

Physics 680: Advanced Quantum Field Theory

Syllabus (Draft version)

1 Class and Instructor Information

Clifford V. Johnson

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office hours: SSC201, TTh 2:00pm–3:00pm

Class location: SOS B38 TTh 10:00–11:50am

2 Textbooks

The primary source of our conceptual material will be:

—*Quantum Field Theory in a Nutshell*, A. Zee, Princeton University Press, 2003.

For some more detailed computational guidance, we will sometimes use:

—*An Introduction To Quantum Field Theory*, M. E. Peskin and D. V. Schroeder, Addison–Wesley, 1995.

Another excellent conceptual guide will be:

—*Aspects of Symmetry*, S. Coleman, Cambridge University Press, 1989.

Other books will be recommended from time to time through the course of the semester.

3 Topics

We will cover a range of topics which will be of interest to two traditional groups who use quantum field theory a lot: people interested in high energy physics, and those interested in condensed matter physics. The precise split between the two is variable and subject to change.

Topics will include (but not be limited to): **Renormalization and Gauge Invariance:** Renormalizability, Counterterms and Physical Perturbation Theory, Vacuum Polarization. **Symmetry and Symmetry Breaking:** Group Theory, Gauge Symmetry, Global symmetry, Symmetry Breaking, Monopoles, Anderson–Higgs Mechanism, Anomalies. **Field Theory and Collective Phenomena:** Superfluids, Finite Temperature, Critical Phenomena, Superconductivity, Vortices, Monopoles, Instantons. **Field Theory and Condensed Matter:** Fractional Statistics, Chern–Simons Terms, Quantum Hall Fluids, Renormalization Group. **Topics in Gauge Theory:** Yang–Mills, Lattice Gauge Theory, Quantum Chromodynamics, Large N Expansions, Electroweak Unification, Grand Unification. **Advanced Topics:** Effective Field Theory, (see later revised list for more topics.)

4 Assessment

This is an advanced class, with a small enrollment. We are going to take advantage of both of these aspects by having a high level of class interactivity. This means that you will be involved in the lesson plan almost as much as the instructor! Some of our classes will be of the standard “chalk and talk” nature, but others will loosely follow the “Socratic” method. We will be able to unpack a lot of the deeper aspects of the material in this way, and have fun while doing it too! Please note that this means participation from you will be required and expected, *and it will be subject to some assessment*, at random points through the semester.

At the end of the semester, there will be a written examination, and also an interview and/or presentation. These will be based on any aspect of the course material that we have covered. It *may* require you to prepare some pre-assigned material beforehand, in which case the examination/interview/presentation will be based upon that.

Homeworks and Classroom Interaction: 60%

End of Semester Interview/Presentation: 20%

Written examination: 20%

5 Important Note:

Students who need to request accommodations based on a disability are required to register each semester with the Office of Disability Services and Programs (DSP). In addition a letter of verification to the instructor from DSP is needed for the semester you are enrolled in this course. If you have any questions concerning this procedure, please contact the instructor and DSP at STU 301, 740-0776.