Advanced Mathematics Courses List

Yueun Lee

Fall 2024

Analysis 2

Course Information	M1407.002100, Mathematics, Graduate
Instructor	Changkeun Oh
Grade	A+
References	*Complex Analysis*, Chapters 1-3, 8. *Functional Analysis* by Lax, Chapters 3-5, 8-11. *Functional Analysis* by Stein, Chapter 3. *Real Analysis* by Folland, Chapter 9.
Subject Matter	Holomorphic functions, Goursat's theorem, Cauchy's integral formulas, Meromorphic functions, The complex logarithm, Conformal mappings, The Schwarz lemma, The Riemann mapping theorem, The Hahn-Banach theorem, Dual space of L^p spaces, Reflexive spaces, Weak convergence, Helly's theorem, Distributions, Tempered distributions, Sobolev spaces, The Sobolev embedding theorem, Rellich's theorem, Elliptic regularity theorem.

Stochastic Differential Equations

Course Information	M1407.002600, Mathematics, Junior
Instructor	Panki Kim
Grade	A+
References	*Brownian Motion*, 3rd ed., Chapters 1-3, 5-6, 9, 15-16, 18-19, 21.
Subject Matter	Continuous-time martingales, Brownian motion, The quadratic variation of Brownian paths, Stochastic integrals, Localization of the stochastic integral, Itô calculus, Doléans–Dade exponentials, Girsanov's theorem, Stochastic differential equations, Existence and uniqueness of solutions

Modern Algebra 2

Course Information	881.302, Mathematics, Junior
Instructor	Seung Jin Lee
Grade	A+
References	*A First Course in Abstract Algebra*, 7th ed., Sections 29-40, 45-56.
Subject Matter	Extension fields, Sylow theorems, Free groups, PID and UFD, Factorization, Automorphisms of fields, Splitting fields, Galois Theory, Insolvability of the Quintic.

Spring 2024

Analysis 1

Course Information	M1407.002000, Mathematics, Graduate
Instructor	Changkeun Oh
Grade	A+
References	*Real Analysis*, Chapters 1-4, 6.
Subject Matter	Lebesgue measure, Integration of Euclidean space, Product measure and the Fubini theorem, Hilbert spaces, The Riesz representation theorem, Abstract measure spaces, Carathéodory's theorem, The Radon-Nykodim theorem, L^p spaces.

Measure Theory and Probability

Course Information	M1407.002500, Mathematics, Junior
Instructor	Panki Kim
Grade	A+
References	*Probability with Martingales*, Chapters 1-14.
Subject Matter	Measure spaces, Monotone convergence theorem, Borel-Cantelli Lemma, Integrals of measurable functions, Completeness of L^p-spaces, Product measure, Conditional expectation, Discrete-time martingales, Stopping time, Doob's optional stopping theorem, Doob's convergence theorem, L^2 martingales, Uniformly integrable martingales, Doob's maximal inequality.

Modern Algebra 1

Course Information	881.301, Mathematics, Junior
Instructor	Jin Hong
Grade	A+
References	*A First Course in Abstract Algebra*, 8th ed., Sections 1-15, 22-32.
Subject Matter	Isomorphism, Groups, Subgroups, Cycles, Lagrange Theorem, Group action, Rings and fields, Integral domain, Fermat's Theorem, Euler's theorem, Field of quotients, Polynomial ring, Factorization of polynomials, Prime & maximal ideal.

Fall 2023

Mathematical Statistics 2

Course Information	326.312, Statistics, Junior
Instructor	Jaeyong Lee
Grade	A+
References	Covered material similar to *Statistical Inference* by Casella and Berger (2nd Edition), Chapters 6-12.
Subject Matter	Maximum Likelihood Estimation (MLE), Asymptotic normality of MLE, Likelihood-ratio test, Asmptotic distribution of Likelihood-ratio test statistics, Comparison of estimators, Rao-Blackwell theorem, Uniformly minimal variance unbiased estimation, Comparison of hypothesis tests, Uniformly most powerful test, Cramer-Rao inequality.

