

- 11:628:305 Field Course—Coral Reefs (3)
- 11:628:306 Marine Geochemistry (1)
- 11:628:307 Aquaculture (3)
- 11:628:308 Marine Biogeochemistry (2)
- 11:628:310 Identification of Marine Invertebrates (2)

MARKETING 630

(See Rutgers Business School:
Undergraduate—New Brunswick section)

MATHEMATICS 640

Department of Mathematics, Faculty of Arts and Sciences

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Major Requirements

The Department of Mathematics annually publishes a *Brochure for Math Majors* which contains detailed information about the math major program; copies of this brochure may be obtained at the department offices and on the web.

The requirements for a math major are as follows:

1. Three terms of calculus (01:640:151-152, and 251, or equivalent), Introductory Linear Algebra (01:640:250) and Elementary Differential Equations (01:640:252). Courses 01:640:250, 251, and 252 must be passed with grades of C or better. Majors normally should take both 01:640:250 and 251 in the first term of their sophomore year.
2. 01:198:111 Introduction to Computer Science with a grade of C or better. (14:330:227 Electrical Engineering may be substituted for 01:198:111.) It is recommended strongly that this course be completed by the end of the second term of the sophomore year.
3. The completion of all the requirements in one of the mathematics major options listed below. (Students must notify the mathematics department in writing if they are not following the standard mathematics major option. Courses in other departments may not be substituted.)

Option A, Standard Mathematics (Curriculum Code 640).

In addition to the requirements above, to complete the standard mathematics major a student must pass eight 300- to 400-level mathematics courses, excluding 01:640:491,492.

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All but one of these courses (curriculum code 640) must be passed with a grade of C or better. At least four of the upper-level courses used to complete the major must be taken at Rutgers–New Brunswick, including one of 01:640:311, 312, 411, 412, and one of 01:640:350, 351, 352, 451, 452. An appropriate Rutgers graduate mathematics course may be substituted for the required analysis and/or algebra course, with departmental approval.

Recommended are probability (01:640:477), statistics (01:640:481), a course in mathematical modeling (01:640:321, 338, or 424), and a course in discrete mathematics (01:640:338, 354, 428, or 454). Also recommended is a two-term sequence of mathematically oriented courses in some other discipline; a list of suggested courses can be found in the *Brochure for Math Majors*.

Option B, Mathematics for Prospective Teachers. New Jersey certification as a mathematics teacher is available to students who complete the Graduate School of Education's five-year Mathematics Teacher Certification Program. For such students, the eight courses required at the 300 to 400 level for the mathematics major must include 01:640:300, 311 or 411, 351 or 451, 435, 477, and an applied mathematics course, in addition to the courses required for certification. At least four of the upper-level mathematics courses (curriculum code 640) must be taken at Rutgers–New Brunswick, including one of 01:640:311, 312, 411, or 412, and one of 01:640:350 or 351. Students interested in teacher certification should contact the mathematics department or the Graduate School of Education as early in the undergraduate career as possible to obtain advice and further information.

Option C, Computer-Oriented Mathematics. Replace the eight courses at the 300 to 400 level with six mathematics courses at the 300 to 400 level, including 01:640:311 or 411, 350 or 351 or 451, 373, 477, and either 374 or 454 (but excluding 01:640:491,492); and four computer science courses, including 01:198:112, 211, 344, and one elective from the following: 01:198:314, 416, 424, 425, 436, and 452. At least four of the upper-level mathematics courses (curriculum code 640) must be taken at Rutgers–New Brunswick, including one of 01:640:311, 312, 411, or 412, and one of 01:640:350 or 351. Prerequisites for some computer science courses may be satisfied by appropriate math courses. Students should consult the head computer science adviser. (This option is not available to students who are majoring in both mathematics and computer science.)

Biomathematics Interdisciplinary Major (Curriculum Code 122)

The major in biomathematics requires 63–67 credits distributed as follows: mathematics 33 credits, and biology and cognate fields 30–34 credits. Students must earn a minimum grade-point average of 2.0 in courses credited toward the major. See *Brochure for Math Majors*.

