

# Syllabus for Particle Physics (Phys 694)

## Spring, 2022

**Special participation and in-person/remote policies:** please read the [Participation and In-Person/Remote Policy](#) on the last two pages of this syllabus.

**Class meeting time and place:** MWF 10:30-11:20 p.m., Cardwell 145

### Instructor information:

Name: Glenn Horton-Smith

Phone: 532-6476

Office: CW032B

Email: [gahs@phys.ksu.edu](mailto:gahs@phys.ksu.edu)

Office Hours: TuTh 3-4, or by appointment

**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, learning outcome is this: by the end of the course, you, the successful student, will ...

- ... have a basis to read and **understand** the **Review of Particle Physics**, especially the sections on the **standard model and related topics** and **experimental methods**.
- ... know the **experimental basis** of the standard model.
- ... be familiar with a range of observable **phenomena** related to particle physics.
- ... be able to perform basic **quantitative calculations** related to particle energy, momentum, cross-section, event rate, and detector performance needed to understand the topics above.

### Primary texts:

- *Modern Particle Physics* by Mark Thomson (Cambridge University Press 2013).
- *The Review of Particle Physics (2021)*, P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020) and 2021 update. Available at <http://pdg.lbl.gov>.

### Supplementary texts (new!):

- *Particle Physics Reference Library, 2020 Edition*, by Herwig Schopper (Editor). A joint CERN-Springer initiative. Open access. Available on Kindle for \$0.00 at <https://www.amazon.com/dp/B08MQ3YK5Q>. Available in PDF and other formats at
  - <https://link.springer.com/book/10.1007/978-3-030-38207-0> (vol. 1),
  - <https://link.springer.com/book/10.1007/978-3-030-34245-6>, (vol. 2), and
  - <https://link.springer.com/book/10.1007/978-3-030-35318-6> (vol. 3).

**Course web site:** access via K-State Online ([canvas.k-state.edu](https://canvas.k-state.edu)).

**Class format:** 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 (please read in advance!) and working out example problems and key derivations in class. On some days it will be mostly me showing how to work out the problems, and on other days it will be mostly students telling or showing me how to work out the problems.

**Reading:** It is important to read the chapters to be discussed in class before class. (See schedule below.)

**Homework problems:** Homework will be given every week, and will be due 7 days after you receive it. I intend to be fairly strict in enforcing the homework deadlines, just so you don't fall behind and I don't get swamped. Most of the homework problems should not take a lot of time. Please let me know if you find a problem is taking you a lot of time.

**Collaboration:** Working with classmates on homework and cross-checking of answers is permitted and encouraged, but you must be able to reproduce and explain your solutions independently. The homework will be graded on the quality of your reasoning and math and how well they support the result obtained.

**Final exam:** There will be one relatively low-stakes 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 90% on homework, 10% on the final exam. (Implication: don't skip any homework, and don't bomb the final!)

**Approximate schedule:** An outline of what we'll cover and some approximate ranges of how long we'll spend on each topic are given in the table below. All references to “Chapter n” or “Appendix x” refer to *Modern Particle Physics* (MPP). Since the *Review of Particle Physics* (RPP) changes its chapter numbering between versions, I refer to its sections by name.

~1 week	Introduction and Underlying Concepts: MPP ch 1 and 2, supplemented by RPP “Kinematics”
~1 week	Decay rates and cross sections: MPP ch 3, supplemented by RPP “Cross-Section Formulae for Specific Processes”
~2 weeks	Experimental Methods: “Passage of particles through matter” and “Particle detection” sections from RPP. (Possibly also “Accelerator Physics” if there is time and interest, but probably not.)
~1 week	The Dirac Equation: MPP ch 4
~3 weeks	QED: MPP ch 5-8
~2 weeks	QCD: MPP ch 9-10. (RPP “Quark Model” may also be of interest.)
~2 weeks	Weak interactions: MPP ch 11-12, supplemented by RPP “Electroweak model”
~1 week	Neutrinos and neutrino oscillations: MPP ch 13 (supplemented by RPP)
~1 week	Electroweak unification: MPP ch 15, 17

~1 week	Physics beyond the standard model, as time allows. This may include leptogenesis, extra dimensions, other “LHC” and “ILC” physics, and other current topics.
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**Help:** Any student wanting individual help is welcome to see me during office hours, or at other times by appointment. You should also talk with other students in the class.

**Conditions requiring academic accommodation:** If you have any condition which will require academic accommodations, please notify the instructor and contact the Student Access Center office. For more information, see the “*Statement Regarding Students with Disabilities*” below.