Deep Learning: Statistical Perspective

Course Information	M1399.000400, Statistics, Graduate
Instructor	Joong-Ho Won
Grade	A0
References	Covered material similar to portions from *Deep Learning* (Goodfellow et al.), *Understanding Machine Learning* (Shalev-Shwartz), and *The Elements of Statistical Learning* (Hastie et al.).
Subject Matter	Linear classification, Reproducing Kernel Hilbert Spaces, Support Vector Machines, Multi-layer perceptron, Backpropagation, Universal approximation theorem, Deep ReLU Networks, Convolutional Neural Networks, Transformers, Autoencoders and variational inference, Generative Adversarial Networks, Wasserstein-distance-based generative models.

Advanced Statistical Computing

Course Information	M1399.000200, Statistics, Graduate
Instructor	Joong-Ho Won
Grade	A0
References	Covered material similar to portions from *Computational Statistics* (Gentle), *Matrix Computations* (Golub & Van Loan), and *Convex Optimization* (Boyd & Vandenberghe).
Subject Matter	Computer arithmetic, LU, Cholesky, and QR decompositions, Iterative methods for solving linear systems, Eigenvalue and singular value decompositions, Linear, Quadratic, Second-order cone, Semidefinite, and Geometric programming, KKT conditions, Optimization in Julia.

Bayesian Statistics and Lab

Course Information	326.411, Statistics, Senior
Instructor	Jaeyong Lee
Grade	A+
References	Covered material similar to *Bayesian Data Analysis* by Gelman et al. (3rd Edition), Chapters 1-4, 10-12, and 15-16.
Subject Matter	Bayesian inference, Bayesian hypothesis testing, Jeffreys priors and reference priors, Gaussian models and noninformative priors, The Bernstein-von Mises theorem, Bayesian information criterion, Importance sampling, Random number generation, Markov chain Monte Carlo, Gibbs sampling, the Metropolis–Hastings algorithm, Hamiltonian Monte Carlo, Hierarchical models, Stan.

Multivariate Data Analysis and Lab

Course Information	326.316, Statistics, Junior
Instructor	Sungkyu Jung
Grade	A-
References	Covered material similar to *Applied Multivariate Statistical Analysis* (Johnson & Wichern), Chapters 1-12.
Subject Matter	Multivariate normal distributions, Mahalanobis distance, Wishart distribution, Hotelling's t^2 statistic, Point and Interval estimation of multivariate normal distribution, Principal component analysis, Factor analysis, Cluster, Discriminant analysis.

Spring 2023

Mathematical Statistics 1

Course Information	326.311, Statistics, Junior
Instructor	Kwonsang Lee
Grade	A+
References	Covered material similar to *Statistical Inference* by Casella and Berger (2nd Edition), Chapters 1-5.
Subject Matter	Conditional probability, Central limit theorem, Stochastic independence and the distributions of random variables such as Normal, Binomial, Multinomial, Gamma, Chi-square, Poisson, and Multivariate normal variables.

Regression Analysis and Lab

Course Information	326.313, Statistics, Junior
Instructor	Taesung Park
Grade	A0
References	Covered material similar to *Introduction to Linear Regression Analysis* (Montgomery), Chapters 1-10, 12-13.
Subject Matter	Simple linear regression, Multiple linear regression, Checking model adequacy, Weighted least squares, Variable transformation, Regression diagnostics, Detection of leverage and influential observations, Regression techniques for categorical variables, Multicollinearity, Ridge regression, Variable selection, Generalized linear models.

Algorithms

Course Information	4190.407, Computer Science and Engineering, Junior
Instructor	Kunsoo Park
Grade	A+
References	Covered material similar to *Introduction to Algorithms* (Cormen et al.), Chapters 1-4, 6-9, 10-13, 15-16, 22-25, 32, 34.
Subject Matter	Correctness, Complexity Analysis, Sorting, Data Structures, Dynamic Programming, Greedy Algorithms, Graph Algorithms, String Matching, NP-Completeness.