Mathematics (MAT)

Major and Minor in Mathematics

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Minors of particular interest to students majoring in Mathematics: Applied Mathematics and Statistics (AMS), Computer Science (CSE), Economics (ECO), Physics (PHY)

Mathematics (MAT)

Mathematics is an essential element in a wide range of human activities. It is the language of the physical sciences, and as such is an indispensable tool in the formulation of the laws of nature. In the social and biological sciences, it plays an increasingly important role in modeling complicated, large-scale phenomena. In addition, mathematics has an aesthetic side: awareness of the possibility of elegance and beauty in mathematical arguments has been a significant feature of human culture throughout history. Today more mathematics is being done, and more needs to be done, than ever before.

The undergraduate course offerings in Mathematics allow students to set up individualized programs of study consistent with their academic interests and career plans. Students should consider majoring in Mathematics even if they do not plan to become mathematicians or teachers of mathematics. The training in abstract reasoning and problem-solving is an excellent foundation for many different careers, such as law, graduate health professions, and business. Completion of a major in Mathematics points to a thinking person.

Students are encouraged to explore the various branches of pure and applied mathematics, as well as other mathematically oriented disciplines, to gain both breadth of knowledge and insight into career options. Mathematics majors can use their training as the foundation for advanced professional study, leading to research and teaching in universities or research in industrial research laboratories; they can use it also in secondary school teaching. In industry, undergraduate training in mathematics is excellent preparation for the important task of liaison work between the technological arm of a company and its marketing arm. A major in Mathematics is particularly appropriate for work in computer applications, operations research, and actuarial science. Double majors in Mathematics and another field, such as physics, computer science, applied mathematics and statistics, or economics, are common and are encouraged.

The secondary teacher education option is designed for students planning a career teaching mathematics in a secondary school. This option is described in detail in the "Education and Teacher Certification" entry in the alphabetical listings of Approved Majors, Minors, and Programs.

The Department of Mathematics offers tutorial help to all undergraduate students in its 100-level courses in the Mathematics Learning Center. Since the Center's staff consists of faculty and graduate students in mathematics as well as undergraduate tutors, students in more advanced courses can also find assistance there.

The Department encourages students to seek information and advice on appropriate mathematics courses, programs, and career goals. Professors in mathematics are available as advisors in the Undergraduate Mathematics Office to help with these matters. Advising hours can be obtained by calling the Department of Mathematics.

Requirements for the Major and Minor in Mathematics (MAT)

Requirements for the Major in Mathematics (MAT)

The major in Mathematics leads to the Bachelor of Science degree. Every student majoring in Mathematics is expected to complete some form of a one-variable calculus sequence, which is a prerequisite for some of the courses listed below. Appropriate sequences at Stony Brook total 8 to 12 credits.

Completion of the major requires 33 to 37 credits.

A. Mathematics and Mathematics-Related Courses
1. a. One course in multivariate calculus: MAT 203 or AMS 261 or MAT 205 or MAT 307 and one course in linear algebra: MAT 211 or AMS 210
or
b. MAT 307
2. Preparation in the language and logic of mathematics: this requirement can be met by either passing MAT 200 or by passing the MAT 200 challenge examination. (Note: the writing intensive course MAT 200 is a requirement for students in the Secondary Teacher Education Program.)
3. a. One course in linear algebra (MAT 211 or AMS 261) and one course in differential equations(MAT 303 or MAT 305 or AMS 361)
or

b. MAT 308
4. One course in computer literacy: MAT 331 or PHY 277 or CSE 114 or (for students graduating with the Secondary Teacher Education option) MAE 330.
Note: MAT 331 and MAE 330 may be used both here and in Requirement 7.
5. Two courses in algebra: MAT 310 and MAT 312 or MAT 313
6. Analysis:
Students must satisfy either a or b:
a. Three courses in analysis:
MAT 319 or MAT 320 and
two of the following:
MAT 322, MAT 324, MAT 341, MAT 342
b. For students graduating with the Secondary Teacher Education option: MAT 319 or MAT 320
7. Four mathematics-related courses beyond those taken to satisfy Requirements 5 and 6 (three will suffice if all of them are MAT courses), to be chosen from the following:
MAE 301
MAT courses numbered 310 or above except MAT 475
AMS courses numbered 301 or above except AMS 361 and AMS 475
CSE courses numbered 301 or above except CSE 475
A list of acceptable upper-division courses in chemistry, economics, philosophy, and physics is available in the Undergraduate Mathematics Office. Students in the Secondary Teacher Education Program must fulfill a modified version of this requirement, consisting of AMS 310, MAT 336, MAT 360, and MAE courses.