**All Course Syllabi Must Include the Following Statements:**

**Statement Regarding Academic Honesty**

Kansas State University has an Honor and Integrity System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor and Integrity System. The policies and procedures of the [Honor and Integrity System](#) apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. A component vital to the Honor and Integrity System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

**Statement Regarding Students with Disabilities**

Students with disabilities who need classroom accommodations, access to technology, or information about emergency building/campus evacuation processes should contact the Student Access Center and/or their instructor. Services are available to students with a wide range of disabilities including, but not limited to, physical disabilities, medical conditions, learning disabilities, attention deficit disorder, depression, and anxiety. If you are a student enrolled in campus/online courses through the Manhattan or Olathe campuses, contact the Student Access Center at [accesscenter@k-state.edu](mailto:accesscenter@k-state.edu), 785-532-6441; for K-State Polytechnic campus, contact Julie Rowe, Diversity, Inclusion and Access Coordinator, at [jarowe@ksu.edu](mailto:jarowe@ksu.edu) or call 785-826-2971.

**Statement Defining Expectations for Classroom Conduct**

All student activities in the University, including this course, are governed by the [Student Judicial Conduct Code](#) as outlined in the Student Governing Association [By Laws](#), Article V, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

**Statement on Mutual Respect and Inclusion in K-State Teaching and Learning Spaces**

At K-State, faculty and staff are committed to creating and maintaining an inclusive and supportive learning environment for students from diverse backgrounds and perspectives. K-State courses, labs, and other virtual and physical learning spaces promote equitable opportunity to learn, participate, contribute, and succeed, regardless of age, race, color, ethnicity, nationality, genetic information, ancestry, disability,

socioeconomic status, military or veteran status, immigration status, Indigenous identity, gender identity, gender expression, sexuality, religion, culture, as well as other social identities.

Faculty and staff are committed to promoting equity and believe the success of an inclusive learning environment relies on the participation, support, and understanding of all students. Students are encouraged to share their views and lived experiences as they relate to the course or their course experience, while recognizing they are doing so in a learning environment in which all are expected to engage with respect to honor the rights, safety, and dignity of others in keeping with the K-State Principles of Community <https://www.k-state.edu/about/values/community/>.

If you feel uncomfortable because of comments or behavior encountered in this class, you may bring it to the attention of your instructor, advisors, and/or mentors. If you have questions about how to proceed with a confidential process to resolve concerns, please contact the Student Ombudsperson Office. Violations of the student code of conduct can be reported here <https://www.k-state.edu/sga/judicial/student-code-of-conduct.html>. If you experience bias or discrimination, it can be reported here <https://www.k-state.edu/report/discrimination/>.

### **Statement Regarding Wearing of Face Masks**

All students are expected to comply with K-State's face mask policy. As of August 2, 2021, everyone must wear face masks over their mouths and noses in all indoor spaces on university property, including while attending in-person classes. This policy is subject to change at the university's discretion. For additional information and the latest on K-State's face covering policy, see <https://www.k-state.edu/covid-19/guidance/health/face-covering.html>.

### **Other syllabus statements**

See <https://www.k-state.edu/provost/resources/teaching/K-State-Course-Syllabi-Statements-Dec-2021.pdf>

### **Copyright**

Copyright 2022 Glenn Horton-Smith as to this syllabus, lectures, and other course materials, except as noted. All persons are prohibited from selling notes to or being paid for taking notes by any person or commercial firm. In addition, students in this class are not authorized to provide class notes or other class-related materials to any other person or entity, other than sharing them directly with another student taking this class in this semester.

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## **Phys 694 Spring 2022 Participation and In-Person/Remote Policy**

**In-person learning:** We're going to meet in CW 145 at the scheduled times. We might pivot temporarily to fully online if I must quarantine or isolate but am otherwise well. In the (hopefully unlikely!) case that I get too sick to teach, then whether we stay in-person or temporarily go fully online will depend on who is available to substitute for me.

**Remote access:** All classes will also be on Zoom and will be recorded.

**Participation:** Real time participation is expected unless you're ill. Participation can be remotely or in person.

**Student notifications of COVID-19 related absence:** Notify me directly of any COVID-19

related absence. Office of Student Life will not verify COVID-19 absences this semester except in cases where the absence extends beyond five class days or other extenuating circumstances exist. If you are well enough to attend remotely, then please do so in real time. If you're not well enough to attend remotely, just let me know, and we'll handle it like any other illness.

**Indoor face masks:** The temporary indoor face mask requirement is still in place, so everyone must wear face masks over their mouths and noses the classroom.