DEPARTMENT OF MATHEMATICS

(Division of Science)

Office: NAC 8113
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Chairman
Professor John Landolfi

Mathematics provides a methodology and a framework of rigorous thought for almost every field of human endeavor.

The Mathematics Department at City College offers several programs of study that enable students to prepare for graduate study and for a wide variety of careers.

Through the many specialization options, students may prepare for graduate work in pure and applied mathematics, and careers in industry, teaching and the actuarial profession. The Department also offers a program through which students may earn B.S. and M.A. degrees in four years.

The Mathematics Department also offers a comprehensive program of remediation to advance the student's level of Mathematics.

Placement in all courses up to and including freshman level is based on a placement examination for all entering freshmen. Transfer students may be required to take this or other diagnostic examinations.

The first part of the mathematics placement exam (given to all entering freshmen) is the City University Mathematics Skills Assesment Test, which must be passed by all students sometime before entering their junior year. Students who do not pass this test when they enter the college will be notified that they must take it again later, and are advised to register for an appropriate Mathematics course in order to prepare for the re-examination.

Every student who is required to take mathematics in the College, or who chooses to do so, will be placed in his first college course on the basis of his score on the entire mathematics placement exam.

An entering freshman who has not previously passed both one year of elementary algebra and one year of plane geometry in high school must pass either Math 53 or Math 55 or receive placement in Math 56 in order to earn the baccalaureate degree. A student who passed both elementary algebra and plane geometry in high school is not required to take any college mathematics unless his department or area of specialization requires mathematics.

Advisement

Vice-Chairman, Undergraduate Student Advisor:
Prof. N. Gordon
Graduate Student Advisor: Prof. J. Barshay
Remedial Course Advisor: Mr. D. Mosenkis, Ms. K. Rustad

Curriculum for Majors

Requirements for the major may be met according to one of the options listed below. Prospective majors *must* consult the Vice-Chairman during their sophomore year to file a specialization card. Unless otherwise noted, *all* students will be expected to complete a minimum of either 27 credits or 8 courses of mathematics and collateral courses beyond the level of Math 203 (or 208). The Mathematics majors who are planning to graduate with a B.A. degree are required to take Math 210. The Vice Chairman will indicate which course of study is appropriate for students who intend to enter graduate school.

A. *Pure Mathematics:* Must include Math 226 and 327 (or 223, 324, 325), 246; and 449 (or 347). Additional courses from among Math 275, 291, 328, 345, 360, 371, 376, 432, 434, 435, 438, 443, 444, 461, 463, 477, 478, 511, 512, 513 (Also see Note below.)

B. *Applied Mathematics:* Must include Math 226 and 327 (or 223, 324, 325); 246; and 449 (or 347). Additional courses from among Math 275, 291 (or 296), 328, 370 (or 371),

376, 435, 438, 461, 477, 478. Collateral advanced non-mathematics courses totaling not more than 6 credits may also be selected and used for this option with permission of the Vice-Chairman.

Note: Students selecting either Option A or B are required to fulfill a minor requirement of two advanced courses with mathematical content, approved by the Vice-Chairman, from an allied discipline (e.g. physical sciences, philosophy, economics, engineering).

C. Secondary Education: Besides mathematics, several education courses are required for students seeking accreditation (consult Vice-Chairman for details). Students may select either of two tracks:

a) Mathematics emphasis: Must include Math 226 and 327 (or 223, 324, 325); 246; and 347 (or 449). Additional courses from among Math 275, 328, 343, 360, 376.

b) Education emphasis: Must include Math 223 (or 226); 246; 275, 347 (or 449), and 360. Additional advanced mathematics courses and education courses to be selected with guidance of the Vice-Chairman.

D. Operations Research

a) Preparatory for graduate work: Must include Math 226 and 327 (or 223, 324, 325); 246; and 449 (or 347). Additional courses in applied mathematics, statistics and computer science to be selected with guidance of the Vice-Chairman.

b) Not preparatory for graduate work: Must include Math 223, 324, 325 or 296, 397; or 291, 392. Must also include Math 246, 269, 275, 328, 370 (or 371), 376, Computer Science 100 and 442.

