Jacky Lee

A full list of my Math and CS coursework.

Note: In Fall 2019, I took graduate courses at the Hong Kong University of Science and Technology (HKUST) as a visiting student.

Math Courses

— Taken —

MATH5230 - Differential Topology — A-

Taught by Guo-Wu Meng — *Fall 2019*

Manifolds, embedding and immersion, Sard's theorem, transversality, degree, vector fields, Euler number, Euler-Poincaré theorem, Morse functions.

MATH5011 - Advanced Real Analysis I — A

Taught by Dong Li — *Fall 2019*

Basic topology, continuous function spaces, abstract measure and integration theory, Lp spaces, convexity and inequalities, Hilbert spaces, Banach spaces, complex measure.

Textbook: Evans - Measure Theory and Fine Properties of Functions

MATH174 - Abstract Algebra II: Representation Theory — A

Taught by Dagan Karp — *Spring 2019*

Group rings, Maschke's theorem, characters, orthogonality relations, induced representations, Specht modules, applications of representation theory, and other select topics from module theory.

Textbook: Sagan - The Symmetric Group: Representations, Combinatorial Algorithms, and Symmetric Functions

MATH157 - Intermediate Probability — A-

Taught by Arthur Benjamin — *Spring 2019*

Continuous random variables, distribution functions, joint density functions, marginal and conditional distributions, functions of random variables, conditional expectation, covariance and correlation, moment generating functions, law of large numbers, Chebyshev's theorem, and central-limit theorem.

Textbook: Carlton, Devore - Probability with Applications in Engineering, Science, and Technology

MATH173 - Advanced Linear Algebra — A

Taught by Weiqing Gu — *Fall 2018*

Dual spaces, spectral theory of matrices, Riesz representation theorem, Hilbert spaces, Perron's theorem. Applications to machine learning and Markov processes.

Textbook: Roman - Advanced Linear Algebra

MATH189R - Big Data Analytics — A

Taught by Weiqing Gu — *Summer 2018*

Linear regression, normal equations, covariance matrix, gradient descent, logistic regression, exponential family and generalized linear models, Poisson regression, softmax regression, marginalized Gaussian and the Schur complement, dimension reduction, SVD, PCA generative learning algorithms, naive Bayes, regularization, lasso, SVMs, kernel methods, k-means, Jensen's inequality, EM algorithm, MAP estimation, learning theory, collaborative filtering, topic modeling and non-negative matrix factorization.

Textbook: Murphy - Machine Learning: A Probabilistic Perspective

MATH172 - Abstract Algebra II: Galois Theory — Pass

Taught by Francis Su — *Spring 2018*

Polynomial rings, field extensions, classical constructions, splitting fields, algebraic closure, separability, Fundamental Theorem of Galois Theory, Galois groups of polynomials, and solvability.

Textbook: Dummit, Foote - Abstract Algebra

MATH106 - Combinatorics — A-

Taught by Nicholas Pippenger — *Spring 2018*

An introduction to the techniques and ideas of combinatorics, including counting methods, Stirling numbers, Catalan numbers, generating functions, Ramsey theory, partially ordered sets, and combinatorial designs.

MATH171 - Abstract Algebra I — A

Taught by Dagan Karp — *Spring 2017*

Groups, rings, fields, and introductory category theory. Topics in group theory include groups, subgroups, quotient groups, Lagrange's theorem, symmetry groups, and the isomorphism theorems. Topics in Ring theory include Euclidean domains, PIDs, UFDs, fields, polynomial rings, ideal theory, and the isomorphism theorems.

Textbook: Dummit, Foote - Abstract Algebra

MATH060 - Multivariable Calculus — A

Taught by Kenji Kozai — *Fall 2016*

Linear approximations, the gradient, directional derivatives and the Jacobian; optimization and the second derivative test; higher-order derivatives and Taylor approximations; line integrals; vector fields, curl, and divergence; Green's theorem, divergence theorem and Stokes' theorem, outline of proof and applications.

