Weekly Schedule

This course is designed as the first quarter of a three-quarter sequence on particle physics. The topics include:

Week 1: Particles, fields, measurements
Week 2: Scattering amplitudes and cross sections
Week 3: QED
Week 4: $R$, mesons, quarks
Week 5: $Z$ resonance
Week 6: Precision electroweak measurements
Week 7: Asymmetries; fermion chirality
Week 8: Symmetries for mesons and baryons
Week 9: Deep inelastic scattering
Week 10: Parton distribution functions
Exam week: (no reading)

Objectives

The objectives of the course is to gain sufficient grasp of the syllabus material to calculate basic
processes in particle physics and to grasp how particle detectors are able to measure particle properties. This involves gaining an understanding of particle classifications, detectors, cross sections, decay rates, symmetries, and other topics relevant to a modern particle physicist. The course expectations are that you successfully work through all of the problems of the homework assignments and give an excellent mini-lecture/presentation.

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### Learning Outcomes

1. Students will be able to compare and contrast the fundamental particles, forces, and their properties.

2. Students will be able to apply relativistic kinematics to describe scattering and decays and compute relevant quantities (e.g., decay widths, branching fractions).

3. Students will be able to draw tree-level Feynman diagrams corresponding to Standard Model interactions.

4. Students will be able to distinguish between chiral and vector-like theories and cite examples in the Standard Model.

5. Students will be able to distinguish between scattering by an elementary particle versus composite particle, and characterize when the scattering regime uses form factors versus deep inelastic scattering.

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### Workload

**Reading:** Reading assignments will be assigned periodically.

**Assignments:** Homework assignments will be assigned periodically and due roughly one week later. There will be one homework assignment due either the last week of classes and/or the exam week. The homework assignments include problems on kinematics, 4-momentum conservation, quantum electrodynamics, Lorentz invariant phase space, Feynman diagram use to construct amplitudes, summing and squaring amplitudes to obtain cross sections and decay rates, simple group theory for particle physics, use and estimate of form factors, observables in deep inelastic scattering, and estimates of parton distribution functions. Anticipate 5-6 assignments over the quarter.

**Final presentation:** The purpose of the final presentation/project is to read and present the experimental evidence for the discovery of a (famous or at least relatively famous) particle. Everyone should select their own particle to present. Investigate what experiment(s), experimental setup(s), and experimental evidence led to the discovery of your particle. Then, summarize and explain it to all of us (oral presentation). The final presentations will be scheduled to occur either the last week of classes or during exam week. Anticipate many hours during the final weeks of the quarter to select your topic, read and research your topic, discuss details with me, prepare your report,
prepare your final presentation, and listen to all of the students’ final presentations.

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**Grading Policy**

Your grade is determined by your weekly homework assignments (75% of grade) and your final project/presentation (25% of grade).

**Assignments:**
A-level grade: All or virtually all problems of all homework assignments done correctly and turned in on-time.
B-level grade: A solid attempt on virtually all problems of all homework sets turned in on-time.
C-level: Habitually late homework, ≥ 1 missed homework sets, several missed or incorrect problems on several problem sets.

**Final project/presentation:**
A-level grade: Project write-up and presentation is clear, well-organized, understandable, and questions during presentation are adequately addressed.
B-level grade: Project write-up and presentation is clear, organized, understandable but with some issues, and questions during presentation are partially addressed.
C-level grade: Project write-up and presentation is less clear, not particularly well organized, not understandable by a few students, and at least one third of questions during presentation cannot be answered.

**Late Assignments:**
General: You must do all of the assignments, and turn them in on-time to get a passing grade in the course.
24 hour rule: Assignments will be accepted up to 24 hours late, but with a late penalty. Assignments will **not** be accepted nor graded more than 24 hours after the deadline.
Late penalty: The late penalty is an overall reduction of grade by \( \frac{1}{3} \times (\# \text{ of late assignments} - 1) \). (\( B+ \) becomes \( B \), after two late assignments; \( A- \) becomes \( B \) after three late assignments, etc.). However, it is **your** responsibility to find the grader and be sure they personally gets it within this timeframe.
One late penalty waiver: Inevitably some students need an extra day to finish one assignment due to some unforeseen reason. To be fair to everyone, all students get one waiver. Use your waiver wisely.

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**Comments on Assignment Grading**

Please write clearly, legibly, and organize your solution. Don’t be afraid to waste paper to ensure your solution can be clearly followed, step-by-step. It is highly preferred that you use one-side of the paper, and start new problems and/or parts of problems on new pages.
Accessible Education Statement

The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 360 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu.

Academic Misconduct Statement

The University Student Conduct Code (available at conduct.uoregon.edu) defines academic misconduct. Students are prohibited from committing or attempting to commit any act that constitutes academic misconduct. By way of example, students should not give or receive (or attempt to give or receive) unauthorized help on assignments or examinations without express permission from the instructor. Students should properly acknowledge and document all sources of information (e.g. quotations, paraphrases, ideas) and use only the sources and resources authorized by the instructor. If there is any question about whether an act constitutes academic misconduct, it is the students’ obligation to clarify the question with the instructor before committing or attempting to commit the act. Additional information about a common form of academic misconduct, plagiarism, is available at https://researchguides.uoregon.edu/citing-plagiarism.

University COVID Policies

Details can be found at this URL:
https://provost.uoregon.edu/academic-council-fall-2021-guidance-and-expectations-during-covid-19-pandemic