E. Actuarial Mathematics: Must include Math 226 and 327 (or 223, 324, 325), 246, 275, 287, 328, 376 or 371, 376, 388, 389, Computer Science 100, 210, and 220. It is suggested that additional courses be selected from among Math 477, 478; Economics 272, 360, 361, 380. This option prepares one for passing the first 3 actuarial examinations.

A mathematics major must maintain at least a C average in mathematics courses. No advanced undergraduate course may be taken unless a C is obtained in all prerequisite courses (This rule may exceptionally be waived by the Vice-Chairman). The Vice-Chairman may allow the passing of a course by exemption examination. With permission of the Vice-Chairman, students may participate in honors seminars or elect advanced work in the Master's level courses: 511, 512, 511, 1736, 1737, 1739, 1740, 1763, 1776, 1777. Mathematics majors are advised to select a foreign language from among French, German, and Russian.

Internships

The Department offers a number of Undergraduate Tutoring Assistantships with stipends from $500 to $1000. Assistants tutor in prebaccalaureate and freshman level courses under the guidance of faculty members.

Co-op Education

The Department of Mathematics offers three courses in Cooperative Education: Math 299, 399 and 499. Students obtain credit for full-time employment that supplements and applies their knowledge of Mathematics. Students can earn 1-6 credits per term, of which not more than a total of 4 credits may be applied toward a major.

Electives for Non-Majors

Students who have completed basic calculus through Mathematics 203 or 208 and who seek elective courses in Mathematics 246, 275, 291, 328, 370, 371, and 376. The Vice-Chairman should be consulted on the selection of such courses, for the appropriateness of the course varies with the major.

Exemption Credit

Students can earn exemption credit in any Mathematics course by taking an exemption examination. Exemption from the course is awarded for a grade of 60 or above; credit is granted for a grade of 80 or above. Students who have registered for a course or who have previously failed an exemption examination in a course may not take an exemption examina-

tion for that course. The Mathematics Department awards credit in Mathematics 107 to students who score 4 or above on the College Board Calculus AB Advanced Placement examination or 3 or above on the BC examination. Depending on the examination paper, credit is sometimes given for a 3 on the AB examination.

Tutoring

The Mathematics Laboratory offers free tutoring in courses from the remedial level through elementary calculus. It is open on Monday-Thursday, 9 A.M. to 6 P.M.; Friday, 9 A.M. to 2 P.M., and two evenings until 8 P.M.

Department Activities

The Mathematics Club is open to Mathematics majors who meet for lectures, discussions, and social activities.

The Mathematics Society is open to students in all levels of Mathematics courses who meet to provide tutorial services and social activities. The Mathematics Colloquium meets regularly for talks by invited guests as well as members of the Department. The Seminar on Algebra, the Seminar on Logic, and the Seminar on Topology meet regularly for talks on topics in these respective areas.

Awards

The Mathematics Department awards several medals and prizes to outstanding students.

THE BELDEN MEDAL: to the student or students who complete the Advanced Calculus sequence with distinction.

THE LEONARD COHEN AWARD: to a senior who has shown promise in Mathematics.

THE ISRAEL E. DRABKIN MEMORIAL AWARD: to a promising Mathematics student with broad cultural interests.

THE BENNINGTON P. GILL MEMORIAL AWARD: to the most promising graduating senior committed to graduate study in Mathematics.

THE KENYON PRIZE: for distinction in pure and applied Mathematics.

THE EMIL POST MEMORIAL AWARD: to the graduating senior or seniors judged most promising in Mathematics.

