2019

PHYS 7510 Condensed Matter Physics 2:
Applications of field theoretical methods in condensed matter

INSTRUCTOR: J. Sirker (Allen 515)

TEXTBOOKS:

There is no required textbook for this course. Course notes will be published online. A lot of the material covered in this course can be found in

A. Altland and B. Simons, *Condensed Matter Field Theory*, Cambridge 2010.

Towards the end of the course, I also plan to cover some bosonization for one-dimensional quantum models. The relevant text book for this chapter is

T. Giamarchi, *Quantum Physics in One Dimension*, Oxford 2003.

The tentative outline looks as follows:

1. INTRODUCTION:
   - Classical and quantum harmonic oscillator
   - Harmonic chain: continuum limit and quantization

2. SECOND QUANTIZATION
   - Brief introduction/reminder

3. IMPORTANT MODELS AND GREEN'S FUNCTIONS
   - Interacting electrons, Feynman diagrams
   - Tight-binding models: Bloch and Wannier basis
   - Magnetic models: ϕ^4 theory
   - Time ordered, retarded, advanced Green's functions; linear response

4. PATH INTEGRALS
   - Feynman path integral (single particle)
   - Coherent states
   - Generating functional, Wick's theorem, Gaussian integrals

5. RENORMALIZATION GROUP
   - ϕ^4 model: scaling analysis, critical exponents
   - Wilson RG of the N-vector model
   - General formulation of the RG
   - Spin coherent states and non-linear sigma model: topological terms and Haldane's conjecture

6. LUTTINGER LIQUIDS
   - Bosonization of the spin-1/2 Heisenberg model