Core Biology and Chemistry required courses:

01:119:101-102 General Biology I and II (4,4),
or equivalent

01:160:161-162 General Chemistry I and II (4,4),
or equivalent

01:160:171 Introduction to Experimentation (1)

Mathematics required courses:

01:640:151, 152, 251 Calculus I, II, and III (4,4,4)

01:640:250 Introductory Linear Algebra (3)

01:640:252 Elementary Differential Equations (3)

01:640:336 Differential Equations in Biology (3)

01:640:338 Discrete and Probabilistic Models in
Biology (3)

01:640:477 Mathematical Theory of Probability (3)

01:640:481 Mathematical Theory of Statistics (3)

One of the following courses:

01:640:350 Linear Algebra (3)

01:640:373 Numerical Analysis (3)

01:640:423 Elementary Partial Differential Equations (3)

01:640:428 Graph Theory (3)

01:640:454 Combinatorics (3)

01:640:478 Probability II (3)

Required lab, one of the following:

01:119:382 (1); 14:125:315 (1); 01:146:357 (1); 01:146:475 (1).

Note: 01:447:390 is a 4-credit elective (see below) and includes a lab that satisfies this requirement.

Electives:

Four courses from the following list. 01:447:380 is highly recommended. No more than one course from 14:125 (biomedical engineering) can count as an elective.

01:146:245 Fundamentals of Neurobiology (3)

01:146:270 Fundamentals of Cell and Developmental
Biology (3)

01:146:302 or 447:302 Computers in Biology (3)

01:146:356 Systems Physiology (3)

01:146:445 Advanced Neurobiology (3)

01:146:470 Advanced Cell Biology (3)

01:146:474 Immunology (3)

01:160:305 (3) or 307 (4) or 315 (4) Organic Chemistry

01:160:306 (3) or 308 (4) or 316 (4) Organic Chemistry

01:447:380 Genetics (3)

01:447:384 Behavioral and Neural Genetics (3)

01:447:390 General Microbiology (4)

01:447:480 Topics in Molecular Genetics (3)

01:447:486 Evolutionary Genetics (3)

11:704:351 Principles of Applied Ecology (3)

11:704:486 Principles of Evolution (3)

16:215:513 Population Genetics (447:380) (3)

No more than one of:

01:146:478 Molecular Biology (3)

01:694:301 Introductory Biochemistry and Molecular
Biology (3)

01:694:407 Molecular Biology and Biochemistry I (3)

01:694:408 Molecular Biology and Biochemistry II (3)

No more than one of:

14:125:403 Cardiovascular Engineering (3)

14:125:407 Fundamentals of Computer
Tomography (3)

14:125:410 Sensory Processes, Mechanisms, and
Computational Models (3)

Statistics-Mathematics Interdisciplinary Major (Curriculum Code 961)

See Statistics 960.

Grade Requirements for Mathematics Majors

To be admitted to the mathematics major program, a student normally must have completed three terms of calculus with a grade of C or better in each course. To continue as a mathematics major, a student must make satisfactory progress toward completing the program. Satisfactory

progress for a full-time student normally means passing at least one mathematics course at an appropriate level each term with a grade of C or better. To complete the mathematics major program, or any of the options, a student must receive grades of C or better in 01:640:250, 251, and 252 and in all but one of the further mathematics courses. A student also must receive grades of C or better in the courses in other departments (e.g., computer science) used to fulfill the requirements of the program.

Minor Requirements

A minor in mathematics consists of three terms of calculus (ordinarily 01:640:151-152, 251), linear algebra (01:640:250), and four additional 3- or 4-credit courses, one of which may be either 01:640:244 or 252, and the rest of which must be 300- or 400-level mathematics courses (curriculum code 640). Three or four courses beyond 01:640:251 must be taken at Rutgers–New Brunswick. Grades of C or better are required in 01:640:250 and 251; at most, one D is permitted in the four courses beyond 01:640:250.