General Prerequisites

There are three calculus sequences: Math 107 and 208; Math 101, 202 and 203; and Math 105 and 206 (or 209 for biology majors). Math 107 and 208 cover the same material as 101, 202 and 203, but at an accelerated pace. Entry to the above sequences is determined by the Placement Examination. Math 105 and 206 (or 209 for biology majors) may be taken by students who do not intend to study more advanced mathematics (e.g. biology, pre-dental, pre-medical and psychology majors). The requirements for the Bachelor of Science may be met either by Math 101, 202; or Math 107, 208; or Math 105, 206 (or 209).

Mathematics 208 or 203 (but not 206 or 209) is a prerequisite for all advanced courses. After Math 105, students may take 202 and 203 with permission of the Vice-Chairman. Without prior approval by the Vice-Chairman, no credit is allowed for an introductory course if a more advanced course has already been or is concurrently being taken.

Description of Courses

Remedial Courses

51: Arithmetic and Elementary Algebra Arithmetic of positive integers, fractions and decimals; percent; graphs; arithmetic of signed numbers, algebra of polynomials, solution of linear equations in one and two variables; graphs of linear equations; areas; Pythagorean theorem, applications to problems from real life. Prereq: Placement by the Mathematics Department.
4 hrs lec, 1 hr lab/wk; no cr

52: Applications of Mathematics Very big and very small numbers, scientific notation, hand calculators, round-off errors and significant figures, applications to real-world problems including linear and exponential relationships and their graphs, Pythagorean theorem and basic geometric relationships, charts and graphs of numerical data. Prereq: Math 51 or placement by the Mathematics Department.
3 hrs lec, 1 hr lab/wk; 1 cr

53: Modern Mathematical Tools Elementary probability and statistics, logical analysis of

problems and processes, flowcharting, power problems and ... and limitations of electronic computers, introduction to programming in BASIC. Prereq: Math 52 or 54 or placement by the Mathematics Department
3 hrs. lec, 1 hr lab/wk; 1 cr.

54: Essentials of Algebra Signed numbers, polynomials and factoring, algebraic fractions, solution of linear and quadratic equations, verbal problems. Prereq: Grade of C or higher in Math 51 or placement by Mathematics Department.
4 hrs. lec, 1 lab. hr/wk; no cr.

55: Further Essentials of Algebra Description measurements and relationships of plane and solid geometric figures; exponents, radicals; logarithms; functions; systems of equations; determinants; conic sections. Prereq: Grade of C or higher in Math 54 or placement by the Mathematics Department.
4 hrs. lec, 1 hr lab/wk; 1 cr.

56: Trigonometry and Precalculus Functions and graphs, trigonometric functions, law of sines and law of cosines, inverse trigonometric functions, trigonometric equations and identities, introduction to complex numbers, sequences and series, binomial theorem, introduction to calculus. Prereq: Grade of C or higher in Math 55 or placement by the Mathematics Department.
4 hrs. lec, 1 hr lab/wk; 1 cr.

Core Courses

100: Mathematics in the Physical World Methods of reasoning, functions and their graphs, basic ideas of calculus, mathematical models of physical phenomena, statistics and probability, introduction to computers. Prereq: Math 53 or 55 or placement by the Mathematics Department.
3 hrs/wk; 3 cr.

101: Analytic Geometry and Calculus I Limits, derivatives, rules of differentiation, differentials, graph sketching, maximum and minimum problems, related rates, antiderivatives, areas. Prereq: Either trigonometry and placement by the Mathematics Department or grade of C or higher in Math 56. Credit will not be given for both Math 101 and 105. (Part of sequence 101, 202, 203.)
4 hrs/wk; 3 cr.

101.9: Analytic Geometry and Calculus I This course is the same as Math 101 but with two additional hours a week devoted to reviewing topics from algebra, geometry, and trigonometry directly related to calculus. Prereq: Placement by the Mathematics Department.
6 hrs/wk; 3 cr.

105: Elements of Calculus I Functions and graphs; rate of change; the limit concept; calculus of algebraic, logarithmic, exponential and trigonometric functions; techniques of integration; elementary applications to curve plotting, areas, and volumes of solids of revolution. Prereq: Either trigonometry and placement by the Mathematics Department or grade of C or higher in Math 56. Credit will not be given for Math 101 and 105. With departmental permission, partial credit may be given for Math 197 after completion of Math 105.
4 hrs/wk; 4 cr.

