Sep 17	Thu	Lagrangians in quantum field theories
Sep 22	Tue	Lagrangians in quantum field theories II
Sep 24	Thu	From Lagrangians to observables: decay rates and cross sections
Sep 29	Tue	Fermi Golden Rule, and Feynman calculus in a toy QFT
Oct 1	Thu	QED: Dirac equation and free particle solution
Oct 6	Tue	QED II: spinors, bilinear covariants, free photons
Oct 8	Thu	QED III: Feynman rules for QED, matrix elements, Casimir trick.
Oct 13	Tue	QED IV: matrix elements computation, traces, cross sections
Oct 15	Thu	Midterm exam
Oct 20	Tue	Fall Break
Oct 22	Thu	EWK
Oct 27	Tue	EWK II
Oct 29	Thu	EWK III
Nov 3	Tue	EWK IV
Nov 5	Thu	EWK V
Nov 10	Tue	Experimental HEP overview
Nov 12	Thu	EWK experimental review
Nov 17	Tue	EWK experimental: Higgs boson studies
Nov 19	Thu	QCD
Nov 24	Tue	QCD II
Nov 26	Thu	Thanksgiving Holiday
Dec 1	Tue	QCD experimental
Dec 3	Thu	Neutrino physics: theory
Dec 8	Tue	Neutrino physics: review of experimental results
Dec 10	Thu	Physics beyond the standard model: theory and experiment overview
Dec 15	Tue	Final exam (Tuesday, 10am-12noon)

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.