B. Upper-Division Writing Requirement
To satisfy the Departmental writing requirement, each student majoring in Mathematics, including double majors, must submit an acceptable portfolio of three pieces of writing from upper-division MAT or MAE coursework. Students should aim for completion of the portfolio early in their next-to-last semester to allow time to resolve any difficulties. Late completion may delay graduation. Each portfolio must be submitted no later than the beginning of the final semester, and each piece in it must have been approved by a Departmental faculty member as being mathematically correct and well written.

Notes:
1. Under special circumstances a student may request the director of undergraduate studies to allow substitution of an equivalent individual program for some or all of these requirements.
2. All courses used to fulfill the requirements for the major must be taken for a letter grade and must be completed with a grade of C or higher.
3. Students whose scores on the College Entrance Examination Board (CEEB) Advanced Placement Examination are documented earn credits as follows:

- 4 or 5 on BC examination: credit for MAT 131, MAT 132 (8 credits);
- 4 or 5 on AB examination: credit for MAT 131 (4 credits);
- 3 on either examination: 3 credits applicable to graduation but not the major.

4. Students who learned some linear algebra or multivariate calculus before entering Stony Brook should see an advisor in the Undergraduate Mathematics Office. For a student who has had some linear algebra, it may be appropriate to skip MAT 211 and to enroll directly in MAT 310.
5. Six credits of graduate MAT courses may be used in place of undergraduate courses in Requirement A7.

Honors Program in Mathematics

The honors program is open to junior and senior Mathematics majors who have completed at least two upper-division MAT courses with grades of B or higher and who have maintained a 3.00 overall grade point average. A prospective honors major must declare to the director of undergraduate studies an intention to participate in the program before registering for the senior year.
The program consists of a set of seven MAT courses, at least three of which are not used to fulfill the MAT major requirements. These courses must include: MAT 322 or MAT 324; MAT 401 or MAT 402; a course in algebra other than MAT 310 or MAT 318; and MAT 495. Substitution of appropriate graduate courses is permitted, and other substitutions are possible at the discretion of the undergraduate director. Conferral of honors is contingent upon:
1. Completion of the set of seven courses with a grade point average of at least 3.50;
2. Approval for honors by the faculty member or members who supervise MAT 495.

Mathematics Secondary Teacher Education Program

See the Education and Teacher Certification entry in the alphabetical listings of Approved Majors, Minors, and Programs.

Requirements for the Minor in Mathematics (MAT)

The minor in Mathematics is available for those students who want their formal university records to emphasize a serious amount of upper-division work in mathematics. Although a one-variable calculus sequence is not a requirement, it is a prerequisite for some of the courses listed below. The requirements listed below do not include single variable calculus or MAT 200 Logic, Language, and Proof; these are prerequisites for some of the courses listed below.
1. MAT 211 or AMS 210 or MAT 308
2. MAT 203 or AMS 261 or MAT 205 or MAT 307
3. MAT 310 or MAT 312 or MAT 313 or MAT 318
4. MAT 319 or MAT 320 or MAT 341 or MAT 342

5. Three additional MAT courses numbered 300 or higher (excluding 475)
All courses used to fulfill the requirements for the minor must be passed with a letter grade of C or higher.

Beginning Mathematics Courses

The Mathematics curriculum begins with a choice of calculus sequences, some including preparatory material from 12th-year mathematics in high school and some not. The three first-term calculus courses that assume knowledge of 12th-year mathematics are MAT 125, MAT 131, MAT 141 and AMS 151. A student may start any of these with the same background.

The three-semester sequence of one-variable calculus, MAT 125, MAT 126, MAT 127, is academically equivalent to the two-semester sequence MAT 131, MAT 132. Engineering students normally take the faster-paced MAT 131, MAT 132, or AMS 151, AMS 161 rather than MAT 125, MAT 126, MAT 127 because of the many requirements they must meet. MAT 141, MAT 142 is an enriched version of MAT 131, MAT 132. MAT 171 is a version of MAT 142 for students who have not taken MAT 141; offered only in the fall semester.
MAT 122 and MAT 123 combine precalculus and calculus for students who have not had a precalculus course in high school. A student who completes MAT 122 will have learned some precalculus material and will have a good idea of what calculus is and how it is used. MAT 123 is designed to lead into MAT 125 or MAT 131. Although MAT 122 is not designed as preparation for further calculus courses, students may follow that course with MAT 125 or MAT 131 if they take the one-credit course MAT 130 in the same semester as MAT 125 or MAT 131.
MAT 118 is a non-calculus course that surveys various topics in mathematics that do not require a background in precalculus or calculus; it is designed for students who do not intend to take further courses in mathematics.
For students whose high school preparation is insufficient to begin the MAT curriculum, or to enroll in another course applicable to the D.E.C. category C requirement, Mathematical and Statistical Reasoning, there are two review courses numbered MAP 101 and MAP 103. These courses do not carry graduation credit. MAP 103, a skills course, is for students who need further work in high school algebra and related topics before continuing with calculus or other mathematics. Some students, upon completing MAP 103, are able to pass the Mathematics Placement Examination at a level that allows them to go directly into MAT 125 or MAT 131.