105.9: Elements of Calculus This course is the same as Math 105 but with two additional hours a week devoted to reviewing topics from algebra, geometry, and trigonometry directly related to calculus. Prereq: Placement by the Mathematics Department.
6 hrs/wk; 4 cr.

107: Analytic Geometry and Calculus A Limits; derivatives; rules of differentiation; differentials; graph sketching; maximum and minimum problems; related rates; antiderivatives; vectors; areas; volumes of solids of revolution; exponential, logarithmic and trigonometric functions. Prereq: Trigonometry and placement by the Mathematics Department. With departmental permission, partial credit may be given for Math 107 after completion of Math 105 (Part of sequence 107, 208).
5 hrs/wk; 5 cr.

Introductory Courses

173: Introduction to Probability and Statistics Descriptive statistics and frequency histograms; measures of location and dispersion; elementary probability; permutations and combinations; multiplication rule and conditional probability; Bayes' Theorem; independent events; random variables; expected values; applications to binomial, hypergeometric, uniform and normal distributions, the Central Limit Theorem; testing statistical hypotheses; correlation; linear regression and least squares. Prereq: Either intermediate algebra and placement by the Mathematics Department or Math 55. Credit given for only one of the following courses: Math 173, Eco 295, Psych 218, Soc 231.
4 hrs/wk; 4 cr.

184: Biostatistics Introduction to probability; the binomial, Poisson, normal, t, X^2, and F distributions, basic non-parametric tests; analysis of variance; contingency tables; experimental design; rates and age adjustment. Prereq: Either intermediate algebra and placement by the Mathematics Department or Math 56. Credit will not be given for both Math 184 and 173.
3 hrs/wk; 3 cr.

185: Basic Ideas in Mathematics Sets, operations with sets, relations, functions, construction of number system, numerical systems with different bases, topics in number theory, geometry. Prereq: Either elementary algebra and plane geometry and placement by the Mathematics Department, or the grade of C in Math 54. Recommended for prospective elementary school teachers.
4 hrs/wk; 3 cr.

202: Analytic Geometry and Calculus II Volumes of solids revolution; conic sections; exponential, logarithmic and trigonometric functions; methods of integration; vectors; improper integrals; parametric representation of curves, polar coordinates. Prereq: Math 101 (Part of sequence 101, 202, 203).
4 hrs/wk; 3 cr.

203: Analytic Geometry and Calculus III Infinite series; Taylor's theorem; solid analytic geometry, partial derivatives, multiple integrals with applications. Prereq: Math 202 (Part of sequence 101, 202, 203.)
4 hrs/wk; 4 cr.

206: Elements of Calculus II Infinite series including Taylor expansion; differential equations, functions of several variables; partial derivatives, evaluation of double integrals; determinants with application to linear simultaneous equations. Prereq: Math 105 or 105.9 (Part of sequence 105, 206).
3 hrs/wk; 3 cr.

208: Analytic Geometry and Calculus II Methods of integration, moments and centroids, improper integrals, infinite series, Taylor's theorem, conic sections, parametric representation of curves, polar coordinates, solid analytic geometry, partial derivatives, multiple integrals with applications. Prereq: Math 107 (Part of sequence 107, 208.)
5 hrs/wk; 5 cr.

