

## **Math and Statistics Courses:**

### **MATH 5660. Numerical Analysis 1 (3) - 2024 Fall**

The course introduces fundamental concepts in numerical analysis and scientific computing, focusing on the mathematical and computational techniques used in engineering, data science, and machine learning. Topics include floating-point arithmetic, numerical stability, solving nonlinear and linear equations, Gaussian elimination, LU factorization, interpolation methods, least squares problems, and optimization techniques. Students will also explore numerical differentiation, integration methods (such as Newton-Cotes and Romberg integration), and error analysis. The course emphasizes practical implementation using Python, Jupyter Notebooks, and relevant mathematical libraries. Through theoretical discussions, coding exercises, and hands-on problem-solving, students will develop strong computational skills essential for tackling real-world numerical challenges.

**Book Used:** Numerical Analysis (3rd Edition) - Timothy Sauer

### **MATH 5792: Probabilistic Modeling (3) - 2024 Fall**

This course provides an introduction to probabilistic modeling and stochastic processes, focusing on Markov chains, Poisson processes, queuing theory, and Monte Carlo simulation. Students will learn to analyze discrete-time and continuous-time Markov chains, model real-world systems using Poisson processes, and explore queuing models used in operations research and network analysis. The course also covers random variate generation, variance reduction techniques, and output analysis for Monte Carlo simulations. Practical implementation will be emphasized using Python, NumPy, SciPy, Matplotlib, and Jupyter Notebooks. Through problem-solving exercises and simulations, students will develop the mathematical and computational skills needed to model and analyze complex stochastic systems in fields such as engineering, computer science, finance, and the social sciences.

**Book Used:** Introduction to Probability Models (13th Edition) - Sheldon Ross

### **MATH 7393. Bayesian Statistics (3) - 2025 Spring**

The course provides an in-depth introduction to Bayesian statistical inference and data analysis, covering fundamental concepts and computational methods. Topics include prior and posterior distributions, conjugate models, single and multiparameter models, hierarchical models, and model evaluation techniques. Students will learn to implement Monte Carlo methods and Markov Chain Monte Carlo (MCMC) for Bayesian analysis and apply these techniques to real-world datasets. The course also explores generalized linear models (GLMs), normal error models, Bayesian regression, model checking, and hierarchical modeling. Emphasis is placed on using statistical software, particularly R, RStudio, and Stan, to perform Bayesian computations.

**Book Used:** Professor's Notes + Bayesian Data Analysis (3rd edition) - Gelman, Carlin, Stern, Dunson, Vehtari and Rubin

### **MTH 347 Applied Statistics - 2017 Spring**

Topics include simple linear regression, analysis of variance, nonparametric statistics, multiple and logistic regression, statistical process control, and basic time series analysis. This course will emphasize the applied nature of statistical analysis and require using a statistical analysis software package.

**Book Used:** The Art and Science of Learning to Make Informed Decisions from Data - Custom Edition for Cleveland State University. Taken From: Statistics: The Art and Science of Learning from Data (4th Edition) - Agresti, Franklin, Klingenberg. + Statistics: Informed Decisions Using Data (5th Edition) - Sullivan III

### **MTH 431 Categorical Data Analysis - 2018 Fall**

The course will cover techniques of modeling data for data that are categorical rather than continuous in nature. Topics to be covered include joint, marginal, and conditional probabilities, relative risk, odds ratios, generalized linear models, logistic regression, multi-category logit models, and log linear models. The course will utilize data examples from the fields of biology, medicine, health, epidemiology, environmental science, and psychology. The course will use a statistical programming language.

**Book Used:** Categorical Data Analysis (2nd Edition) - Agresti

### **MTH 467 Applied Regression Models - 2019 Spring**

An applied data analysis course focused on regression. A review of simple linear regression will progress into using more than one predictor variable to predict another. Topics will include model checking, variable selection methods, dummy variables, and diagnostic measures. Instruction will include the use of a statistical programming language.

**Book Used:** Regression Analysis by Example (5th Edition) - Chatterjee, Hadi

### **MTH 252 Calculus III - 2021 Spring**

Continuation of Calculus I and II. Three-dimensional analytic geometry, vectors, derivatives, multiple integrals, applications. The honors course offers an in-depth treatment of these topics. Admission to the honors course requires honors standing or permission of the instructor.

