

# MATHEMATICS (MATH)

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## MATH 409 - DATA MINING

Methods of knowledge discovery in massive data, i.e. the study of computer-assisted process of digging through and analyzing enormous data sets and then extracting the "meaning" of the data by applying mathematical methods. The methods that we study in this course are designed to predict behaviors and future trends based on existing data. Topics include classifications techniques, clusterization techniques, association rule discovery techniques, techniques for improving data quality. See CST 421.

Credits: 3

Course Notes: Math 246 and (Math 217 or Math 347)

## MATH 416 - HISTORY OF MATHEMATICS

Evolution of mathematical ideas; major developments; problem solving, algorithms, and theoretical framework.

Credits: 3

Course Notes: MATH 231

## MATH 418 - NUMBER THEORY

Study of integers. Division and Euclidean algorithms, prime numbers, unique factorization; Diophantine equations; congruences; Fermat's and Euler's theorems; quadratic reciprocity.

Credits: 3

Course Notes: MATH 231 or MATH 245 or MATH 290 required

## MATH 420 - INTRODUCTION TO ABSTRACT ALGEBRA

Elementary properties of groups, rings, integral domains, and fields; symmetry; factorization of integers and polynomials; construction of quotient field of an integral domain.

Credits: 3

Course Notes: Math 245 and Math 246 required.

## MATH 423 - GAME THEORY AND APPLICATIONS

Study of the ways in which strategic interactions among players produce outcomes with respect to their preferences (or utilities). This course covers game-theoretic foundations of cooperative and non-cooperative behavior. The course emphasizes applications drawn from artificial intelligence, decision theory, economics, psychology, and finance.

Coursework includes an independent study component where students learn advanced topics in game theory. See CST 423

Credits: 3

Course Notes: Additional credit for "COOPERATION AND COMPETITION" not granted. Math 246 and (Math 245 or Math 217 or Math 448) with a C- or higher required.

## MATH 428 - LINEAR PROGRAMMING & OPTIM

Models of optimization with linear constraints and objectives; simplex method and related algorithms; duality and sensitivity; transportation and assignment problems; games and network flows. See also Cst 428.

Credits: 3

Course Notes: MATH 246

## MATH 430 - NUMERICAL ANALYSIS

Solution of equations by iteration; interpolation; numerical differentiation and integration; numerical solutions to linear systems. Computer use course. See also Cst 330.

Credits: 3

Course Notes: MATH 232 and MATH 246

## MATH 432 - OPERATIONS RESEARCH

Stochastic methods in operations research. Queuing theory; Markov processes; decision analysis; simulation; stochastic dynamic programming.

Credits: 3

Course Notes: Math 231, Math 217 or Math 347.

## MATH 445 - COMBINATORICS

Permutations and combinations; identities involving binomial coefficients; inclusion-exclusion principle; recurrence relations; generating functions; introduction to theory of graphs.

Credits: 3

Course Notes: MATH 232 and (MATH 245 or MATH 290) all with a C- or higher required.

## MATH 446 - STOCHASTIC PROCESSES

Poisson and renewal processes. Markov chains with applications to queuing theory, inventory control, and population growth.

Credits: 3

Course Notes: MATH 347

## MATH 447 - ADVANCED PROBABILITY

Probability models; random variables; probability distributions; expectation and moment generating functions of random variables; multivariate distributions.

Credits: 3

Course Notes: MATH 347

## MATH 448 - PROBABILITY AND STATISTICS II

Distributions of functions of random variables, sampling distributions; Central Limit Theorem; point estimators and confidence intervals; hypothesis testing; linear models.

Credits: 3

Course Notes: Math 347 or ACSC 347 with min grade C-.

## MATH 449 - REGRESSION & TIME SERIES

Simple and multiple linear regression models; time series analysis; applications to forecasting. Use of a statistical computer package; no previous experience with computers required.

Credits: 3

Course Notes: (MATH 231 and MATH 217) or MATH 348 or MATH 448

## MATH 457 - ANOVA & EXPERIMENTAL DESIGN

One-way analysis of variance (ANOVA), multiple comparison methods, basic experimental designs, analysis of covariance (ANCOVA), factorial treatment structures, split plots, confounding and fractional replication in  $2^n$  factorial systems.

Credits: 3

Course Notes: MATH 217 or MATH 348 or MATH 448 or PSYC 407 or MGMT 403

## MATH 458 - THEORY OF INTEGRATION

The Lebesgue integral and its relation to the Riemann integral, convergence theorems, elements of measure theory.