Departmental Honors Programs

Eligible first-year students and sophomores may take 01:640:192, 291, and 292, which are honors courses in second-, third-, and fourth-term calculus, respectively. Entry into these courses is determined by the department and is based on the student's previous performance in mathematics. The department occasionally offers honors sections of other courses.

To be a candidate for graduation with departmental honors, a mathematics major must maintain a cumulative grade-point average of 3.4 or better in mathematics courses and an overall cumulative grade-point average of at least 3.0, and must complete successfully two courses that are either approved independent study courses, approved graduate courses, or approved sections of 300- or 400-level courses, or approved project. A student who would like to have a course count toward the two-course honors requirement must apply at the department office no later than the first week of classes of the term during which he or she takes the course. The determination of whether a candidate graduates with departmental honors depends on the student's total performance in mathematics (including the written exposition of mathematical ideas). A more detailed description of the honors program can be obtained at the departmental offices or on the web.

Before Taking Mathematics Courses

Entering first-year students and most transfer students are required to take the mathematics placement test before registering for any mathematics course at Rutgers–New Brunswick. Students will be informed by their college of the times for taking the test.

Courses

The following abbreviations are used in the course listing.

1. CALC1 indicates that the prerequisite is any one of 01:640:135, 151, 153, or 191.
2. CALC2 indicates that the prerequisite is any one of 01:640:152, 154, or 192.

3. CALC3 indicates that the prerequisite is any one of 01:640:251 or 291.
4. CALC4 indicates that the prerequisite is any one of 01:640:244, 252, or 292.
5. CR1 indicates that students may not receive credit for more than one of the first-term calculus courses 01:640:135, 151, 153, or 191.
6. CR2 indicates that students may not receive credit for more than one of the courses including second-term topics 01:640:136, 138, 152, 154, or 192.
7. CR3 indicates that students may not receive credit for more than one of the courses including third-term topics 01:640:251 or 291.
8. CR4 indicates that students may not receive credit for more than one of the fourth-term courses 01:640:244, 252, or 292.

01:640:011. PRECALCULUS I WORKSHOP (E2)

Corequisite: 01:640:111.

Workshop to accompany 01:640:111.

01:640:012. PRECALCULUS II WORKSHOP (E2)

Corequisite: 01:640:112.

Workshop to accompany 01:640:112.

01:640:025. ELEMENTARY ALGEBRA (E3)

Operations with polynomials, rational and square root expressions, exponents, solving linear and quadratic equations, basic applications and graphing.

01:640:026. INTERMEDIATE ALGEBRA (E3)

Prerequisite: 01:640:025 or appropriate performance on the placement test in mathematics.

Absolute value equations and inequalities, radical expressions, rational exponents, quadratic equations and inequalities, introduction to functions, and topics in analytic geometry.

01:640:027. ELEMENTS OF ALGEBRA (E3)

Prerequisites: Acceptable performance on placement test and permission of department. Not for students preparing for calculus.

Review of fundamentals of elementary and intermediate algebra. Exponents, polynomials, solution of linear and quadratic equations. Focus on mathematical translation of verbal statements.

01:640:103. TOPICS IN MATHEMATICS FOR THE LIBERAL ARTS (3)

An elementary course for liberal arts majors. Prerequisite: 01:640:026 or 027 or appropriate performance on the placement test in mathematics. May not be used as an elective for the math major or minor.

Topics emphasizing fundamental ideas of mathematics, selected from set theory, mathematical logic, game theory, number theory, algebra, and geometry.

01:640:104. ELEMENTARY COMBINATORICS AND PROBABILITY (3)

An elementary course for liberal arts majors. Prerequisite: 01:640:026 or appropriate performance on the placement test in mathematics. May not be used as an elective for the math major or minor.

Introduction to the basic concepts of combinatorial mathematics, probability, and statistics.