Placement

The Department of Mathematics offers a placement examination which indicates the level of mathematical preparation of each student. The score on the examination is used to place the student in appropriate courses in mathematics, applied mathematics and statistics, biology, chemistry, and physics. It tests the student's skills at the time the test is taken; students are advised to study beforehand. There is a preliminary version of the examination given prior to orientation; all incoming students, including transfers, should take the preliminary placement examination. This exam is used only for registration purposes and cannot be used to fulfill graduation requirements. The preliminary score becomes invalid after two semesters.
A student wishing to use the placement examination to fulfill D.E.C. Category C or other graduation-related requirements or Skill 1, or if they have been or wish to be accepted into a major in the College of Engineering and Applied Sciences, must take a proctored version of the examination. This examination is given several times during the academic year, and by appointment with the Mathematics Department.
The placement exam consists of several parts; not all students will take all parts of the exam. Part I covers high school algebra, Part II deals with 12th year high school Mathematics (precalculus), and Part III covers single-variable calculus. The outcome of the test is one of nine levels:

Outcome	Placement
Level 1	MAP 101
Level 2	MAP 103
Level 2+	MAT 118 and Skill 1 or statistics
Level 3	MAT 118, MAT 123 or statistics
Level 4	MAT 125
Level 5	MAT 131 or MAT 141 or AMS 151
Level 6	MAT 126
Level 7	MAT 132 or MAT 142 or MAT 171 or AMS 161
Level 8	MAT 127 or MAT 132 or MAT 171 or MAT 142 or AMS 161
Level 9	Beyond 100-level calculus

Levels 1-3 can be achieved by a sufficiently high score on Part I, and levels 4-5 can be achieved by a sufficiently high score on Part II, and attaining levels 6-9 requires sufficiently high scores on Parts II and III. The entry skill in mathematics requirement may be satisfied by attaining a score of level 3 or higher on the proctored exam. The general education requirement for Mathematics (D.E.C. category C) may be satisfied by attaining a score of level 6 or higher on the proctored exam. Certain majors will also accept a sufficiently high score on the proctored exam in lieu of required math courses. A student who achieves a particular level is free to begin with a mathematics course corresponding to a lower level, so long as taking the course does not mean that credit is given for the same material twice.

Transfer Credit

When they enter, transfer students automatically receive credit toward graduation at Stony Brook for any courses they have already successfully completed at accredited institutions of higher education and that count toward graduation at that institution. The number of credits transferred appears on the Stony Brook transcript with no courses or grades indicated, and the number of transferred credits is unaffected by the student's score on the Mathematics Placement Examination. In some cases, a course designator ending in PQ (such as MAT 131PQ) may be placed on the student's transcript. In addition, transferred mathematics courses are automatically evaluated for applicability to the entry skill in mathematics requirement and the D.E.C. category C requirement; this evaluation does not depend on the result of the placement examination.

Sample Course Sequence for the Major in Mathematics

Freshman Fall	Credits	Spring	Credits
First Year Seminar 101	1	First Year Seminar 102	1
D.E.C. A	3	D.E.C. A	3
MAT 131 or MAT 141 or MAT 125*	3-4	MAT 132 or MAT 142 or MAT 171 or MAT 126*	3-4
D.E.C.	3	D.E.C.	3
D.E.C.	3	D.E.C.	3
Elective	3	MAT 200 or Elective	3
Total	16-17	Total	16-17
Sophomore Fall	**Credits**	**Spring**	**Credits**
MAT 203 or MAT 205 or AMS 261	3	MAT 303 or MAT 305 or AMS 361	3
MAT 211 or AMS 210	3	MAT 331	3
D.E.C.	3	D.E.C.	3
D.E.C.	3	D.E.C.	3
Elective	3	Elective	3
Total	15	Total	15
Junior Fall	**Credits**	**Spring**	**Credits**
MAT 312 or MAT 313	3	MAT 322 or MAT 341 or MAT 342 or MAT 324	3
MAT 319 or MAT 320	3	MAT 310	3
D.E.C.	3	D.E.C.	3
D.E.C.	3	Upper-Division electives	6
Elective	3		
Total	15	Total	15
Senior Fall	**Credits**	**Spring**	**Credits**
Upper-Division MAT electives	9	Upper-Division MAT electives	9
D.E.C.	3	Electives	6
Elective	3		
Total	15	Total	15