Textbook: Colley - Vector Calculus

MATH035 - Probability and Statistics — High Pass

Taught by Talithia Williams — *Fall 2016*

Sample spaces, events, axioms for probabilities; conditional probabilities and Bayes' theorem; random variables and their distributions, discrete and continuous; expected values, means and variances; covariance and correlation; law of large numbers and central limit theorem; point and interval estimation; hypothesis testing; simple linear regression; applications to analyzing real data sets.

Textbook: Barnett - Applied Statistics

— Audited —

MATH132 - Real Analysis II — Audited

Taught by Francis Su — *Fall 2018*

Riemann-Stieltjes integration, function spaces, equicontinuity, uniform convergence, Arzelà–Ascoli theorem, the inverse and implicit function theorems, differential forms, and an introduction to Lebesgue integration and measure theory.

Textbook: Rudin - Principles of Mathematical Analysis

— Waived —

MATH131 - Real Analysis I — Waived

This course is a rigorous analysis of the real numbers and an introduction to writing and communicating mathematics well. Topics include properties of the rational and the real number fields, the least upper bound property, induction, countable sets, metric spaces, limit points, compactness, connectedness, careful treatment of sequences and series, functions, differentiation and the mean value theorem, and an introduction to sequences of functions.

Textbook: Rudin - Principles of Mathematical Analysis

MATH065 - Differential Equations and Linear Algebra II — Waived

General vector spaces and linear transformations; change of basis and similarity. Applications to linear systems of ordinary differential equations, matrix exponential; nonlinear systems of differential equations; equilibrium points and their stability.

MATH045 - Introduction to Differential Equations — Waived

Modeling physical systems, first-order ordinary differential equations, existence, uniqueness, and long-term behavior of solutions; bifurcations; approximate solutions; second-order ordinary differential equations and their properties, applications; first-order systems of ordinary differential equations.

Textbook: Braun - Differential Equations and Their Applications: An Introduction to Applied Mathematics

MATH040 - Introduction to Linear Algebra — Waived

Theory and applications of linearity, including vectors, matrices, systems of linear equations, dot and cross products, determinants, linear transformations in Euclidean space, linear independence, bases, eigenvalues, eigenvectors, and diagonalization.

Textbook: Poole - Linear Algebra: A Modern Introduction

MATH030G - Calculus — Waived

A comprehensive view of the theory and techniques of differential and integral calculus of a single variable; infinite series, including Taylor series and convergence tests. Focus on mathematical reasoning, rigor, and proof, including continuity, limits, induction. Introduction to multivariable calculus, including partial derivatives, double, and triple integrals.

Textbook: Spivak - Calculus

CS Courses

— Taken —

COMP6211D - Deep Learning — A

Taught by Qifeng Chen — *Fall 2019*

Basis of deep learning and its applications in computer vision, 3D vision, sequential modelling, speech processing, graph processing, and generative models. Convolutional neural networks, context aggregation networks, recurrent neural networks, graph neural networks, and generative adversarial networks. Implementation of deep learning models for some AI tasks such as image understanding, image synthesis, graph analysis, and speech enhancement. Taken officially as *COMP4971C (Independent Work)* since UG visiting students are not officially able to enroll in a PG course offered by the CSE department at HKUST.

CSCI145 - Advanced Topics in Algorithms — A

Taught by Ran Libeskind-Hadas — *Fall 2018*

The objective of this course is to explore sophisticated algorithm design and analysis techniques that are generally not taught in a first algorithms course. The course addresses topics such as graph matching, competitive analysis of online algorithms, matroid theory, and approximation algorithms and schemes.

CSCI131 - Programming Languages — A

Taught by Michael Greenberg — *Spring 2018*

A thorough examination of issues and features in language design and implementation including language-provided data structuring and data-typing, modularity, scoping, inheritance, and concurrency. Compilation and run-time issues. Introduction to formal semantics. Functional programming and lambda calculus.

CSCI081 - Computability and Logic — A

Taught by Robert Keller, Ran Libeskind-Hadas — *Fall 2017*

An introduction to some of the mathematical foundations of computer science, particularly logic, automata, and computability theory. Develops skill in constructing and writing proofs, and demonstrates the applications of the aforementioned areas to problems of practical significance.