01:640:105. INTRODUCTION TO LINEAR MATHEMATICS (3)

An elementary course for liberal arts majors. Prerequisite: 01:640:026 or appropriate performance on the placement test in mathematics. May not be used as an elective for the math major or minor.

Systems of linear equations, matrices, linear algebra, and linear programming.

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01:640:111-112. PRECALCULUS I,II (2,2)

Prerequisite: 01:640:026 or appropriate performance on the placement test in mathematics. *Corequisites:* 01:640:011 for 111; 01:640:012 for 112. These two courses cover the same material as 01:640:115, but at a slower pace. Students may not receive more than 4 normal credits for any combination of 01:640:111-112 and 115.

Math 111: Algebraic expressions, algebraic equations, inequalities, functions, and graphing. Math 112: Exponential, logarithmic, and trigonometric functions.

01:640:115. PRECALCULUS COLLEGE MATHEMATICS (4)

Prerequisite: 01:640:026 or appropriate performance on the placement test in mathematics. Students may not receive more than 4 normal credits for any combination of 01:640:111-112 and 115. Students who feel unprepared for this course (who have not had math for several years or whose mathematical background is weak) should consider taking 01:640:111-112, which covers the same material as 115 but at a slower pace and begins with an extensive review of intermediate algebra.

Algebraic expressions, algebraic equations, inequalities, functions, graphing. Exponential, logarithmic, and trigonometric functions.

01:640:131. CALCULUS I PRACTICUM (1)

Corequisite: 01:640:135.

Application of algorithms studied in 01:640:135 to problems.

01:640:132. CALCULUS II PRACTICUM (1)

Corequisite: 01:640:136.

Application of algorithms studied in 01:640:136 to problems.

01:640:135-136. CALCULUS I,II (4,4)

For liberal arts majors. Prerequisite for 135: 01:640:112 or 115 or appropriate performance on the placement test in mathematics. *Prerequisite for 136:* CALC1. *Credit restrictions:* CR1, CR2.

Math 135: Analytic geometry, differential calculus with applications, logarithmic and exponential functions, introduction to the integral. Math 136: Continuation of Calculus I for students who do not intend to continue beyond 01:640:250. Survey of techniques and applications of calculus. Taylor series, differential equations, multivariate calculus.

01:640:138. CALCULUS II FOR THE BIOLOGICAL SCIENCES (4)

For biological sciences majors. Prerequisite: CALC1. *Credit restrictions:* CR2.

Techniques of integration, elementary differential equations and their applications to biological sciences, and an introduction to linear algebra. For students who do not intend to continue beyond 01:640:250.

01:640:151-152. CALCULUS FOR MATHEMATICAL AND PHYSICAL SCIENCES (4,4)

For mathematics, physics, computer science, statistics, chemistry, or engineering majors. Prerequisite for 151: 01:640:112 or 115 or appropriate performance on the placement test in mathematics. *Prerequisite for 152:* CALC1. *Credit restrictions:* CR1, CR2.

Math 151: Same topics as 01:640:135, with additional theory and numerical applications. Math 152: Techniques of integration, elementary differential equations, sequences, infinite series, Taylor series, parametric equations, polar coordinates.

01:640:153-154. INTENSIVE CALCULUS I,II (6,6)

For students satisfying the prerequisites for first-term calculus who are invited by the department. Credit restrictions: CR1, CR2.

Math 153: Intensive study of analytic geometry, differential calculus of elementary functions, applications, and introductory integral calculus with emphasis on the analysis and solution of problems and on mathematical exposition. Math 154: Intensive study, techniques of integration, polar coordinates, and series, with emphasis on solution of problems and on mathematical exposition.

01:640:157. CALCULUS I FOR MATHEMATICAL AND PHYSICAL SCIENCES PRACTICUM (1)

Corequisite: 01:640:151.

Application of algorithms studied in 01:640:151 to problems.

01:640:158. CALCULUS II FOR MATHEMATICAL AND PHYSICAL SCIENCES PRACTICUM (1)

Corequisite: 01:640:152.

