Methods of Statistical Physics
PHY 603- Spring 2021

Instructor: Prof. Paulo Bedaque
3147 Physical Sciences Complex
Grader:
Lecture times/place: Tuesdays & Thursdays, 9:30am to 10:45am (Eastern Standard Time) on Zoom:

Tuesdays

Topic: Statistical Mechanics
Time: This is a recurring meeting Meet anytime

Join Zoom Meeting
https://umd.zoom.us/j/99724038600?pwd=dmtqWWtyVmpITmlyZ090QndvZFVLUT09

Meeting ID: 997 2403 8600
Passcode: 953103

Thursdays
Topic: Statistical Mechanics
Time: This is a recurring meeting Meet anytime

Join Zoom Meeting
https://umd.zoom.us/j/93577071312?pwd=aE9aTklzL3BDOWtDSEl0ZVVnMm8xUT09

Meeting ID: 935 7707 1312
Passcode: 166710

Office hours: Tuesdays after class
Textbook(s): We will not follow closely any textbook. I, personally, like short books where the structure of the theory is more apparent. "Elementary Statistical Mechanics" by Charles Kittel (be careful, there are many other Kittel textbooks), "Essential Statistical Mechanics" by Malcolm Kennett are in this category. A book that is not too different from the lectures is "Statistical Mechanics" by Pathria. Another source that might help are the D. Tong's lectures available (freely) from his website (http://www.damtp.cam.ac.uk/user/tong/statphys.html). I will also provide with somewhat detailed lecture notes following closely the lectures. My notes, however, are not polished and contain many typos/mistakes.
Computer: We will perform some numerical exercises in the class. Basis familiarity with plotting, doing simple calculations using a high level language (Maple, Mathematica, MatLab, Python) and very basic programming (loops, variables, input/output) in ANY language will be assumed. If you don't have easy access to a computer or you lack any experience in programming let me know.

Grades: The grade will be based on one midterm (30%), one final exam (40%), one numerical project (20%) and homeworks (10%)

Tentative Syllabus:

Introduction

Microscopic and macroscopic variables

Ensembles in phase space, ergodic hypothesis, microcanonical ensemble

Thermodynamics

The fundamental problem of thermodynamics, entropy

Energy minimum principle

Thermodynamics processes and engines

Other ensembles

Canonical ensemble, fluctuations of energy, equivalence to microcanonical ensembe, free energy

Grand canonical ensemble, fluctuations of particle number , equivalence to microcanonical ensemble, Gibbs potential

Other thermodynamical potentials

Quantum statistical mechanics

Density matrices and mixed states

Quantum gases

Ideal Bose gas, boson condensation; Black body radiation

Ideal Fermi gas, Fermi pressure and White dwarfs, paramagnetism and diamagnetism

Phase transitions

First order phase transition, Maxwell construction

Second order phase transitions; Ginsburg-Landau; spontaneous symmetry breaking, long range correlations, Landau-Wilson ideology, universality