*Note: http://www.stonybrook.edu/ugrdbulletin/current/pdfs/matM.pdf

MAE

Mathematics Teacher Preparation

MAE 301: Foundations of Secondary School Mathematics

A re-examination of elements of school mathematics, including topics in algebra, geometry, and elementary functions. Competence in basic secondary-level ideas and techniques are tested.

Prerequisites: MAT 200 and 211; admission to mathematics or applied mathematics secondary teacher preparation program Corequisite: MAE 311

3 credits

MAE 302: Methods and Materials for Teaching Secondary School Mathematics

The goals of mathematics education, learning theories, mathematics curricula, lesson planning, evaluation and teaching strategies. Lesson plans are drawn up and presented to the group.

Prerequisites: MAE 301 and C or higher in MAE 311
Pre- or Corequisite: MAE 312

3 credits

MAE 311: Introduction to Methods of Teaching Secondary School Mathematics

Aspects of teaching mathematics on the secondary school level, including lesson designs based on the NCTM standards, cooperative learning, and technology in mathematics education. Students observe classes in middle school and high school settings.

Prerequisites: MAT 211; admission to mathematics or applied mathematics secondary teacher preparation program; department consent Corequisite: MAE 301

3 credits

MAE 312: Micro-Teaching

Twice-weekly supervised classroom experience, tutoring, or working with small groups of students as a teacher's aide.

Prerequisite: C or higher in MAE 311
Pre- or Corequisite: MAE 302

2 credits

MAE 330: Technology in Mathematics Education

Introduces students in the secondary mathematics teacher preparation program to techniques and requirements for effective use of technology in the mathematics classroom. Emphasis on projects. Use of graphing calculators and computer software such as Geometer's Sketchpad.

Prerequisites: MAE 301 and 311

3 credits

MAE 412: Issues in Teaching and Learning in Collegiate Mathematics

Investigation of the issues involved in the teaching and learning of introductory collegiate mathematics. A supervised teaching internship of undergraduate mathematics accompanies this seminar.

Prerequisite: MAE 302

4 credits

MAE 447: Directed Readings in Mathematics Education

Tutorial studies in recent advances in mathematics education.

Pre- or Corequisite: MAE 312

1 credit

MAE 451: Supervised Teaching - Middle School Level Grades 7-9

Intensive supervised teaching in secondary schools. Students work in the school under the supervision of an experienced teacher.

Prerequisites: MAE 312; MAT 312, 319 and 360; AMS 310; permission of director of mathematics teacher education program Corequisites: MAE 452 and 454

6 credits, S/U grading

MAE 452: Supervised Teaching - High School Grades 10-12

Intensive supervised teaching in secondary schools. Students work in the school under the supervision of an experienced teacher.

Prerequisites: MAE 312; MAT 312, 319 and 360; AMS 310; permission of director of mathematics teacher education program Corequisites: MAE 451 and 454

6 credits, S/U grading

MAE 454: Student Teaching Seminar

Weekly discussions of teaching techniques and experiences, learning theory, curriculum content, and classroom problems.

Corequisites: MAE 451 and 452

3 credits

MAP

Mathematics Proficiency

MAP 101: Fundamentals of Arithmetic and Algebra

Arithmetic: fractions, decimals, and percent. Algebra: signed numbers, monomials, linear equations in one unknown, and word problems. This course is intended for students who have never studied algebra. Does not satisfy the entry skill in mathematics requirement or the D.E.C. category C requirement. Students who have otherwise satisfied D.E.C. category C may not register for this course. Overqualified students as determined by a placement test may be deregistered and directed to transfer to another course. Does not count toward graduation. A through C/Unsatisfactory grading only. The Pass/No Credit option may not be used.