Application of algorithms studied in 01:640:152 to problems.

01:640:171. HONORS INTRODUCTION TO DISCRETE MATH (4)

Prerequisite: Permission of department.

Introduction to the principal elementary problems, methods, and proof techniques of discrete mathematics.

01:640:191-192. HONORS CALCULUS I,II (4,4)

For students with a serious interest in mathematics. Credit restrictions: CR1, CR2. *Grades of B or better are required to continue in the honors sequence.*

These courses cover the same material as 01:640:151-152 but in a more thorough and demanding fashion.

01:640:195,196. FIRST-YEAR SEMINAR I,II (1,1)

Prerequisite: Permission of department. *Corequisite:* Enrollment in a calculus course.

Discussion of selected topics in mathematics.

01:640:244. DIFFERENTIAL EQUATIONS FOR ENGINEERING AND PHYSICS (4)

Prerequisite: CALC3. *Credit restriction:* CR4.

First- and second-order ordinary differential equations; introduction to linear algebra and to systems of ordinary differential equations.

01:640:250. INTRODUCTORY LINEAR ALGEBRA (3)

Prerequisite: CALC2 or 01:640:136 or 138.

Systems of linear equations, Gaussian elimination, matrices and determinants, vectors in two- and three-dimensional Euclidean space, vector spaces, introduction to eigenvalues and eigenvectors. Possible additional topics: systems of linear inequalities and systems of differential equations.

01:640:251. MULTIVARIABLE CALCULUS (4)

Prerequisite: CALC2. *Credit restriction:* CR3.

Analytic geometry of three dimensions, partial derivatives, optimization techniques, multiple integrals, vectors in Euclidean space, and vector analysis.

01:640:252. ELEMENTARY DIFFERENTIAL EQUATIONS (3)

Prerequisites: 01:640:250 and CALC3. *Credit restriction:* CR4.

First- and second-order ordinary differential equations; systems of ordinary differential equations.

01:640:291-292. HONORS CALCULUS III,IV (4,4)

Prerequisites: 01:640:191-192 or permission of department. *Prerequisite for 292:* 01:640:250. *Credit restrictions:* CR3, CR4. *Grades of B or better are required to continue in the honors sequence.*

Covers the same material as 01:640:251 and 252 in a more thorough and demanding fashion.

01:640:293. HONORS MATHEMATICS FOR THE PHYSICAL SCIENCES I (4)

Prerequisites: CALC3 and 01:750:227 or 272, or permission of the department. *Primarily for students majoring in the physical sciences or engineering. Credit not given for this course and 01:640:244, 250, and 252.*

Selected topics from linear algebra and ordinary differential equations with illustrations of their use in the physical sciences and engineering.

01:640:300. INTRODUCTION TO MATHEMATICAL REASONING (3)

Prerequisite: CALC2 or permission of department.

Fundamental abstract concepts common to all branches of mathematics. Special emphasis placed on ability to understand and construct rigorous proofs.

01:640:311. ADVANCED CALCULUS I (4)

Prerequisites: CALC4 and 01:640:300 or permission of the department.

Introduction to language and fundamental concepts of analysis. The real numbers, sequences, limits, continuity, differentiation in one variable.

01:640:312. ADVANCED CALCULUS II (3)

Prerequisite: 01:640:311.

Series of numbers and functions, integration of functions of one variable, pointwise and uniform convergence, differential calculus in several variables, implicit and inverse function theorems.

01:640:321. INTRODUCTION TO APPLIED MATHEMATICS (3)

Prerequisite: CALC4.

Mathematical models of mechanical vibrations, population dynamics, and traffic flow, involving ordinary differential equations and nonlinear first-order partial differential equations.

01:640:336. DIFFERENTIAL EQUATIONS IN BIOLOGY (3)

Prerequisites: CALC4 and 01:640:250.

