

PHYSICS 56400 - Fall 2019

Introduction to Elementary Particle Physics I

Lecturer: Prof. Matthew Jones

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Office hours: Any time really... try your luck (or by appointment).

Class: Lecture: Tuesday and Thursday 10:30–11:45 PM, room PHYS 201.

Text: Martin and Shaw, *Particle Physics*

Website: <http://www.physics.purdue.edu/~mjones/phys56400>

COURSE OVERVIEW:

This is the first part of a two-semester course sequence to give an introduction to Particle Physics. Focus is given to the experimental features, with phenomenological and theoretical considerations and the interplay between theory and experiment. This is not intended to be a formal course in particle theory. Most students will be concurrently taking a course in field theory (PHYS 662/663) which will serve as a more formal complement to the treatment given in this class.

The goal of the course is to prepare graduate students for research in particle physics and related areas. The emphasis is on the understanding of the basic concepts and on doing simple calculations.

After a chronological introduction, the Standard Model of particles and interactions is described with an emphasis given to the electroweak theory. The topics covered include a historical survey of the major discoveries in particle physics, kinematics and quantum mechanics of scattering and decay of particles, particle accelerators, particle interactions with matter, experimental techniques, quarks and leptons, the role of symmetries and a discussion of the electromagnetic, strong, and weak interactions.

LECTURES:

The lectures will be used to introduce new concepts. Read the assigned material in advance of the lecture and then again afterwards for optimal comprehension. Your active participation during lectures with questions and comments is strongly encouraged. Please do not hesitate to, or be shy about, asking questions.

We will loosely follow the textbook: Martin & Shaw, “Particle Physics”, 4th edition (John Wiley and Sons, 2017). I also recommend David Griffiths, “Introduction to Elementary Particles”, 2nd edition (Wiley, 2008). The textbook for this course is more experimentally oriented, while the textbook by Griffiths has more theoretical details. It is not required to

have a book but will be useful for further explanation. Decide for yourself if you want to buy one.

PREREQUISITES:

No previous background in particle physics is assumed but understanding of quantum mechanics at the PHYS 360/PHYS 550 or PHYS 460/PHYS 461 level is required. These courses may be taken simultaneously.

ASSIGNMENTS:

Specific reading assignments will be given supplementing the lecture material covered in class. A tentative reading and homework assignment schedule will be posted on the course website. You should read the assigned sections before attending lecture. You can always find an up-to-date version on the course website (Schedule).

HOMEWORK:

Problem solving is an essential as well as an integral part of this course. There will be approximately 10 homework assignments and problem sets will be assigned each Tuesday. The homework is due and has to be brought to the lecture on Thursday of the following week. Homework grades will count approximately 30% towards your course grade. Students may discuss the problems with each other in a general way but should **not** do the homework as a group effort. No carbon copy homework sets are acceptable. Further, the problem solutions should be clearly and neatly written on one side only of standard size paper. Your fellow students should be able to read, follow and understand the solutions. The quality of the presentation counts towards the grade. The problem sets will be written in a format that has your name, PHYS 564, and the due date in the upper right hand corner of the first page and your name and PHYS 564 on each following page. The question should first be written out and then followed by the solution. Assignments will be posted on the course web page.

1. Use 8½ by 11” paper.
2. Write only on one side of the page.
3. Number the pages.
4. Write clearly and neatly.
5. Solutions should be complete, comprehensive, logical, and clearly presented.
6. Staple pages together for hand in.
7. Remember to put your name on the front of the first page in hand in.
8. Homework is due in class on the day indicated on the problem set.
9. Please contact your instructor prior to the due date if you need an extension.

EXAMS:

There will be one midterm exam during the semester but no final exam. Information regarding the exams will be announced later. Instead of the usual final exam, a research paper with both written and oral presentations is required. Students will be asked to write a brief review paper and present a twenty-minute seminar on a topic selected from a list. Starting literature will be provided and students will be expected to find additional

resources. The seminars will be presented near the end of the semester.

GRADING:

Your course grade will be based on homework, exam scores and the final term paper, with the approximate weights:

Homework	30%
Midterm exam	30%
Final term paper	40%

We will use plus-minus letter grades in the final grading of this course. **The exact cut-offs for letter grades will not be determined until the end of the semester.**

ABSENCES AND EXCUSED GRADES:

Homework sets are due on the dates indicated on the class calendar. Your work is due on time, with the exception of reasonable documented excuses. If you are going to miss an exam, you must notify the instructor **in advance** (preferably one week) so alternative arrangements can be made. Unexcused absences from any exam will be assigned a zero grade; Excused grades will be given only in one of the following circumstances: (1) illness; (2) personal crisis (e.g., automobile accidents, required court appearance, death of a close relative, weather conditions that make it impossible to get to the university); and (3) required attendance at an official Purdue activity (e.g. athletics). You **must** contact your lecturer as soon as possible but **before** the exam and discuss your problem. Appropriate documents (e.g., a written note from a doctor, with his/her name and phone number included) may be needed to judge the merit of the excuse.

SUPPLEMENTAL TEXTS:

Besides our textbook, the following are useful references:

1. D. Griffiths, *Introduction to Elementary Particles*, 2nd ed., Wiley-VCH, 2008, ISBN: 978-3527406012.
2. F. Halzen and A.D. Martin, *Quarks & Leptons: An Introductory Course in Modern Particle Physics*, John Wiley & Sons, 1984, ISBN: 978-0471887416.
3. M. Thomson, *Modern Particle Physics*, Cambridge University Press, ISBN: 978-1107034266
4. D.H. Perkins, *Introduction to High Energy Physics*, 4th ed., Cambridge University Press, 2000, ISBN: 978-0521621960.
5. B.R. Martin and G. Shaw, *Particle Physics*, 3rd ed., John Wiley & Sons, ISBN: 978-0470032947.
6. A. Seiden, *Particle Physics: A Comprehensive Introduction*, Addison-Wesley, 2004, ISBN: 978-0805387360.
7. V.D. Barger and R.J.N. Phillips, *Collider Physics*, Addison-Wesley, 1996, ISBN: 978-0201149456.
8. W.R. Leo, *Techniques for Nuclear and Particle Physics Experiments*, 2nd ed.,

- Springer, 1994 ISBN: 978-3540572800.
9. C. Grupen and B. Shwartz, *Particle Detectors*, 2nd ed., Cambridge University Press, 2011, ISBN: 978-0521187954.

Additional Resources:

[Particle Data Group](#)

[The Particle Adventure](#)

[The Particle Detector Briefbook](#)

[Ch. Joram: Particle Detectors](#)

STUDENTS WITH DISABILITIES:

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University. It is the student's responsibility to notify the Disability Resource Center of an impairment/condition that may require accommodations and/or classroom modifications.

EMERGENCIES:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Here are ways to get information about changes in this course:

- Course web site: <http://www.physics.purdue.edu/~mjones/phys56400/>
- E-mail: jones105@purdue.edu (use subject PHYS 564)
- Phone: 49-62464