209: Elements of Calculus and Statistics Exponential and logarithmic functions, equations of growth and decay, integration techniques, improper integrals, differential equations, counting techniques, probability on finite sample spaces, binomial distribution; continuous distributions, normal distribution, statistical measures, statistical inference, biological applications. Prereq: Math 105 or 105.9.
4 hrs/wk; 4 cr. 3 credits will be given for Math 209 after completion of Math 107. (Part of sequence 105, 209 for biology majors)

210: The Use of Computers in Mathematics Rapid survey of Fortran programming; backtracking; Monte Carlo and simulation techniques; combinatorial and graph-theoretic algorithms; applications to mathematical programs. Through work on projects, students will gain experience in the use of a computer to solve elementary problems in areas of mathematics such as number theory, probability, games, queuing theory, and geometry. Prereq: Math 203 or 208 or departmental permission. This course is required for all math majors planning to graduate with a B.A. degree and recommended for all who plan to do advanced work in mathematics. Prior knowledge of computer programming is not required. Credit will be allowed for both Science 200 and Math 210.
3 hrs/wk; 3 cr.

Advanced Courses

223: Introduction to Higher Mathematics (Advanced Calculus I) Sets, relations, functions, operations, construction of number systems, point-sets in higher dimensions, metric spaces, limits and continuity, uniform convergence. Prereq: Math 203 or 208 or departmental permission. Credit is not given for both Math 266, 327 and 223, 324, 325. These sequences are similar. The principal differences are that Math 226 and 327 cover

the material in greater depth and at a faster rate.

4 hrs/wk: 4 cr.

226: Introduction to Higher Analysis I Sets, relations, function operations, construction of number systems, properties of the real numbers, point sets in higher dimensions, compactness, connectedness, completeness, metric spaces, topological spaces, limits and continuity, topological properties of continuous functions, uniform convergence, Taylor's theorem, theorems of partial differentiation, implicit function theorems. Prereq: Math 203 or 208 or departmental permission. Credit is not given for both Math 226, 327 and 223, 124, 325. These sequences are similar. The principal differences are that Math 226, 327 cover the material in greater depth and at a faster rate.

5 hrs/wk: 5 cr.

246: Elements of Linear Algebra Vector spaces, basis and dimension, matrices, linear transformations, determinants, solution of systems of linear equations, eigenvalues and eigenvectors. Prereq: Math 203 or 208, or Coreq: Math 203 or 208, and departmental permission.

3 hrs/wk: 3 cr.

268: Applied Logic and Discrete Mathematics Mathematical models, mathematical reasoning, set theory, binary relations, functions, counting and algorithm analysis. Prereq: Math 203 or 208.

4 hrs/wk: 4 cr.

269: Elementary Combinatorial Mathematics Classification of finite functions, partitions, sets, relations, principle of induction permutations and combinations, binomial and multinomial coefficients, stochastic processes, basic definitions of abstract algebra. Prereq: Math 203 or 208 or permission of the instructor. This course is required for the operations research option. Specialization credit for other options will be given only with departmental permission. Credit will not be given for both Math 269 and CSc 350.

3 hrs/wk: 3 cr.

275: Elements of Probability Theory Permutations and combinations, conditional probability, independent events, random variables, probability distributions and densities, expectation, moments, moment generating func-

tions, functions of random variables, Central Limit Theorem, sampling, confidence intervals. Prereq: Math 203 or 208.

3 hrs/wk: 3 cr.

287: Actuarial Mathematics I Special aspects of calculus, linear algebra, and algebra of complex numbers which are found on the first actuarial examination. Prereq: Math 203 or 208, Coreq: Math 246.

2 hrs/wk: 2 cr. In order to receive specialization credit, a student must be in the actuarial mathematics option and either must receive at least the grade of B or pass the actuarial examination.

291: Methods of Differential Equations First order equations, equations with constant coefficients, Sturm comparison theorem, series solutions, special functions, linear systems, phase plane, stability, nonlinear systems, periodic solutions, applications. Prereq: Math 203 or 208.

3 hrs/wk: 3 cr. Credit will not be given for both Math 291 and 296.

294: Linear and Boolean Algebra for Electrical Engineers Matrices, determinants, solution of systems of equations, vector spaces, transformation, eigenvalues, switching algebra and functions, Karnaugh maps, minimal functions, basic logical gates, NAND and NOR circuits. Prereq: Math 101.

3 hrs/wk: 3 cr.