3 credits

MAP 103: Proficiency Algebra

An intensive review of high school algebra as preparation for calculus and other mathematics. Facility with exponents, basic graphing, solving linear and quadratic equations in one variable, solving linear systems in two variables, polynomials, factorization of algebraic expressions, binomial theorem, and inequalities. Algebraic manipulations, analytic geometry of lines. Does not count toward graduation. A through C/Unsatisfactory grading only. The Pass/No Credit option may not be used. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: Level 2 on the mathematics placement examination or MAP 101

3 credits

MAT

Mathematics

MAT 118 - C: Mathematical Thinking

Development of quantitative thinking and problem solving abilities through a selection of mathematical topics: logic and reasoning; numbers, functions, and modeling; combinatorics and probability; growth and change. Other topics may include geometry, statistics, game theory, and graph theory. Through their engagement in problem solving, students develop an appreciation of the intellectual scope of mathematics and its connections with other disciplines.

Prerequisite: C or better in MAP 103 or level 2+ or higher on the mathematics placement examination
(Prerequisite must be met within one year of beginning this course.)
3 credits

MAT 122 - C: Overview of Calculus with Applications

The basics of calculus in a self-contained, one-semester course. Properties and applications of polynomial, exponential, and logarithmic functions. Derivatives: slopes, rates of change, optimization, integrals, area, cumulative change, and average. The fundamental theorem of calculus. Emphasis on modeling examples from economics. Students who subsequently wish to enroll in MAT 125 or 131 will be required to take MAT 130 as a pre- or corequisite to either course or to score level 4 on the mathematics placement examination before taking either course. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or better in MAP 103 or level 3 on the mathematics placement exam
(Prerequisite must be met within one year prior to beginning the course.)
3 credits

MAT 123 - C: Introduction to Calculus

Comprehensive preparation for the regular calculus sequences, with introduction to derivatives. Careful development of rational, exponential, logarithmic, and trigonometric functions, and their applications. Asymptotics and limits. Linear approximations, slope and derivatives, detailed curve sketching. General modeling examples. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or better in MAP 103 or level 3 on the mathematics placement exam
(Prerequisite must be met within one year prior to beginning the course.)
3 credits

MAT 125 - C: Calculus A

Differential calculus, emphasizing conceptual understanding, computations and applications, for students who have the necessary background from 12th-year high school mathematics. Differentiation of elementary algebraic, trigonometric, exponential and logarithmic functions; graphing; modeling; and maximization. May not be taken for credit in addition to MAT 131 or 141 or AMS 151. This

course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in MAT 123; or level 4 on the mathematics placement examination; or MAT 122 and coregistration in MAT 130
3 credits

MAT 126 - C: Calculus B

A continuation of MAT 125, covering integral calculus: the fundamental theorem, symbolic and numeric methods of integration, area under a curve, volume, applications such as work and probability, complex numbers. May not be taken for credit in addition to MAT 142 or AMS 161. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in MAT 125 or 131 or 141 or AMS 151 or level 6 on the mathematics placement examination
3 credits

MAT 127 - C: Calculus C

A continuation of MAT 126, covering: improper integrals and l'Hospital's rule, sequences, series, Taylor series, differential equations and modeling. May not be taken for credit in addition to MAT 132, MAT 142, MAT 171, or AMS 161. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in MAT 126 or level 8 on the mathematics placement examination
3 credits

MAT 130: Functions

Inverse functions, exponential and logarithmic functions, radian measure of angles and trigonometric functions. Open to prospective students in engineering, physical sciences, and mathematics who need to bridge the gap between MAT 122 and 125 or MAT 131 or AMS 151. May not be taken for credit in addition to MAT 123.

Advisory Prerequisite: C or higher in MAT 122
Advisory Corequisite: MAT 125 or 131 or AMS 151
1 credit

MAT 131 - C: Calculus I

The differential calculus and integral calculus, emphasizing conceptual understanding, computations and applications, for students

who have the necessary background from 12th-year high school mathematics. Differentiation of elementary algebraic; trigonometric, exponential, and logarithmic functions; graphing; modelling and maximization; the Riemann integral; and the fundamental theorem. May not be taken for credit in addition to MAT 125 or 141 or AMS 151. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: B or higher in MAT 123, or level 5 on the mathematics placement examination, or B or higher in MAT 122 and concurrent registration for MAT 130
4 credits

MAT 132 - C: Calculus II

A continuation of MAT 131, covering symbolic and numeric methods of integration; area under a curve; volume; applications such as work and probability; improper integrals and l'Hospital's rule; complex numbers; sequences; series; Taylor series; differential equations; and modelling. May not be taken for credit in addition to MAT 127, MAT 142, MAT 171, or AMS 161. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in AMS 151 or MAT 131 or 141, or level 7 on the mathematics placement examination
4 credits

MAT 141 - C: Honors Calculus I

The topics of MAT 131 treated with additional attention to the underlying theory as a means of understanding why the processes of calculus work. May not be taken for credit in addition to MAT 125 or 131. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: Level 5 on the mathematics placement examination; priority given to students in the University's honors programs
4 credits

MAT 142: Honors Calculus II

A continuation of MAT 141 in the same spirit, covering the topics of MAT 132. May not be taken for credit in addition to MAT 126, MAT 127, MAT 171, MAT 132 or AMS 161. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in MAT 141, or B or higher in MAT 131 or AMS 151, or level 7 on the mathematics placement examination

4 credits

MAT 160: Mathematical Problems and Games

Intended for students interested in sharpening their problem-solving skills and in developing their ability to express mathematical ideas.

