Rowechen Zhong

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Coursework

Daggered courses are ongoing.
Notes for some mathematics (including many subjects I self-studied, such as algebraic topology and functional analysis!) can be found at https://publish.obsidian.md/vision.

Computer Science

P **6.1220**, *Design and Analysis of Algorithms*, Fall 2022, Piotr Indyk
Sorting, search trees, heaps, and hashing. Divide-and-conquer, dynamic programming, and greedy algorithms. Amortized analysis. Graph algorithms and shortest paths. Network flow, computational geometry, number-theoretic algorithms, polynomial and matrix calculations, caching, and parallel computing.

† **6.7720**, *Discrete Probability and Stochastic Processes*, Spring 2024, Guy Bresler
Graduate course on discrete systems and processes. Probabilistic method, first and second moment method, martingales, concentration and correlation inequalities, theory of random graphs, weak convergence, random walks and Brownian motion, branching processes, Markov chains, Markov random fields, correlation decay method, isoperimetry, coupling, and influences. Emphasizes algorithmic aspects and connections to statistics and machine learning.

A **6.7800**, *Inference and Information*, Spring 2023, Polina Golland
Graduate course on Bayesian and non-Bayesian statistical inference. Hypothesis testing and parameter estimation, sufficient statistics; exponential families. EM agorithm. Log-loss inference criterion, entropy and model capacity. Kullback-Leibler distance and information geometry. Asymptotic analysis and large deviations theory. Model order estimation; nonparametric statistics. Computational issues and approximation techniques; Monte Carlo methods. Universal inference and learning, and universal features and neural networks.

A+ **6.7900**, *Machine Learning*, Fall 2023
Graduate course on machine learning, formalized by statistical inference. Representation, generalization, and model selection; and methods such as linear/additive models, active learning, boosting, support vector machines, non-parametric Bayesian methods, hidden Markov models, Bayesian networks, and convolutional and recurrent neural networks.

A+ **6.8611**, *Quantitative Methods for Natural Language Processing*, Fall 2023
The study of human language from a computational perspective, including syntactic, semantic and discourse processing models. Emphasizes machine learning methods and algorithms. Uses these methods and models in applications such as syntactic parsing, information extraction, statistical machine translation, dialogue systems.

P **6.9620**, *Web Lab: A Web Programming Class and Competition*, IAP 2023
Design and build functional and user-friendly web applications. Topics included HTML, CSS, JavaScript, ReactJS, and nodejs.

Physics

P **8.05**, *Quantum Physics II*, Fall 2022, Barton Zwiebach
Part of standard quantum physics sequence.

A **8.06**, *Quantum Physics III*, Spring 2023, Max Metlitski
Part of standard quantum physics sequence. A focus is put on quantitative analysis.

A **8.08**, *Statistical Physics II*, Spring 2023, Julien Tailleur
Modern non-equilibrium statistical mechanics, focusing on stochastic dynamics (in or out of equilibrium) applied to single or many-body systems. Langevin and Fokker-Planck equations, master equations, ratchet currents, stochastic thermodynamics, emergent behaviors. Systems studied range from soft-matter physics to biophysics including colloid dynamics, bacterial motion, as well as active-matter systems. Applications outside physics will also be discussed (epidemic spreading, econophysics, sociophysics). Simulation methods to study non-equilibrium dynamics.

A **8.13**, *Experimental Physics I*, Fall 2023, Gunther Roland
Advanced laboratory sequence in modern physics, where students could pick their experiments. I am particularly proud of my work replicating the compton scattering experiment, where I constructed custom lead shielding to reduce background radiation. I also analyzed data from LIGO detectors and measured the azimuthal distribution of cosmic muons.

P **8.223**, *Classical Mechanics II*, IAP 2023, Michael Williams
Generalized coordinates, Lagrangian and Hamiltonian formulations, canonical transformations, and Poisson brackets. Applications to continuous media. The relativistic Lagrangian and Maxwell's equations.

A+ **8.323**, *Quantum Field Theory*, Spring 2023, Hong Liu
Graduate course on quantum field theory. Classical field theory, symmetries, and Noether's theorem. Quantization of scalar fields, spin fields, and Gauge bosons. Feynman graphs, analytic properties of amplitudes, and unitarity of the S-matrix. Calculations in quantum electrodynamics. Introduction to renormalization.