Models for biological processes based on ordinary and partial differential equations. Topics selected from models of population growth, predator-prey dynamics, biological oscillators, reaction-diffusion systems, pattern formation, neuronal and blood flow physiology, neural networks, and biomechanics.

01:640:338. DISCRETE AND PROBABILISTIC MODELS IN BIOLOGY (3)

Prerequisites: 01:640:250 and either 01:640:477, 01:198:206, or 01:960:381.

Only one of 01:640:338 and 339 may count for credit toward any math major or minor option.

Models for biological processes based on discrete mathematics (graphs, combinatorics), probabilistic and optimization methods, Markov chains and Markov fields, Monte-Carlo simulation, maximum-likelihood estimation, entropy, and information. Applications selected from epidemiology, inheritance and genetic drift, combinatorics and sequence alignment of nucleic acids, energy optimization in protein structure prediction, and topology of biological molecules.

01:640:339. MATHEMATICAL MODELS IN THE SOCIAL SCIENCES (3)

Prerequisites: 01:640:250 and either 01:640:477, 01:198:206, or 01:960:381.

Only one of 01:640:338 and 339 may count for credit toward any math major or minor option.

Introduction to the modeling process and survey of mathematical models from such areas as economics, sociology, psychology, and urban and policy science. Models dealing with energy use, air pollution, currency transfer, transportation, bargaining, voting, auctions, e-commerce, learning, and allocation of scarce resources. Models use graphs, signed graphs, Markov chains, n-person games, consensus functions, and differential equations.

01:640:350. LINEAR ALGEBRA (3)

Prerequisites: CALC4, 01:640:250, and 300, or permission of the department.

Continuation of 01:640:250. Abstract vector spaces and linear transformations, inner product spaces, diagonalization, and canonical forms. Possible additional topics: systems of ordinary differential equations and numerical techniques.

01:640:351-352. INTRODUCTION TO ABSTRACT ALGEBRA I,II (4,3)

Prerequisites: CALC3, 01:640:250, and 300, or permission of the department.

Abstract algebraic systems, including groups, rings, fields, polynomials, and some Galois theory.

01:640:354. LINEAR OPTIMIZATION (3)

Prerequisite: 01:640:250. *Credit not given for both this course and 01:640:453 or 01:711:453.*

Linear programming problems, the simplex method, duality theory, sensitivity analysis, introduction to integer programming, the transportation problem, network flows, and other applications.

01:640:355. GAME THEORY (3)

Prerequisite: 01:640:354. *Credit not given for both this course and 01:220:406.*

Introduction to two-person and n -person game theory, with applications to economics, politics, strategic studies, and other areas. Pure and mixed strategies, the minimax theorem, cooperative and noncooperative games, and bargaining models.

01:640:356. THEORY OF NUMBERS (3)

Prerequisite: CALC3.

Properties of the natural numbers, congruences, diophantine equations, and elementary arithmetical functions.

01:640:357. TOPICS IN APPLIED ALGEBRA (3)

Prerequisites: CALC3 and 01:640:250.

Material relevant for various applications. Topics chosen from finite machines, languages, coding theory, Boolean algebras, graph theory, group-theoretic counting arguments, algebraic computational complexity.

01:640:361. FOUNDATIONS OF MATHEMATICS (3)

Prerequisites: CALC3 and either 01:640:300 or permission of the department.

Introduction to concepts and tools used in abstract mathematics. Emphasis on writing of proofs. Elementary logic and set theory, formal axiom systems, transfinite numbers, the real number system, and the foundations of mathematics.

01:640:373-374. NUMERICAL ANALYSIS I,II (3,3)

Prerequisites: CALC4 and familiarity with a computer language. *Credit not given for both these courses and 01:198:323,324.*

Analysis of numerical methods for the solution of linear and nonlinear equations, approximation of functions, numerical differentiation and integration, and the numerical solution of initial and boundary value problems for ordinary differential equations.

01:640:393. HONORS MATHEMATICS FOR THE PHYSICAL SCIENCES II (4)

Prerequisites: 01:640:293, or 250 and 252, or permission of the department.