1 credit, S/U grading

MAT 200: Logic, Language and Proof

A basic course in the logic of mathematics, the construction of proofs and the writing of proofs. The mathematical content is primarily set theory, combinatorics and Euclidean geometry. There is considerable focus on writing.

Prerequisites: C or higher in MAT 203, 205 or AMS 261, and in MAT 211 or AMS 210; or A- or higher in MAT 125, 131, 141 or AMS 151; or B- or higher average in MAT 125/126/127, 131/132, 141/142, 171 or AMS 151/161; or permission of instructor

3 credits

MAT 203: Calculus III with Applications

Vector algebra in two and three dimensions, multivariate differential and integral calculus, optimization, vector calculus including the theorems of Green, Gauss, and Stokes. Applications to economics, engineering, and all sciences, with emphasis on numerical and graphical solutions; use of graphing calculators or computers. May not be taken for credit in addition to AMS 261 or MAT 205.

Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination

4 credits

MAT 205: Calculus III

Vector algebra, multivariate differential and integral calculus, divergence and curl, line and surface integrals, theorems of Green, Gauss, and Stokes. More theoretical than MAT 203 with applications to the physical sciences. Not for credit in addition to AMS 261 or MAT 203.

Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination
Pre- or Corequisite: MAT 211 or AMS 210

4 credits

MAT 211: Introduction to Linear Algebra

Introduction to the theory of linear algebra with some applications; vectors, vector spaces, bases and dimension, applications to geometry, linear transformations and rank, eigenvalues and eigenvectors, determinants and inner products. May not be taken for credit in addition to AMS 210.

Prerequisite: C or higher in AMS 151 or MAT 131 or 141 or coregistration in MAT 126 or level 7 on the mathematics placement examination

3 credits

MAT 260: Problem Solving in Mathematics

Students actively solve challenging problems in plane geometry, basic number theory, and calculus, and write precise arguments. Relevant preparation for problem-solving is provided in the course.

Prerequisite: Permission of instructor

1 credit

MAT 303: Calculus IV with Applications

Homogeneous and inhomogeneous linear differential equations; systems of linear differential equations; series solutions; Laplace transforms; Fourier series. Applications to economics, engineering, and all sciences with emphasis on numerical and graphical solutions; use of computers. May not be taken for credit in addition to AMS 361, MAT 305, or MAT 308.

Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination

4 credits

MAT 305: Calculus IV

Linear versus nonlinear equations and their numerical solutions, existence and uniqueness, Duhamel's principle for linear equations, series solutions, systems. Fourier series; comparison of separation of variables with integral formulas. More theoretical than MAT 303. Applications to the physical sciences. May not be taken for credit in addition to MAT 303 or AMS 361.

Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination

4 credits

MAT 307: Multivariable Calculus with Linear Algebra

Introduction to linear algebra: vectors, matrices, systems of linear equations, bases and dimension, dot product, determinants. Multivariate differential and integral calculus, divergence and curl, line and surface integrals, theorems of Green, Gauss, and Stokes. More theoretical and intensive than MAT 203, this course is primarily intended for math majors. Together with MAT 308, it forms a 2-semester sequence covering the same material as the 3-semester sequence of MAT 205, MAT 211 and MAT 305. May not be taken for credit in addition to MAT 203, MAT 205 or AMS 261.

Prerequisite: MAT 127 or MAT 132

4 credits

MAT 308: Differential Equations with Linear Algebra

Linear algebra: determinants, eigenvalues and eigenvectors, diagonalization. Differential equations; existence and uniqueness of solutions. First- and second-order equations; linear versus nonlinear equations. Systems of linear equations. Laplace transform. Applications to physics. More theoretical and intensive than MAT 303, this course is primarily intended for math majors. Together with MAT 307, it forms a 2-semester sequence covering the same material as the 3-semester sequence of MAT 205, MAT 211 and MAT 305. May not be taken for credit in addition to MAT 303, MAT 305 or AMS 361.