**Book Used:** Calculus (8th edition) - Stewart

### **MTH 222 Introduction to Linear Algebra - 2020 Fall**

Treatment with emphasis on Euclidean spaces and matrix algebra: systems of linear equations, elementary matrix operations, determinants, vector methods in geometry, vector spaces, and linear transformations.

**Book Used:** Professor's Notes

### **MTH 231 Elements of Discrete Mathematics - 2023 Spring**

Service course. Topics, techniques and terminology in discrete mathematics: logic, sets, proof by mathematical induction, relations, counting.

**Book Used:** Discrete Mathematics with Applications (5th edition) - Susanna S. Epp

### **STA 401 Probability - 2021 Spring**

Development of probability theory with emphasis on how probability relates to statistical inference. Topics include review of probability basics, counting rules, Bayes Theorem, distribution function, expectation and variance of random variables and functions of random variables, moment generating function, moments, probability models for special random variables, joint distributions, maximum likelihood estimation, unbiasedness, distributions of functions of random variables, chi-square distribution, students t distribution, F distribution, and sampling distributions of the sample mean and variance.

**Book Used:** Mathematical Statistics with Applications (7th Edition) - Wackerly, Mendenhall, Scheaffer

### **STA 462 Inferential Statistics - 2023 Spring**

A study of estimation and hypothesis testing including a development of related probability ideas. Topics include derivation of the distribution of functions of random variables, point estimation methods, properties of point estimators, derivation of confidence interval formulas, and derivation of test statistics and critical regions for testing hypotheses.

**Book Used:** Mathematical Statistics with Applications (7th Edition) - Wackerly, Mendenhall, Scheaffer

### **STA 463 Regression Analysis - 2023 Spring**

Linear regression model, theory of least squares, statistical inference procedures, general linear hypothesis, partial F tests, residual analysis, regression diagnostics, comparison of several regressions, model adequacy, and use of statistical computer packages.

**Book Used:** Applied Linear Statistical Models (5th edition) - KNNL

### **MTH 433 Applied Linear Algebra - 2023 Fall**

This course revisits the fundamentals of linear algebra with a focus on practical applications and computational methods. Starting with a review of solving linear equations and matrix operations, it progresses to explore LU and LDV factorizations, subspaces, and vector spaces. Key applications include data fitting and least squares, image compression, and statistical data analysis through singular value decomposition (SVD), and the exploration of Markov chains for ranking systems like Google's PageRank. The course integrates computational exercises using Python within Jupyter notebooks, covering packages such as numpy and pandas, to apply linear algebra concepts to real-world problems.

**Book Used:** Applied Linear Algebra (2nd edition) - Olver and Shakiban

### **STA 333 Nonparametric Statistics - 2023 Fall**

Applied study of statistical techniques useful in estimating parameters of a population whose underlying distribution is unknown. Chi-square, runs, and association tests covered.

**Book Used:** Professor's Notes

**STA 427 Introduction to Bayesian Statistics - 2023 Fall**

Introduces the Bayesian approach to statistical inference for data analysis in a variety of applications. Topics include: comparison of Bayesian and frequentist methods, Bayesian model specification, prior specification, basics of decision theory, Markov Chain Monte Carlo, Bayes factor, empirical Bayes, hierarchical models, and use of computational software.

**Book Used:** Bayesian Data Analysis (3rd edition) - Gelman, Carlin, Stern, Dunson, Vehtari and Rubin

**STA 432 Survey Sampling in Business - 2024 Spring**

Survey sampling with applications to problems of business research. Simple random sampling, systematic sampling, stratified random sampling, ratio estimation, and cluster sampling.

**Book Used:** Sampling: Design and Analysis (3rd edition) - Lohr

# **Computer Science, Data Science, and Bioinformatics**

## **Courses:**

### **CSE 271 Object-Oriented Programming - 2021 Fall**

The design and implementation of software using object-oriented programming techniques including inheritance, polymorphism, object persistence, and operator overloading. Students will analyze program specifications and identify appropriate objects and classes. Additional programming topics include dynamic memory recursion, using existing object libraries, and binary/ASCII file processing.

**Book Used:** Big Java: Late Objects (1st Edition) - Horstmann

### **CSE 274 Data Abstraction and Data Structures - 2022 Spring**

Abstract data types and their implementation as data structures using object-oriented programming. Use of object-oriented principles in the selection and analysis of various ADT implementations. Sequential and linked storage representations: lists, stacks, queues, and tables. Nonlinear data structures: trees and graphs. Recursion, sorting, searching, and algorithm complexity.

