

Syllabus for Particle Physics (Phys 694)

Spring, 2006

Instructor information:

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Course objectives: This course is, in the words of the course catalog, “an experimental and phenomenological introduction to high energy physics.” A specific and measurable, if somewhat ambitious, “student learning outcome” is as follows: by the end of the course, you, the successful student will

- ... have a basis to read and **understand** any part of the **Review of Particle Physics**, especially the sections on the **standard model and related topics** and **experimental methods**.
- ... know the **experimental basis** of the model.
- ... be familiar with the range of observable **phenomena** related to particle physics.

This goal should be qualified by the caveat that the understanding gained may not extend to the deepest possible level. For example, you might not be able to write down the most general Lagrangian containing every possible renormalizable term obeying $SU(3) \times SU(2) \times U(1)$ symmetry and then derive the Feynman rules for the interactions of the corresponding particles. But you should have some idea what the previous sentence means, what courses you would take in order to be able to learn how to do such a thing, and what might motivate someone to do so.

Texts:

- D. Griffiths, **Introduction to Particle Physics**, J. Wiley and Sons.
- S. Eidelman, *et al.*, **The Review of Particle Physics**, Phys. Lett. B592, 1 (2004), as updated for edition 2006.

Please note that **The Review of Particle Physics** is available online from <http://pdg.lbl.gov>. It is possible to obtain all parts of the book electronically. We also have some printed copies in the HEP group offices. It is possible to order a printed copy from the Particle Data Group (PDG) if you really want, but it shouldn't really be necessary.

Course web site: <http://www.phys.ksu.edu/personal/gahs/phys694/>

Homework problems: (initial plan, subject to improvement) Homework is due at the beginning of class on Tuesday. In class on Tuesday, I'll hand out my solutions, and you'll swap and grade each other's papers. (See “How to grade your peers' homework” below.) This will be followed by some in-class discussion. Then if you want, you can take your own paper home (but not my solution!), re-do it, and turn it in on Thursday for a final grade. I intend to be fairly strict in enforcing the homework deadlines, just so you don't fall behind and I don't get swamped.

Collaboration in figuring out how to do the homework and cross-checking of results is permitted and encouraged, but you must work out and write up your solutions independently. (No copying!) The homework will be graded on the quality of your reasoning and math and how

well they support the result obtained.

Homework problems will be assigned on Thursday. After the first week, I intend to ask for your participation in choosing the problems that will most enhance your understanding. Generally, homework problems will be taken from Griffiths, but sometimes we might choose problems based on the Review of Particle Physics or some other source.

How to grade your peers' homework: Evaluate the reasoning and math shown. Is it clear? Is it correct? Does it lead to the stated conclusion, and none other? Assign a rating something like a critic would rate a movie:

- ☆☆☆☆ Goal, strategy, and solution are all outstanding.
- ☆☆☆ All basically okay, but some problem in execution or presentation.
- ☆☆ Good try, but went off track.
- ☆ Clear understanding of goal, no clear strategy or solution.
- X None of the above.

Feel free to grade my solutions, too. You may not always feel I deserve 4 stars. ☺

When exchanging papers for “peer review”, please exchange with someone with whom you have not collaborated, to avoid any “echo chamber” effect. It should be possible to arrange collaborations such that this is always possible.

Reading: It is important that you read the chapters to be discussed in class before class, for reasons that will become clear.

“Lectures”: Rather than give one-way lectures, I intend to run the class as more of a seminar or workshop. Classes will consist mostly of discussion of the text (this is why you must read it!) and working out example problems and key derivations in class.

Final exam: There will be one exam at the end to confirm you really can do this work independently. It will be take-home, open-text, and open-notes. No collaboration is allowed on the final, and no outside help is permitted other than the official course texts, your notes, and your own homework from the course. You must be able to work independently in the end – keep this in mind throughout the course! The final will be handed out on the last day of class, and will be due at noon on Wednesday of finals week.

Course grade: The course grade will be based ~85% on homework, ~15% on the final exam. (Implication: don't skip any homework, and don't bomb the final!)

Help: Any student wanting individual help is welcome to see me during office hours, or at other times by appointment. You should also try talking to other students in the class.

Approximate schedule: As noted in Griffiths's preface, there is more material than can be covered in a single semester. I will follow Griffiths's lead, and ask you to read the Introduction and Chapters 1 and 2 on your own. Just to make sure everyone is up to speed with that material, the first homework will be from those two chapters. We will review that on the first Tuesday,

and then if everyone's okay with it, I'll begin teaching in earnest with Chapter 3.

Some open-ended limits on what we'll cover and how long we'll spend on each topic are given in the table below. All references to "Chapter n" refer to Griffiths. Since the Review of Particle Physics (RPP) changes its chapter numbering between versions, I refer to its sections by name.

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| $\geq \frac{1}{2}$ week | Chapters 1 & 2 "on your own" Homework: problems 1.3, 2.5, and 2.7, due first Tuesday of semester. |
| ≥ 1 week | Chapter 3 (Relativistic Kinematics), plus "Kinematics" from RPP |
| $\geq 1\frac{1}{2}$ week | Chapter 4 (Symmetries), plus "Clebsch-Gordon, SU(3) and SU(n)" and "CP violation" sections from RPP. |
| ≥ 1 week | Chapter 6 (Feynman calculus) |
| ≥ 2 weeks | Chapter 7 (QED) |
| ≥ 1 week | "Passage of particles through matter" and "Particle detection" sections from RPP. (Possibly also "Accelerator Physics" given time and interest.) |
| ≥ 1 week | Chapter 8 (Electrodynamics of quarks and hadrons), plus "Cross sections for specific processes" from RPP |
| ≥ 1 week | Chapter 10 (Weak Interactions), plus "Electroweak model" from RPP |
| > 1 week | Chapter 11 (Gauge Theories), plus "Electroweak model" from RPP (again!) |
| < 5 weeks | Physics beyond the standard model: may include LHC, leptogenesis, SUSY, extra dimensions, and other current topics, as time allows. |

The above plan is ambitious, but if we do well then we get to have a lot more fun at the end.

Other important notices:

Students with Disabilities: If you have any condition such as a physical or learning disability which will make it difficult for you to carry out the work as outlined here, or which will require academic accommodations, please notify me and contact the Disability Support Services office (Holton 202, see also <http://www.ksu.edu/dss/>) during the first two weeks of the course.

University Honor System: All students are participants in the University's Honor System. Among other things, this means that the Honor Pledge applies to all work done for this class. In this class, you are permitted and encouraged to work with (but not to copy from!) other students on homework problems. If anything is unclear about the Honor System, the Honor Pledge, the concept of "unauthorized aid", or anything else, please talk to me about it sooner rather than later.

Academic Dishonesty Warning: Plagiarism and cheating are serious offenses and may be punished by failure on the exam, paper or project; failure in the course; and/or expulsion from the university. For more information refer to the "Academic Dishonesty" policy in the K-State Undergraduate Catalog and the Honor System Policy on the web at <http://www.ksu.edu/honor/>.

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