Prerequisite: MAT 307 or MAT 205 and MAT 211

4 credits

MAT 310: Linear Algebra

Finite dimensional vector spaces, linear maps, dual spaces, bilinear functions, inner products. Additional topics such as canonical forms, multilinear algebra, numerical linear algebra.

Prerequisites: C or higher in MAT 211 or 305 or 308 or AMS 210; C or higher in MAT 200 or permission of instructor

4 credits

MAT 311: Number Theory

Congruences, quadratic residues, quadratic forms, continued fractions, Diophantine equations, number- theoretical functions, and properties of prime numbers.

Prerequisites: C or higher in MAT 312 or 313 or 318; C or higher in MAT 200 or permission of instructor

3 credits

MAT 312: Applied Algebra

Topics in algebra: groups, informal set theory, relations, homomorphisms. Applications: error correcting codes, Burnside's theorem, computational complexity, Chinese remainder theorem. This course is offered as both AMS 351 and MAT 312.

Prerequisite: C or higher in AMS 210 or MAT 211

Advisory Prerequiste: MAT 200 or CSE 113

3 credits

MAT 313: Abstract Algebra

Groups and rings together with their homomorphisms and quotient structures. Unique factorization, polynomials, and fields.

Prerequisites: C or higher in MAT 310 or 312 or 318; C or higher in MAT 200 or permission of instructor

3 credits

MAT 319: Foundations of Analysis

A careful study of the theory underlying topics in one-variable calculus, with an emphasis on those topics arising in high school calculus. The real number system. Limits of functions and sequences. Differentiations, integration, and the fundamental theorem. Infinite series.

Prerequisites: C or higher in MAT 200 or permission of instructor; C or higher in one of the following: MAT 203, 205, 211, 307, AMS 261, or A- or higher in MAT 127, 132, 142, or AMS 161

4 credits

MAT 320: Introduction to Analysis

A careful study of the theory underlying calculus. The real number system. Basic properties of functions of one real variable. Differentiation, integration, and the inverse theorem. Infinite sequences of functions and uniform convergence. Infinite series.

Prerequisites: C or higher in MAT 200 or permission of instructor; C or higher in one of the following: MAT 203, 205, 211, 307, AMS 261, or A- or higher in MAT 127, 132, 142, or AMS 161

4 credits

MAT 322: Analysis in Several Dimensions

Continuity, differentiation, and integration in Euclidean n-space. Differentiable maps. Implicit and inverse function theorems. Differential forms and the general Stokes's theorem.

Prerequisites: C or higher in MAT 203, 205, or AMS 261; C or higher in MAT 211 or AMS 210; B or higher in MAT 320
Advisory Pre- or Corequisite: MAT 310

3 credits

MAT 324: Real Analysis

Metric spaces, including compactness, connectedness, completeness, and continuity. Introduction to Lebesgue integration. Aspects of Fourier series, function spaces, Hilbert spaces, Banach spaces.

Prerequisites: C or higher in MAT 203 or 205 or 307 or AMS 261; B or higher in MAT 320

3 credits

MAT 331: Computer-Assisted Mathematical Problem Solving

Exploration of the use of the computer as a tool to gain insight into complex mathematical problems through a project-oriented approach. Students learn both the relevant mathematical concepts and ways that the computer can be used (and sometimes misused) to understand them. The particular problems may vary by semester; past topics have included cryptography, fractals and recursion, modeling the flight of a glider, curve fitting, the Brachistochrone, and computer graphics. No previous experience with computers is required.

Prerequisite: C or higher in MAT 203 or 205 or 307 or AMS 261

3 credits

MAT 336 - H: History of Mathematics

A survey of the history of mathematics from the beginnings through the 19th century, with special attention to primary sources and to the interactions between culture and mathematics. Emphasis on topics germane to the high school curriculum. Mesopotamian, Egyptian, and Greek mathematics; non-European mathematics; early Renaissance mathematics; the birth and flowering of calculus; the beginnings of probability theory; and the origin of non-euclidean gemetrics and the modern concept of number.

Prerequisite: MAT 200 or AMS 301

3 credits

MAT 341: Applied Real Analysis

Partial differential equations of mathematical physics: the heat, wave, and Laplace equations. Solutions by techniques such as separation of variables using orthogonal functions (e.g., Fourier series, Bessel functions, Legendre polynomials). D'Alambert solution of the wave equation.

