An introduction to field theory in condensed matter physics:

Phys 625 introduces field theory techniques for the understanding of many-body condensed matter systems focusing mostly on the many-electron system. While quantum field theory originated in high-energy physics, it also provides the framework to understand many-body quantum systems specifically response as well as perturbation theory. A key complication is that Lorentz invariance typically doesn't apply to condensed matter systems, but simplification is the presence of a natural regularization scale. Familiarity with graduate level quantum mechanics, statistical mechanics and E&M will be assumed.

Some of the topics covered are (suggestions welcome):

- Phonons as an intro to quantum fields
- Field theory for fermions
- Jordan-Wigner/Hubbard models etc
- Green functions, Wick's theorem etc
- Linked cluster theorem, RPA etc
- Fermi surface and Fermi liquids - zero sound
- Imaginary time Green functions
- Linear response, Kubo formula etc
- Diagrams for electron diffusion versus localization
- Landau theory of phase transitions
- Goldstone theorem
- Anderson-Higgs mechanism

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Class Meets
Mondays & Wednesdays
12:30 pm – 1:45 pm
Phy1219

Office Hours
PSC 3143 by appointment

Grader
TBD

Suggested Prerequisite
Phys 604, 606, 622, 623
Graduate E&M, quantum math-methods
• Path integral for Bosons/Fermions
• Coherent state path integral for magnets
• Hubbard stratonovich transformation
• Nambu-Gorkov Green function approach to superconductivity
• Local moments and the Kondo effect

Required Resources

Course website: elms.umd.edu


Course Communication

All updates and information regarding the course will be made using the announcements on ELMS – please make sure your ELMS settings do not delay announcements. I may not repeat in class.

Please send any questions or notification of absences to the instructor. You need to inform me of any absence preferably by email (see course website for further details).

Campus Policies

It is our shared responsibility to know and abide by the University of Maryland’s policies that relate to all courses, which include topics like:

• Academic integrity
• Student and instructor conduct
• Accessibility and accommodations
• Attendance and excused absences
• Grades and appeals
• Copyright and intellectual property

Please visit www.ugst.umd.edu/courserelatedpolicies.html (http://www.ugst.umd.edu/courserelatedpolicies.html) for the Office of Undergraduate Studies’ full list of campus-wide policies and follow up with me if you have questions.

Activities, Learning Assessments, & Expectations for Students

Lectures: Class time will be occupied by lectures that follow a set of notes that closely follow sections in https://umd.instructure.com/courses/1321420