

**Physics 33-771
Field Theory II
Spring 2020
Carnegie Mellon University**

Meeting Times and Places

Classes:	MWF	1:30pm to 2:20pm	DH 2105
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Instructor: Prof. Colin Morningstar
Office: Wean Hall 8420
Phone: (412) 268-2728
e-mail: cmorning@andrew.cmu.edu
Course web site: <http://www.cmu.edu/canvas>

Course Overview:

This is a second course in relativistic classical and quantum field theory. Topics include calculating scattering cross sections, quantum electrodynamics, spontaneous symmetry breaking, anomalies, the standard model of particle physics, and other advanced special topics in quantum field theory.

Office Hours:

Open-door policy during normal working hours; questions by email or through canvas welcome any time.

Textbook:

There is no textbook for this course; for some topics, lecture notes will be provided. A list of useful references is given below.

Course Objectives

By the conclusion of this course, you should have developed:

- an appreciation for and understanding of elementary particle dynamics and their interactions and the need for quantum field theory to describe them.
- an appreciation of the physical motivations behind both classical and quantum field theories, as well as their symmetries and the repercussions of these symmetries.
- an ability to calculate the n -point functions of a quantum field theory using renormalized perturbation theory and Feynman diagrams, especially in quantum electrodynamics.
- an appreciation of advanced topics in quantum field theory, such as anomalies, spontaneous symmetry breaking, and the standard model of elementary particles.

Grading Overview:

Your final grade will be based on assignments and a written and orally-presented project:

Assignments	50%
Written project report	25%
Project oral presentation	25%

The letter grade cutoffs are A+ 90, A 86, A- 82, B+ 78, B 74, B- 70, subject to small adjustments. In determining the assignment portion of your final grade, all assignments will be

included weighted according to their total points. **Attendance is mandatory.** If you miss more than 3 lectures, your assignment grade weighting will be reduced, and extra work, such as a final examination or an additional assignment, will compensate for the reduction.

Useful references:

- M. Peskin and D. Schroeder, *An Introduction to Quantum Field Theory* (Westview Press)
- S. Weinberg, *The quantum theory of fields*
- J.D. Bjorken and S. Drell, *Relativistic quantum fields*
- Stefan Pokorski, *Gauge field theories*
- C. Itzykson and J.B. Zuber, *Quantum field theory*
- L.S. Brown, *Quantum field theory*
- A. Zee, *Quantum Field Theory in a Nutshell*
- P. Ramond, *Field theory: A modern primer*
- G. Sterman, *Introduction to quantum field theory*
- M. Srednicki, *Quantum Field Theory*
- S. Schweber, *An introduction to relativistic quantum field theory*
- M. Swanson, *Path integrals and quantum processes*

Special Dates:

Monday, January 13	First day of classes
Monday, January 20	Martin Luther King Day (no class)
Friday, March 6	Mid-semester Break (no class)
Mon Mar 9-Fri Mar 13	Spring break (no classes)
Friday, April 17	Spring Carnival (no class)
Friday, May 1	Last day of classes

Assignments:

There will be a handful of take-home assignments during the semester. The due dates will be announced at the time that the assignments are given. These assignments must be done neatly and completely. You should solve each problem as a rough draft, then rewrite the solutions in a final draft that you hand in, with adequate textual asides and information, defining all symbols. You should view these assignments in the same way as essays in a humanities course.

Project:

Each individual will decide on a project in discussion with me. A project can be a particular in-depth calculation, an analysis of a particular paper or series of papers, or a description of an important experiment, for example. A default list of projects will be provided. (Likely examples include: grand unification, supersymmetry, instantons, the standard model, technicolor theories.) You may choose a project from this list, but you are free to choose beyond this list. You must decide on a project by the middle of February.

The written report should be about 8 to 10 pages in length (but longer is acceptable), and the oral presentation should be 20 to 30 minutes in duration. Further details will be provided as the course progresses.

Accommodations for Students with Disabilities:

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

Student Wellness:

As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at: <http://www.cmu.edu/counseling/>. Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.