Primarily for students majoring in the physical sciences or engineering. Credit not given for this course and 01:640:403, 421, and 423.

The important partial differential equations of mathematical physics and an introduction to the theory of functions of a complex variable.

01:640:395. STUDIES IN MATHEMATICS (3)

Topics vary from term to term. Details available at time of registration.

01:640:403. INTRODUCTORY THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3)

Prerequisite: CALC4.

First course in the theory of a complex variable. Cauchy's integral theorem and its applications. Taylor and Laurent expansions, singularities, conformal mapping.

01:640:411-412. MATHEMATICAL ANALYSIS I,II (3,3)

Prerequisites: Permission of the department and the instructor. *For students preparing for graduate study in the mathematical sciences.*

Rigorous analysis of the differential and integral calculus of one and several variables.

01:640:421. ADVANCED CALCULUS FOR ENGINEERING (3)

Primarily for mechanical engineering majors. Prerequisite: CALC4. *Credit not given for both this course and 01:640:423.*

Laplace transforms, numerical solution of ordinary differential equations, Fourier series, and separation of variables method applied to the linear partial differential equations of mathematical physics (heat, wave, and Laplace's equation).

01:640:423. ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS (3)

Prerequisite: CALC4. *Credit not given for both this course and 01:640:421.*

Linear partial differential equations of mathematical physics (heat, wave, and Laplace's equation), separation of variables, Fourier series.

01:640:424. STOCHASTIC MODELS IN OPERATIONS RESEARCH (3)

Prerequisites: CALC4 and 01:640:250 and 477.

Introduction to stochastic processes and their applications to problems in operations research: Poisson processes, birth-death processes, exponential models, continuous-time Markov chains, queuing theory, computer simulation of queuing models, and related topics in operations research.

MEDICAL TECHNOLOGY

01:640:426. TOPICS IN APPLIED MATHEMATICS (3)

Prerequisite: 01:640:421 or 423.

Topics selected from integral transforms, calculus of variations, integral equations, Green's functions; applications to mathematical physics.

01:640:428. GRAPH THEORY (3)

Prerequisites: CALC3 and 01:640:250.

Colorability, connectedness, tournaments, eulerian and hamiltonian paths, orientability, and other topics from the theory of finite linear graphs, with an emphasis on applications chosen from social, biological, computer science, and physical problems.

01:640:429. INDUSTRY-ORIENTED MATHEMATICS: CASE STUDIES (3)

Prerequisites: Announced each year (including one or more of the following: CALC4, 01:640:250, 373, 477, 481); proficiency in computer programming.

Introduces students to an actual industrial problem requiring mathematical techniques (including computer science and statistics) for its solution. Problem presented by an industry representative, who also discusses methodology; instructor covers relevant mathematical topics. Students expected to participate actively in discussion, research, bibliography search, and computer programming (if appropriate), and to prepare a detailed report describing the problem, approach, and conclusions.

01:640:432. INTRODUCTION TO DIFFERENTIAL GEOMETRY (3)

Prerequisite: 01:640:311.

Investigation of the properties of curves and surfaces using methods of analysis.

01:640:435. GEOMETRY (3)

Prerequisites: CALC3, 01:640:250, and 300, or permission of the department.

Various geometries, including projective and non-Euclidean geometries, and geometric axiom systems.

01:640:436. HISTORY OF MATHEMATICS (3)

Prerequisites: 01:640:250,251; recommended to be taken after Geometry (01:640:435).

Selected topics from the history of mathematics including number systems; Euclidean geometry; the development of algebra in India, Arabia, and the West; and calculus.

01:640:441-442. INTRODUCTORY TOPOLOGY I,II (3,3)

Prerequisite: CALC4 and either 01:640:300 or permission of the department.

Math 441: Introduction to topology with emphasis on the foundations of analysis; Euclidean spaces, metric spaces, topological spaces, and their properties; applications to analysis. Math 442: Basic concepts of algebraic topology, including the fundamental group, plane curves, homotopy, and a brief introduction to homology.