296: Topics in Advanced Calculus for Students of Physics I Ordinary differential equations; functions of several variables; vector analysis; integration; Green's, Stokes' and divergence theorems. Prereq: Math 203 or 208.

3 hrs/wk: 3 cr. Credit will not be given for both Math 296 and 291.

299: Cooperative Education in Mathematics I Introductory experience in Cooperative Education. Assignment will be made in entry-level position of employment. Taken only with permission of Faculty Advisor and acceptance in Cooperative Education Program. Prereq: Math 203.

1-6 credits.

324: Advanced Calculus II Taylor's theorem, theorems of partial differentiation, implicit-function theorems, mappings, vector fields, surface theory, line and surface integrals.

Prereq: Math 223 (part of sequence 223, 124, 325.)

3 hrs/wk: 3 cr.

325: Advanced Calculus III Theory of integration, infinite series and uniform convergence, improper integrals. Prereq: Math 324.

3 hrs/wk: 3 cr. Specialization credit not given for both Math 392 and 325. (Part of sequence Math 223, 324, 325.)

327: Introduction to Higher Analysis II Mappings, Jacobians, vector fields, surface theory, line and surface integrals, theorems of Green and Stokes, divergence theorem, theory of integration, Riemann integral, Stieltjes integral, infinite series and uniform convergence, improper integrals. Prereq: Math 226. (Part of sequence 226, 327.)

5 hrs/wk: 5 cr.

328: Methods of Numerical Analysis Solution of equations by iteration techniques, interpolation and approximation, numerical differentiation and integration, difference methods and difference equations. Prereq: Math 291 or 296, and knowledge of FORTRAN.

3 hrs/wk: 3 cr.

342: History of Mathematics Greek mathematics, non-Euclidean geometries, Hilbert's Grundlagen, algebraic structure, the modern method, axiomatics for the reals, symbolic logic and foundations. Prereq: Math 203 or 208.

3 hrs/wk: 3 cr.

345: Theory of Numbers Divisibility, primes, fundamental theorem of arithmetic, congruences, number theory from algebraic viewpoint, quadratic reciprocity, number theoretic functions, diophantine equations. Prereq: Math 223 or 226 or departmental permission.

3 hrs/wk: 3 cr.

347: Elements of Modern Algebra Sets, mappings, rings, isomorphisms, integral domains, properties of integers, fields, rational numbers, complex numbers, polynomials, groups. Prereq: Math 203 or 208.

4 hrs/wk: 4 cr. With departmental permission, partial credit may be given for Math 449 after completion of Math 347. Recommended for prospective teachers and others who want a basic course in abstract algebra.

360: Introduction to Modern Geometry Logical deficiencies in Euclidean geometry, Euclid's parallel postulate, introduction to non-Euclidean geometry, the logical consistency of the non-Euclidean geometries, the theory of incidence, the theory of order on the line. Prereq: Math 203 or 208.

3 hrs/wk: 3 cr.

367: Selected Topics and Problems in Industrial Mathematics Problems from industry, mathematical models, process of mathematical abstraction, problem solving techniques application of solutions. Prereq: Math 246, 275, 291.

3 hrs/wk: 3 cr.

370: Elementary Operations Research Mathematical modeling; decision theory; linear and dynamic programming, game theory, stochastic models in queuing, inventory, and reliability theory; network analysis including PERT and CPM. Prereq: Math 246 and 275.

3 hrs/wk: 3 cr. Credit will not be given to a student who has taken Math 371. Specialization credit not given for both Math 370 and CSc 446.

371: Theory of Games and Mathematical Methods of Operations Research Theory of games, linear programming, network analysis and PERT, dynamic programming, non-linear programming. Prereq: Math 223 or 226: Math 246.

3 hrs/wk: 3 cr. Credit will not be given for both Math 371 and CSc 446.