Prerequisites: C or higher in the following: MAT 203 or 205 or 307 or AMS 261; MAT 303 or 305 or AMS 361
Advisory Prerequisite: MAT 200

3 credits

MAT 342: Applied Complex Analysis

Functions of a complex variable, calculus of residues including evaluation of real integrals, power and Laurent series, conformal mappings and applications, Laplace and Cauchy-Riemann equations, the Dirichlet and Neumann problems, and the Laplace and Hilbert transforms and their applications to ordinary and partial differential equations.

Prerequisites: C or higher in the following: MAT 203 or 205 or 307 or AMS 261; MAT 303 or 305 or AMS 361
Advisory Prerequisite: MAT 200

3 credits

MAT 351: Differential Equations: Dynamics and Chaos

A study of the long-term behavior of solutions to ordinary differential equations or of iterated mappings, emphasizing the distinction between stability on the one hand and sensitive dependence and chaotic behavior on the other. The course describes examples of chaotic behavior and of fractal attractors, and develops some mathematical tools for understanding them.

Prerequisites: C or higher in the following: MAT 203 or 205 or 307 or AMS 261; MAT 303 or 305 or 308 or AMS 361; MAT 200 or permission of instructor

3 credits

MAT 360: Geometric Structures

Formal geometries and models. Topics selected from projective, affine, Euclidean, and non-Euclidean geometries.

Pre- or Corequisites: C or higher in the following: MAT 203 or 205 or 307 or AMS 261; MAT 211 or AMS 210; MAT 200 or permission of instructor

3 credits

MAT 362: Differential Geometry of Surfaces

The local and global geometry of surfaces: geodesics, parallel transport, curvature, isometries, the Gauss map, the Gauss-Bonnet theorem.

Prerequisite: C or higher in MAT 319 or 320 or 364

3 credits

MAT 364: Topology and Geometry

A broadly based introduction to topology and geometry, the mathematical theories of shape, form, and rigid structure. Topics include intuitive knot theory, lattices and tilings, non-Euclidean geometry, smooth curves and surfaces in Euclidean 3-space, open sets and continuity, combinatorial and algebraic invariants of spaces, higher dimensional spaces.

Prerequisites: MAT 203 or 205 or 307 or AMS 261
Advisory Prerequisite: MAT 319 or 320

3 credits

MAT 371: Logic

A survey of the logical foundations of mathematics: development of propositional calculus and quantification theory, the notions of a proof and of a model, the completeness theorem, Goedel's incompleteness theorem. This course is offered as both CSE 371 and MAT 371.

Prerequisite: CSE 150 or CSE 215 or MAT 200

3 credits

MAT 373: Analysis of Algorithms

Mathematical analysis of a variety of computer algorithms including searching, sorting, matrix multiplication, fast Fourier transform, and graph algorithms. Time and space complexity. Upper-bound, lower- bound, and average-case analysis. Introduction to NP completeness. Some machine computation is required for the implementation and comparison of algorithms. This course is offered as CSE 373 and MAT 373.

Prerequisites: MAT 211 or AMS 210; CSE 214 or CSE 260

3 credits

MAT 401: Seminar in Mathematics

Discussions of a specific area of interest in mathematics. The work of each semester covers a different area of mathematics. May be repeated as topic changes. Prerequisites will be announced with the topic each time the course is offered.

Prerequisites: U3 or U4 standing; additional prerequisites announced with topic

3 credits

MAT 402: Seminar in Mathematics

Discussions of a specific area of interest in mathematics. The work of each semester covers a different area of mathematics. May be repeated as topic changes. Prerequisites will be announced with the topic each time the course is offered.

Prerequisites: U3 or U4 standing; additional prerequisites announced with topic

3 credits

MAT 475: Undergraduate Teaching Practicum

Each student assists in teaching a lower-division mathematics course or works in the Mathematics Learning Center. The student's work is regularly supervised by a faculty member. In addition, a weekly seminar is conducted. Responsibilities may include preparation of materials for student use and discussions, helping students with problems, and involvement in "alternative" teaching projects. Intended for upper-division students who have excelled in the calculus sequence. May not be used for major credit.

Prerequisite: Permission of the director of undergraduate studies

3 credits, S/U grading

MAT 487: Independent Study in Special Topics

A reading course for juniors and seniors. The topics may be chosen by the student with the approval of a supervising member of the faculty, who also takes responsibility for evaluation. A topic that is covered in a course regularly offered by the department is not appropriate for independent study. May be repeated.

Prerequisite: Permission of the director of undergraduate studies

0-6 credits

MAT 495: Honors Thesis

The student and a supervising faculty member together choose a topic in mathematics, and the student writes a substantial paper expounding the topic in a new way.

Prerequisite: Permission of the director of undergraduate studies

3 credits