Quantum Field Theory, continued (Physics 215B)
Winter 2025

Lecturer: John McGreevy
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Office Hours: After lecture or by appointment.

Course times and locations: For times and locations of lectures and office hours please see the course webpage.

Use of the Web: The course web page is

http://physics.ucsd.edu/~mcgreevy/w25/ .

Problem sets, solutions, lecture notes, handouts, announcements, *etc* will be distributed via this page. You should check it regularly (*e.g.* before each lecture) for new material. It will help to look at the relevant lecture notes *before* the lecture happens. Problem set hand-in and return will happen through Canvas.

Content: Here's my initial plan: We will continue the study of (mostly) perturbative quantum field theory, and we will come to terms with the effects of loops. We will learn to use the path integral. Most importantly we will learn the renormalization group point of view on QFT.
After that, maybe: We will learn some things about field theory which are true non-perturbatively. We will learn about gauge theory. We will learn about the crucial notion of Effective Field Theory. We will learn about the Standard Model of particle physics.

Texts: I do not plan to follow any textbook very closely. My posted lecture notes will be the main text. The textbook by Zee is wonderful and you should all keep it by your bedside. I will sometimes refer you to some relevant sections of the following books, which I've tried to place on reserve at the UCSD Library (or are available electronically):

Quantum Field Theory in a Nutshell, by Anthony Zee (electronic version through UCSD library here).

Quantum field theory and the standard model, by Matthew D. Schwartz.

An Introduction to Quantum Field Theory, by Michael Peskin and Daniel Schroeder.

Quantum field theory: an integrated approach, by Eduardo Fradkin.

The quantum theory of fields, vol. 1: foundations by Steven Weinberg (electronic version through UCSD library here).

The quantum theory of fields, vol. 2: modern applications by Steven Weinberg (electronic version through UCSD library here).

Grading:

Grades will be determined by problem sets, class participation, and take-home final.

Problem sets:

Problem sets are a very important part of this course. Sitting down yourself and trying to reason your way through a problem not only helps you learn the material deeply, but also develops analytical tools fundamental to a successful career in science. I recognize that students also learn a great deal from talking to and working with each other. I encourage each student to make his/her own attempt on every problem and then, having done so, to discuss the problems with one another and collaborate on understanding them more fully. Such collaboration adds most to the understanding of those participants who have done the most by themselves first. The solutions you write up after any discussion and then submit must reflect your own work. They must not be transcriptions or reproductions of other people's work.

In doing the problems, you should feel free to use whatever computational software (*e.g. Mathematica*) you find useful; please make a note in your write-up when you do so.

Problem sets will be posted on the course web page

http://physics.ucsd.edu/∼mcgreevy/w22/hw.html .

They will generally be due at the beginning of lecture.

- This quarter, homework will be handed in electronically. The preferred option is to typeset your homework. It is easy to do and you need to do it anyway as a practicing scientist. A LaTeX template file with some examples is provided here. If you need help getting set up or have any other questions please email me.

- To hand in your homework, please submit a pdf file through the course's canvas website (at canvas.ucsd.edu) under the appropriate assignment, hwnm (where *nm* are the decimal digits of the assignment number).

Thanks in advance for following these guidelines. Please ask me if you have any trouble.

Miscellaneous unsolicited advice about how to do well in this class:

Come to lecture! I will post my lecture notes, but they are intended as a supplement to what is presented in lecture, not a substitute.

Keep up with the material. Review the lecture notes from previous lectures before the next one. The structure of this course is a bit of an experiment, and I am relying on all of you to follow its twists and turns. I will post the relevant reading assignments in advance; read ahead.

Start the homework problems as early as possible. Give yourself some time to think about them, and keep them in mind when you are reading and in lecture.

Ask lots of questions: in lecture, in office hours, in the hallway. The fact that you can ask questions is the point of having classes and not just having everyone go learn on their own.