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REQUIRED TEXTBOOK:

Quantum Field Theory and the Standard Model, by Matthew D. Schwartz

Recommended Outside Reading:

Secondary texts:

An Introduction to Quantum Field Theory, by Michael Peskin and Daniel Schroeder
Quantum Field Theory (Second edition), by Lewis H. Ryder

Other useful texts:

Introduction to Gauge Field Theory (Revised Edition), by David Bailin and Alexander Love
Modern Quantum Field Theory, by Thomas Banks
The Conceptual Framework of Quantum Field Theory, by Anthony Duncan
Quantum Field Theory: A Modern Perspective, by V. Parameswaran Nair
Gauge Field Theories, by Stefan Pokorski
The Quantum Theory of Fields, Volumes 1 and 2, by Steven Weinberg
Field Theory: A Modern Primer, by Pierre Ramond *Quantum Field Theory*, by Mark Srednicki
An Introduction to Quantum Field Theory, by George Sterman
Quantum Field Theory in a Nutshell by Anthony Zee
Quantum Field Theory, by Claude Itzykson and Jean-Bernard Zuber

Winter 2015 Course Outline

Topic	Readings*
1. Path Integral Formulation of Quantum Field Theory	Chapter 14
2. Non-Abelian Gauge Theory	Chapters 25, 26.1
3. Spontaneous Symmetry Breaking and Goldstone's Theorem	Chapters 28.1, 28.2
4. Spontaneously Broken Gauge Theories and the Higgs Mechanism	Chapters 28.3, 28.4
5. The Standard Model of particle physics	Chapter 29
6. Introduction to Regularization and Renormalization	Chapters 15.4, 16, 18
7. One-Loop Renormalization of Gauge Theories	Chapters 19, 26.4–26.7
8. The Renormalization Group	Chapter 23
9. The Effective Action and the Effective Potential**	Chapter 34
10. Anomalies**	Chapter 30

* The readings above refer to the textbook by Schwartz.
** If time permits.

Course Requirements

The requirements of this course consist of problem sets and a final project. There will be no midterm or final exam. A list of suggested topics for the final project is provided in the next two pages. Some of the topics require only additional readings in Schwartz or one of the other recommended textbooks already cited. Others will require some consultation with outside sources. Feel free to ask for additional references if needed.

The project may be presented orally or in written form at the end of the academic quarter. Oral presentations are encouraged since they will benefit all members of the class. In choosing your project, you should plan on meeting the following deadlines:

Initial choice of topic for term .... February 5
Short written proposal for term .... February 19
Oral Presentation of term project .... March 18, 4–7 pm
Written version of term project .... March 20

All projects should include a one page bibliography (containing references pertinent to the project). For those projects presented orally, a digital copy of the powerpoint slides (or equivalent) and a brief set of notes will be acceptable in lieu of a full written version.

Suggestions for the final project

For the final project, you may select from one of the topics listed below, or propose another project that is connected to quantum field theory. I will be available during my office hours for suggestions and consultation on your choice for the term project. If you need some suggestions, you might consider choosing from the following list of possible topics for term projects. Note that for each subject listed below, each subtopic constitutes a possible project.

1. Spinor Helicity methods
   (a) Spinor Helicity formalism and applications to tree-level processes
   (b) MHV and NMHV amplitudes
2. Anomalies
   (a) Path integral derivation *vs.* the triangle graph computation
   (b) Broken scale invariance and the anomalous trace of the energy momentum tensor
3. QCD
   (a) The DGLAP equations
   (b) The operator product expansion
4. Topological Objects in Field Theory
   (a) Classical lumps and their quantum descendants
   (b) Instantons and the θ-vacua
5. Infrared divergences and mass singularities
   (a) Summing soft photons
   (b) The Kinoshita-Lee-Nauenberg theorem
6. Effective field theory
   (a) The chiral Lagrangian at one-loop
   (b) Heavy quark effective theory
7. Supersymmetry
   (a) Cancellation of quadratic sensitivity to the ultraviolet cut-off.
   (b) Vanishing of $g-2$ in the supersymmetric limit

8. Precision Tests of the Standard Model
   (a) The one-loop prediction of the W mass
   (b) The S, T and U parameters
9. Fixed points in renormalization group flows
   (a) Conformal field theory
   (b) Wilsonian effective action and renormalization group equations
10. Non-perturbative effects in quantum field theory
   (a) Lattice gauge theory
   (b) The $1/N$ expansion
11. Finite temperature field theory
   (a) Temperature dependent effective potential
   (b) Phase transitions in the early universe