376: Mathematical Statistics The gamma, chi-square, T and F distributions, and bivariate normal distribution; the Central Limit Theorem; confidence intervals and tests of hypothesis; the Neyman-Pearson Theorem, likelihood ratio tests; estimation; sufficiency, unbiasedness, completeness, the Rao-Blackwell Theorem; the Rao-Cramer inequality, the method of maximum likelihood; the chi-square tests; introduction to the analysis of variance and regression. Prereq: Math 275.

4 hrs/wk: 4 cr.

388: Actuarial Mathematics II Special aspects of probability and statistics which are found on the second actuarial examination. Prereq: Math 376. In order to receive specialization credit, a student must be in the actuarial mathematics option and either must receive at

least grade of B or pass the actuarial examination. 1 hr/wk; 1 cr.

389: Actuarial Mathematics III Special aspects of numerical analysis with emphasis on finite differences, and topics which are found on the third actuarial examination. Prereq: Math 328. 1 hr/wk; 1 u. In order to receive specialization credit, a student must be in the actuarial mathematics option and either must receive at least the grade of B or pass the actuarial examination.

392: Linear Algebra and Vector Analysis for Engineers Linear algebra, vector spaces, vector field theory, theorems of Green and Stokes. Prereq: Math 291 or Math 203 (or 208) and departmental permission. No specialization credit given for Math 392 and 325. 3 hrs/wk; 3 cr.

397: Topics in Advanced Calculus for Students of Physics II Matrix algebra, series solutions to ordinary differential equations, special functions, Bessel and Legendre functions, Fourier series and integral. Prereq: Math 296. 3 hrs/wk; 3 cr.

398: Topics in Advanced Calculus for Students of Physics III Complex variables, evaluation of integrals by residues, separation of variable methods for partial differential equations. Prereq: Math 397 or 392. 3 hrs/wk; 3 cr.

399: Cooperative Education in Mathematics II A second assignment with the following alternatives: higher-level position, and/or increased responsibilities, with the same or different employer and with recognition of general career objectives. Taken only with permission of Faculty Advisor. Prereq: Math 299. 1-6 credits.

432: Theory of Functions of a Complex Variable Cauchy-Riemann equations; conformal mapping; elementary, entire, meromorphic, multiple-valued functions. Cauchy integral theorems; series expansion. Prereq: Math 325 or 327. 4 hrs/wk; 4 cr.

434: Theory of Functions of Real Variables Lebesgue measure and integration on the real line, differentiation of real functions and the relation with integration, classical L spaces. Prereq: Math 325 or 327. 4 hrs/wk; 4 cr.

435: Partial Differential Equations, Integral Equations, Boundary Value Problems First order equations, classification and canonical forms of higher order equations, the Cauchy problem for hyperbolic equations, Riemann function, wave equation, potential theory and the Dirichlet problem, harmonic and subharmonic functions, elementary functional analysis and the Fredholm alternative. Prereq: Math 327 (or 325) and 291 (or 296). 4 hrs/wk; 4 cr.

438: Calculus of Variations Extremal problems for one or several functions; the necessary conditions of Euler, Legendre, Weierstrass, Jacobi; sets of sufficient conditions; problems in parametric form; Hamilton-Jacobi theory; isoperimetric problems. Prereq: Math 325 or 327. 4 hrs/wk; 4 cr.

443: Set Theory Axioms of Zermelo-Fraenkel set theory, the axiom of choice and equivalent formulations, rank and regularity, ordinal and cardinal numbers, the generalized continuum hypothesis. Prereq: Math 223 or 226 or departmental permission. 4 hrs/wk; 4 cr.

444: Mathematical Logic The propositional calculus, the sentential calculus, normal forms, first order theories, consistency, categoricity, decidability, Gödel's completeness theorem, the Loewenheim-Skolem theorem. Prereq: Math 223 or 226 or permission of the instructor. 4 hrs/wk; 4 cr. Credit is given for only one of the following courses: Math 444, Philo 240, Philo 347.

449: Introduction to Modern Algebra Groups, rings, fields. Prereq: Math 223 or 226. 4 hrs/wk; 4 cr. With departmental permission, partial credit may be given for Math 449 after completion of Math 347.

