Physics 461-01: Elementary Particle Physics

Spring 2020 | Department of Physics, Loyola Marymount University

Lecturer: J. Mureika
Class meetings: TR 13:00-14:30, Seaver 109
Office (hours): Seaver 102A (T 14:30-15:30, W 11:30-12:30, R 10:20-11:20 or by appointment)
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Outline:

Particle physics describes the elementary building blocks of Nature: matter and energy. In fact, with the discovery of the Higgs Boson in 2012, the Standard Model of Particle Physics is (along with General Relativity) one of the most experimentally-validated theories to date. This course will introduce you to the historical developments that led to this foundational theory, review its mathematical framework, and most importantly, explain where the Standard Model begins to break down – and what might lie beyond!

Learning Outcomes: By the end of this course, you will:

- Understand the concept of a field, as well as particle creation and annihilation.
- Know the difference between fermions and bosons, and their general functions.
- Appreciate the impact of Lorentz invariance in particle physics.
- Understand the connection between gauge symmetries and conserved quantities.
- Know the importance of the Standard Model and its extensions.
- Recognize the difficulties in incorporating gravitation and particle physics.

Math background: This course requires an advanced knowledge of calculus (MAT 234), differential equations (MATH 245), and linear algebra (MATH 250). Familiarity with group theory (MATH 331), topology (MATH 471), and differential geometry (MATH 473) is useful, but not required. You should know how to use Maple and/or Mathematica for heavy-duty equation solving, as we will make extensive use of this to calculate and solve otherwise-daunting coefficients and equations. Quantum Mechanics (PHYS 321/22) is a pre/co-requisite.

Textbooks and Reading:

- Required: *Introduction to Elementary Particles (2nd revised ed.),* David Griffiths

Other relevant material will be distributed in handout form and/or as a downloadable document on the website.

Readings will generally be assigned for each upcoming class. *Please be sure to complete them prior to coming, and bring questions*! The small size of the class demands interactivity.

Marking scheme:

Problem sets	8 @ 5%	40%
Midterm exam	1 @ 30%	30%
Final exam	1 @ 30%	30%
Total:		100%

A	93-100%	C+	76-79%
A-	90-92%	C	73-75%
B+	86-89%	C-	70-72%
B	83-85%	D	60-69%
B-	80-82%	F	0-59%

Problem Sets: There will be 8 problem sets distributed at regular intervals during the term. In addition to usual problem solving, some may also be focusing on numerical and symbolic solution techniques using Maple/Mathematica or other computer applications. Problem sets must be submitted *in class* on the due date indicated, and will not be accepted for credit beyond that time.

Midterm exam: The midterm exam will be a **take-home exam** distributed during the week of March 2nd. More details will be given prior to this date.

Final Exam: The final exam will be cumulative, and will also be a **take-home exam** written during finals week**.** Details will be specified as the course proceeds.

Attendance: Class attendance is strongly encouraged in order for you to master the material. Three unexcused absences will result in a full letter grade reduction, as will each subsequent unexcused absence. A maximum of six unexcused absences will result in ***failure of the course***. Any medical-related absence *must* be documented by appropriate documentation from the attending physician, or this will count as an unexcused absence.

Class conduct advisory: The use of cellular phones, PDAs, MP3 players and other electronic equipment is not allowed during class time. Cell phones must be set to vibrate before entering the classroom and must be kept inside a backpack, purse or pocket. Bluetooth earpieces must be removed and music players must be put away before entering the classroom. Emergency communications are exempted.

Statement of Academic Honesty: Academic dishonesty will be treated as an extremely serious matter, with serious consequences that can range from receiving no credit for assignments/tests to expulsion. It is never permissible to turn in any work that has been copied from another student or copied from a source without properly acknowledging the source. It is your responsibility to make sure that your work meets the standard of academic honesty set forth in the "LMU Honor Code and Process" in the Undergraduate Bulletin 2008-2010 pages 61 – 64.

THIS SYLLABUS AND ITS CONTENTS ARE SUBJECT TO REVISION; STUDENTS ARE RESPONSIBLE FOR ANY CHANGES OR MODIFICATIONS ANNOUNCED IN CLASS, ON THE CLASS WEBSITE, OR VIA EMAIL.