**Book Used:** Object-Oriented Data Structures Using Java (4th Edition) - Dale, Joyce, Dale

### **CSE 374 Algorithms I - 2023 Fall**

Design, analysis and implementation of algorithms and data structures. Dynamic programming, brute force algorithms, divide and conquer algorithms, greedy algorithms, graph algorithms, and red-black trees. Other topics include: string matching and computational geometry.

**Book Used:** Introduction to Algorithms (3rd Edition) - Cormen, Leiserson, Rivest, Stein

### **CSE 385 Database Systems - 2022 Fall**

Overview of database management, database system architecture, and database modeling principles. Logical database design. The relational database model, relational integrity constraints, and relational algebra. Relational commercial database management systems and languages. Interactive database processing, view processing, and database application programming. Database integrity. Relational database design by normalization. File structures for database systems.

**Book Used:** Databases Illuminated (3rd Edition) - Ricardo and Urban

### **STA 402 Statistical Programming - 2023 Spring**

Introduction to the use of computers to process and analyze data. Techniques and strategies for managing, manipulating, and analyzing data are discussed. Emphasis is on the use of the SAS system. Statistical computing topics, such as random number generation, randomization tests, and Monte Carlo simulation, will be used to illustrate these programming ideas.

**Book Used:** Statistical Programming in SAS (2nd edition) - A.J. Bailer

### **STA 404 Advanced Data Visualization - 2023 Fall**

Communicating clearly, efficiently, and in a visually compelling manner using data displays. Identifying appropriate displays based on various data characteristics/complexity, audiences, and goals. Using software to produce data displays. Integrating narratives and data displays. Critiquing visualizations based on design principles, statistical characteristics, and narrative quality.

**Book Used:** Professor's Notes

### **CSE 432 Machine Learning - 2022 Fall**

This course introduces the process, methods, and computing tools fundamental to machine learning. Students will work on large real-world datasets to write code to accomplish tasks such as predicting outcomes, discovering associations, and identifying similar groups. Students will complete a term project showcasing the different steps of the machine learning process, from data cleaning to the extraction of accurate models and the visualization of results.

**Book Used:** Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems (1st Edition) - Géron

### **STA 467 Statistical Learning - 2024 Spring**

Introduction to methods of statistical learning, with emphases on both theory and implementation. Topics include supervised and unsupervised learning methods, including linear and nonlinear models for regression and classification, additive models, recursive partitioning methods, neural networks, support vector machines, association rules, and cluster analysis; ensemble methods; and methods of model assessment and selection.

**Book Used:** An Introduction to Statistical Learning with Applications in R (2nd Edition) - James, Witten, Hastie, Tibshirani

### **CSE 273 Optimization Modeling - 2024 Spring**

Use of deterministic models and computers to study and optimize systems. Includes an introduction to modeling, calculus-based models, financial models, spreadsheet models, and linear-programming models.

**Book Used:** Optimization Modelling with Spreadsheets (3rd Edition) - Baker

**Book Used:** Operations Research: A Model-Based Approach (3rd Edition) - Eiselt and Sandblom

### **BIO 466 Bioinformatics Computing Skills - 2022 Fall**

Study of the core computational and biological concepts in bioinformatics, with programming in Python, MySQL and Ubuntu OS. You will gain hands-on experience in popular bioinformatics applications, including BLAST, sequence alignment, genome browser, and gene annotation, among others.

**Book Used:** Professor's Notes

**BIO 485 Bioinformatics Principles - 2022 Spring**

Concepts and basic computational techniques for mainstream bioinformatics problems. Emphasis placed on transforming biological problems into computable ones and seeking solutions.

**Book Used:** Professor's Notes

**Other:****HMGP 7600. Graduate Survey of Human Genetics (3) - 2025 Spring**

The course explores key concepts and methodologies in human genetics and genomics, focusing on genomic technologies, medical genetics, and complex disease genetics. Topics covered include genes and genomes, next-generation sequencing, functional genomics, population structure, genome-wide association studies (GWAS), polygenic risk scores, and multi-omic approaches. Students will critically analyze research papers, learn how to design experiments to test genetic hypotheses, and develop grant-writing skills. The course also includes molecular diagnostic approaches, genetic syndromes, biochemical genetics, targeted vs. broad genetic testing, and the ethical implications of genetic research. Through discussions, take-home exams, and a final research proposal, students will gain hands-on experience in analyzing genetic data and understanding its applications in biomedical research, epidemiology, and computational biology.