A **8.324**, *Quantum Field Theory II*, Fall 2023, Washington Taylor
Graduate course on quantum field theory. Perturbation theory, Feynman diagrams, scattering theory, Quantum Electrodynamics, one loop renormalization, quantization of non-abelian gauge theories, the Standard Model of particle physics.

† **8.325**, *Quantum Field Theory III*, Spring 2024, Washington Taylor
Final graduate course on quantum field theory. Proper theoretical discussion of the physics of the standard model. Quantum chromodynamics, Higgs phenomenon, deep-inelastic scattering and structure functions, basics of lattice gauge theory, operator products and effective theories, detailed structure of the standard model, spontaneously broken gauge theory and its quantization, instantons and theta-vacua, topological defects, introduction to supersymmetry.

† **8.334**, *Statistical Mechanics II*, Spring 2024, Mehran Kardar
Graduate course on statistical field theory. The hydrodynamic limit and classical field theories. Phase transitions and broken symmetries: universality, correlation functions, and scaling theory. The renormalization approach to collective phenomena. Dynamic critical behavior. Random systems.

A **8.371**, *Quantum Information Science*, Spring 2023, Isaac Chuang
Graduate course on quantum computing. Quantum circuits, the quantum Fourier transform and search algorithms, the quantum operations formalism, quantum error correction, Calderbank-Shor-Steane and stabilizer codes, fault tolerant quantum computation, quantum data compression, quantum entanglement, capacity of quantum channels, and quantum cryptography and the proof of its security.

Mathematics

A **18.112**, *Functions of a Complex Variable*, Fall 2023, Andrew W Lawrie
Standard complex analysis course.

† **18.212**, *Algebraic Combinatorics*, Spring 2024, Alexander Postnikov
Enumeration methods, permutations, partitions, partially ordered sets and lattices, Young tableaux, graph theory, matrix tree theorem, electrical networks, convex polytopes, and more.

A **18.615**, *Stochastic Processes*, Spring 2023, Jimmy He
Graduate combinatorics course on Markov chains (finite and infinite state spaces, discrete and continuous-time), Poisson processes, random walks, birth and death processes, Brownian motion. Markov Chain Monte Carlo methods.

A **18.675**, *Theory of Probability*, Fall 2023, Konstantinos Kavvadias

Graduate measure-theoretic probability course. Sums of independent random variables, central limit phenomena, infinitely divisible laws, Levy processes, Brownian motion, conditioning, and martingales.

† **18.676**, *Stochastic Calculus*, Spring 2024, Nike Sun

Graduate stochastic calculus course. Brownian motion, continuous parameter martingales, Ito's theory of stochastic differential equations, Markov processes and partial differential equations, local time and excursion theory.

† **18.677**, *Random Geometry*, Spring 2024, Scott Sheffield

Graduate course on the theory of random geometry. A central object of study is the Gaussian Free Field, which has deep connections to many areas of physics (conformal field theory, quantum field theory, string theory, statistical mechanics, etc.) as well as to many natural objects in mathematics (including random surfaces and random fractal curves).

P **18.701**, *Abstract Algebra I*, Fall 2022, Henry Cohn

Part of standard algebra sequence.

A **18.745**, *Lie Groups and Lie Algebras I*, Fall 2023, Ju-Lee Kim

Graduate course on the theory of Lie algebras. Theorems of Engel and Lie; enveloping algebra, Poincare-Birkhoff-Witt theorem; classification and construction of semisimple Lie algebras; the center of their enveloping algebras; elements of representation theory; compact Lie groups and/or finite Chevalley groups.

† **18.755**, *Lie Groups and Lie Algebras II*, Spring 2024, Pavel Etingof

Graduate course on Lie theory. Classical groups, Haar measure on locally compact groups, the representation-theoretic understanding of the hydrogen atom, representations of compact groups, the Peter-Weyl theorem with proof, maxi- mal tori, Cartan and Iwasawa decompositions, classification of real reductive Lie groups, topology of Lie groups, proof of the third fundamental theorem of Lie the- ory, Levi decomposition, Ado's theorem, Borel subgroups, flag manifolds.