01:640:451-452. ABSTRACT ALGEBRA I,II (3,3)

Prerequisites: Permission of the department and the instructor. For students preparing for graduate study in the mathematical sciences.

Rigorous study of abstract algebraic systems including groups, rings, and fields.

01:640:453. THEORY OF LINEAR OPTIMIZATION (3)

Prerequisite: 01:640:250. Credit not given for both this course and 01:640:354 or 01:711:453.

Emphasis on the theory of linear optimization. Topics include convex sets, polyhedra, Farkas lemma, canonical forms, simplex algorithm, duality theory, revised simplex method, primal-dual methods, complementary slackness theorem, maximal flows, transportation problems, 2-person game theory.

01:640:454. COMBINATORICS (3)

Prerequisites: CALC2 and 01:640:250.

Existence and enumeration of designs and patterns such as codes, graphs, and block designs, and extremal problems related to such objects. Emphasis on applications to computer, biological, physical, and social problems.

01:640:457-458. COMPUTATIONAL METHODS IN ABSTRACT ALGEBRA (1.5,1.5)

Pre- or corequisites: 01:640:351-352. No prior computing experience is assumed.

Computer techniques for the study of particular algebraic objects such as finite groups, finitely generated abelian groups, and vector spaces over finite fields. APL programming language used.

01:640:461. MATHEMATICAL LOGIC (3)

Prerequisite: CALC3 and either 01:640:300 or permission of the department.

Intuitive and formal development of the sentential and predicate calculus. Special emphasis given to questions of consistency, completeness, and independence. Formal systems; incompleteness and undecidability; theorems of Gödel. Exploration of which properties of structures can be defined in the first-order language.

01:640:477. MATHEMATICAL THEORY OF PROBABILITY (3)

Prerequisite: CALC3. Credit not given for both this course and 01:198:206, 14:330:349, or 01:960:381.

Basic probability theory in both discrete and continuous sample spaces, combinations, random variables and their distribution functions, expectations, law of large numbers, central limit theorem.

01:640:478. PROBABILITY II (3)

Prerequisites: 01:640:250 and either 01:640:477 or both 01:640:251 and 01:960:381.

Sums of independent random variables, moments and moment-generating functions, characteristic functions, uniqueness and continuity theorems, law of large numbers, conditional expectations, Markov chains, random walks.

01:640:481. MATHEMATICAL THEORY OF STATISTICS (3)

Prerequisites: 01:440:250 and either 01:640:477 or both 01:640:251 and 01:960:381. Credit not given for both this course and 01:960:382.

Fundamental principles of mathematical statistics, sampling distributions, estimation, testing hypotheses, correlation analysis, regression, analysis of variance, nonparametric methods.

01:640:491,492. UNDERGRADUATE MATHEMATICS SEMINAR (1,1)

Reading, presentation, and discussion of mathematical topics.

01:640:493,494. INDIVIDUAL STUDY IN MATHEMATICS (1-3 BA,1-3 BA)

Prerequisite: Permission of department.

01:640:495. SELECTED TOPICS IN MATHEMATICS (3)

01:640:496. RESEARCH IN MATHEMATICS (3)

01:640:497,498. HONORS IN MATHEMATICS (3,3)

MEDICAL TECHNOLOGY 660

Douglass College

Adviser: Jacqueline D. Heads

Medical technology, also called clinical laboratory science, is a professional field for which the student prepares in chemistry, microbiology, hematology, and related disciplines. Certified medical technologists or clinical laboratory technicians may enter careers in teaching or may work in clinical laboratories, research institutions, and pharmaceutical firms. The program, which leads to a bachelor of science degree, includes a yearlong, full-time clinical internship that qualifies the student to take national certification exams. Internships are competitive; grade-point averages of 2.8 in the sciences and cumulatively are required to apply. Application is made during the fall term of the junior year.