CSCI070 - Data Structures and Program Development — A

Taught by Beth Trushkowsky — *Fall 2017*

Abstract data types including priority queues, dynamic dictionaries, and disjoint sets. Efficient data structures for these data types, including heaps, self-balancing trees, and hash tables. Analysis of data structures including worst-case, average-case, and amortized analysis. Storage allocation and reclamation. Secondary storage considerations. Extensive practice building programs for a variety of applications.

CSCI060 - Principles of Computer Science — A

Taught by Colleen Lewis — *Spring 2017*

Introduction to principles of computer science. Information structures, functional programming, object-oriented programming, grammars, logic, logic programming, correctness, algorithms, complexity analysis, finite-state machines, basic processor architecture, and theoretical limitations.

CSCI005 - Introduction to Computer Science — A

Taught by Geoff Kuenning — *Fall 2016*

Introduction to elements of computer science. Students learn general computational problem-solving techniques and gain experience with the design, implementation, testing and documentation of programs in a high-level language. In addition, students learn to design digital devices, understand how computers work, and learn to program a computer in its own machine language. Finally, students are exposed to ideas in computability theory.

— Audited —

CSCI181 - Computational Complexity / Computer Science Seminar — Audited

Taught by Ran Libeskind-Hadas — *Spring 2018*

Review of foundations of computability theory including the diagonal language, the halting problem, uncomputable functions (e.g., the Busy Beaver Function), Rice's Theorem, and the Recursion Theorem. NP-completeness and the Cook-Levin Theorem, the polynomial hierarchy, PSPACE completeness, PSPACE=NPSPACE, PSPACE-complete games and puzzles, complexity classes 'easier' than P (L, NL, and NL-complete problems), Hierarchy and Gap Theorems, interactive proofs

— Waived —

CSCI140 - Algorithms — Waived

Algorithm design, analysis, and correctness. Design techniques including divide-and-conquer and dynamic programming. Analysis techniques including solutions to recurrence relations and amortization. Correctness techniques including invariants and inductive proofs. Applications including sorting and searching, graph theoretic problems such as shortest path and network flow, and topics selected from arithmetic circuits, parallel algorithms, computational geometry, and others. An introduction to computational complexity, NP-completeness, and approximation algorithms. Proficiency with programming is expected as some assignments require algorithm implementation.

Miscellaneous Courses

These 'courses' are not courses in the usual sense but are instead more along the lines of seminars or projects.

MATH193 - Mathematics Clinic — A

Supervised by Nicholas Pippenger — *Fall 2018 - Spring 2019*

The Clinic Program brings together teams of students to work on a research problem sponsored by business, industry or government. Teams work closely with a faculty advisor and a liaison provided by the sponsoring organization to solve complex real-world problems. Students are expected to present their work orally and to produce a final report conforming to professional publication standards. I was the team project manager during the spring semester.

MATH198 - Undergraduate Mathematics Forum — A

Taught by Andrew Bernoff — *Fall 2018*

The goal of this course is to improve students' ability to communicate mathematics, both to a general and technical audience. Students will present material on assigned topics and have their presentations evaluated by students and faculty. This format simultaneously exposes students to a broad range of topics from modern and classical mathematics.

MATH093 - Putnam Seminar — Pass

Taught by Andrew Bernoff, Nicholas Pippenger, Francis Su, Mohamed Omar — *Fall 2016, Fall 2017, Fall 2018*

This seminar meets one evening per week during which students solve and present solutions to challenging mathematical problems in preparation for the William Lowell Putnam Mathematics Competition, a national undergraduate mathematics contest.

MATH055A - Topics in Discrete Mathematics — A

Taught by Arthur Benjamin — *Fall 2016*

Accelerated course for students who are already experienced with discrete mathematics. Consisted entirely of four lectures and a final exam. Topics include combinatorics (clever ways of counting things), number theory, and graph theory with an emphasis on creative problem solving and learning to read and write rigorous proofs. Possible applications include probability, analysis of algorithms, and cryptography.