461: Differential Geometry Local geometry of plane and space curves and surface in 3-space. Some global results. Prereq: Math 325 or 327. 3 hrs/wk; 4 cr.

463: Topology A course in general topology. Sets of points on the real line and in general abstract spaces, relations between sets of points and between a set and the space containing it, operations with sets, open sets, countability, compactness, connectedness, mappings, continuity, metric spaces, general topological spaces. Prereq: Math 325 or 327. 4 hrs/wk; 4 cr.

477: Probability Theory II Special topics in probability such as stochastic processes, Markov chains, etc. Prereq: Math 246, 275; Pre or Coreq: Math 325 or 327. 4 hrs/wk; 4 cr.

478: Mathematical Statistics II The multivariate normal distribution, multiple and partial correlation, regression and least squares, the analysis of variance. Prereq: Math 246 and 376. 3 hrs/wk; 3 cr.

499: Cooperative Education in Mathematics III A third assignment as a supervised professional with recognition of specific career objectives. Taken only with permission of Faculty Advisor. Prereq: Math 399 and Junior standing in CLAS. 1-6 credits.

511: Selected Topics In Pure Mathematics Topics to be chosen from the areas of algebra, analysis, topology, geometry, and logic. Prereq: to be determined by the instructor. 3 hrs/wk; 4 cr.

512: Selected Topics In Classical Analysis Topics to be chosen from applied mathematics and related fields. Typical subjects are: asymptotic methods, wave propagation, mathematical biology. Prereq: Math 246, 291, and 325 or 327, and other requirements to be determined by the instructor. 3 hrs/wk; 4 cr.

513: Selected Topics In Probability, Statistics, and Operations Research Topics to be chosen from the areas of probability, statistics, game theory, combinatorial analysis, etc. Prereq: to be determined by the instructor. 3 hrs/wk; 4 cr.

301-304: Honors I-IV Approval of Dean and department Honors Supervisor required. Apply in NAC 4160 no later than December 10 in the fall term or May 1 in the spring term. Credit flexible but usually 3 credits per term.

310: Independent Study A program of independent study under the direction of a member of the Department with the approval of the Vice-Chairman. Credit may be from 1-4 credits, as determined before registration by the instructor with the approval of the Vice-Chairman.

311-320: Selected Topics in Mathematics Topics not covered in the usual department offerings. Topics vary from semester to semester depending on student and instructor interest. Credits and hours will be determined by instructor and department with a maximum of 4 credits per course. Prerequisites as determined by instructor.

Graduate Courses Open to Undergraduates

Qualified students may take, with Departmental approval, any course available in the Master's Program in Mathematics or the first year of the Doctoral Program in Mathematics. These courses are described in their appropriate catalogs.

Faculty

Ethan Akin, Professor
B.S., The City College 1965, Ph.D., Princeton 1969

Harry W. Appelgate, Associate Professor
B.A., Hofstra 1958; M.A., Harvard 1960; Ph.D., Columbia 1965

Ralph A. Artino, Associate Professor
B.A., Manhattan 1966; M.S., Rutgers 1969; Ph.D. 1971

Joseph Bak, Associate Professor
B.A., Yeshiva 1966; M.A., 1968; Ph.D., 1971

Jacob Barshay, Associate Professor
A.B., Princeton 1961; M.A., Brandeis 1963; Ph.D., 1966

Gilbert Baumslag, Distinguished Professor
B.S., Witwatersrand (South Africa) 1953; D.Sc., 1976; Ph.D., Manchester (England) 1958

Irwin S. Berstein, Associate Professor
B.S., The City College 1955; S.M., M.I.T. 1956, Ph.D. 1959

Mark Brown, Professor
B.S., The City College 1964, M.S., Stanford 1965; Ph.D. 1968

Isaac Chavel, Professor
B.A., Brooklyn 1961; M.S., New York University 1964; Ph.D., Yeshiva 1966