Credits: 3

Course Notes: MATH 246 and MATH 352

**MATH 466 - CRYPTOGRAPHY**

Cryptography provides algorithms and protocols for secure communication over an insecure channel. These tools are also used in many other aspects of information security such as access control or digital signature. Cryptography plays a crucial role in a wide scope of real-world applications, from the classical military and national security applications to email and online banking. The course focuses on concepts and techniques underlying public-key cryptography. Course topics include symmetric cryptosystems, RSA and other public-key cryptosystems, digital signatures, key exchange protocols, secret sharing, identification schemes, etc.

Credits: 3

Course Notes: Graduate students should have taken an undergraduate discrete mathematics course as well as introductory programming.

**MATH 467 - FINANCIAL MATHEMATICS**

Mathematics of interest, accumulated value, and present value; annuities certain; amortization schedules and sinking funds; bonds and related securities; depreciation; rates of return; spot and forward rates of interest; cashflow duration and immunization; stocks, mutual funds, fixed income. Financial calculator.

Credits: 3

Course Notes: Students should have passed a calculus course which included material through integration by parts (such as Math 232).

**MATH 469 - ACTUARIAL MATHEMATICS I**

Survival distributions and life tables; life insurance; life annuities.

Credits: 3

Course Notes: MATH 347 and MATH 367

**MATH 470 - ACTUARIAL MATHEMATICS II**

Benefit premiums; benefit reserves; multiple life functions; multiple decrement models.

Credits: 3

Prerequisites: MATH 469

Course Notes: or Math 369 or Acsc 369 with a min grade C-.

**MATH 475 - DERIVATIVES MARKETS**

We will cover binomial option pricing, the Black-Scholes Formula and equation, market-making and delta hedging, exotic options, the lognormal distribution, Monte Carlo valuation, Brownian motion and Itôparity and other option relationships, volatility, interest rate models.

Credits: 3

Course Notes: MATH 367, FIN 311, or consent of Instructor.

**MATH 476 - LOSS MODELS**

Actuarial models; classifying and creating distributions; frequency and severity with coverage modifications; construction of empirical models; estimation for complete data; estimation for modified data; parameter estimation; interpolation and smoothing; simulation.

Credits: 3

Prerequisites: MATH 448 (may be taken concurrently)

Course Notes: or ACSC 348 or MATH 348.

**MATH 477 - SURVIVAL MODELS**

Survival data, survival functions, hazard functions, life tables, comparing two groups of survival data, parametric models of survival data, and sample size for survival studies.

Credits: 3

Prerequisites: ACSC 348 (may be taken concurrently) or MATH 348 (may be taken concurrently) or MATH 448 (may be taken concurrently)

Course Notes: or concurrent

**MATH 478 - TOPICS IN ACTUARIAL MATH**

Course content varies. Topics in actuarial models and actuarial modeling. May be repeated for credit for up to six semester hours.

Credits: 3

Course Notes: Consent of instructor.

**MATH 480FM - ACTUARIAL SCIENCE SEMINAR**

Preparation for the Society of Actuaries Exam FM and the Casualty Actuarial Society Exam 2.

Credits: 3

Course Notes: MATH 367

**MATH 480P - ACTUARIAL SCI SEM: EXAM P/1**

Preparation for the Society of Actuaries Exam P and the Casualty Actuarial Society Exam 1.

Credits: 3

Prerequisites: MATH 448 (may be taken concurrently)

Course Notes: MATH 347

**MATH 488 - SPECIAL TOPICS**

Course content varies. May be repeated for up to nine semester hours. This topics course may not be cross-listed with undergraduate coursework.

Credits: 1-3

Course Notes: Prerequisites vary by topics.

**MATH 489 - SPECIAL TOPICS**

Course content varies. May be repeated for up to nine semester hours.

Credits: 3

**MATH 490 - MASTER'S THESIS**

Individual projects pursued under an instructor's supervision.

Credits: 3

**MATH 491 - INDUSTRIAL APP OF MATH**

Students work on a semester long research project solving a real world problem from industry using various methods of mathematical modeling. Problems vary by semester.

Credits: 3

Course Notes: Open to graduate students in Mathematics, Actuarial Science or related fields.

**MATH 495 - INDEPENDENT STUDY**

Individual projects pursued under an instructor's supervision.

Credits: 1-6

Course Notes: Consent of instructor

**MATH 500 - GRAD BIOSTATS**

GRAD BIOSTATS

Credits: 3

**MATH 505 - RESEARCH DESIGN**

RESEARCH DESIGN

Credits: 3