Material for Week 1

Physics 4488/6562: Statistical Mechanics

https://sethna.lassp.cornell.edu/Teaching/562/

Exercises due Mon. Jan 27

Last correction at January 16, 2025, 6:35 pm

Before class, read the assigned material. Pre-class questions are due 8:00am on the morning before class on days when homeworks are not due (usually Wednesdays and Fridays), and otherwise should be turned in with the homeworks. Emergent vs. fundamental, is due *tomorrow evening.* If you are not registered for the class, sign up on the sheet today, and we'll add you to the Canvas site tonight.

All exercises are from the second edition of the text: https://sethna.lassp.cornell.edu/StatMech/EntropyOrderParametersComplexity20.pdf. Python and Mathematica hints for computational exercises at https://sethna.lassp.cornell.edu/StatMech/EOPCHintsAndMaterials.html.

Wednesday

In-class question: 1.4 *Stirling's formula*

In-class question: 1.1 *Quantum dice and coins*

Friday

Read: Ch. 1, What is Statistical Mechanics?, Ch. 2, Sec. 2.1 (Random walk universality), Sec. 2.2 (Diffusion eqn)

Pre-class question: 1.11 *Emergent vs. fundamental*

Pre-class question: 2.1 *Random walks in grade space*

In-class question: 1.1 *Quantum dice and coins*

In-class question: 2.2 *Photon diffusion in the Sun*

Monday

Read: Chapter 2, Sec. 2.3 (Currents and forces)

Pre-class question: 2.17 *Local conservation*

Assigned exercise for everyone

1.13 *The birthday problem.* (Probability, Emergence) New law emerges for large classes.

Special topic exercises (6562 do one; 4488 do 7 during 14 weeks)

1.14 *Width of the height distribution.* (Statistics) A modern view of the $1/\sqrt{N-1}$ factor in the standard deviation formula.

1.5 *Stirling and asymptotic series.* (Mathematics,Computation) An asymptotic series has zero radius of convergence, which makes it extra powerful. Do the lowest couple of orders in part (d) by hand, or use the hints file.

1.6 *Random matrix theory.* (Mathematics, Quantum, Computation). Used to understand nuclei, mesoscopic systems, replica theory, neural nets. Use the hints file!

2.21 *Lévy flight.* What happens when our random steps can have very large jumps?

1.9 *First to fail: Weibull.* (Mathematics, Statistics, Engineering) Extreme value statistics. Used to plan for disasters, fracture mechanics, and by the insurance industry

1.12 *Self-propelled particles.* (Active matter) Self-propelled particles and the onset of flow. Flocking and broken symmetry.