Applied Mathematics and Statistics (AMS)

Major and Minor in Applied Mathematics and Statistics

Department of Applied Mathematics and Statistics, College of Engineering and Applied Sciences

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Students majoring in Applied Mathematics and Statistics often double major in one of the following: Computer Science (CSE), Economics (ECO), Information Systems (ISE)

Applied Math and Statistics (AMS)

The undergraduate program in Applied Mathematics and Statistics aims to give mathematically oriented students a liberal education in quantitative problem solving. The courses in this program survey a wide variety of mathematical theories and techniques that are currently used by analysts and researchers in government, industry, and science. Many of the applied mathematics courses give students the opportunity to develop problem-solving techniques using campus computing facilities.

About half of the Applied Mathematics majors enter graduate or professional programs, primarily in statistics, operations research, computer science, and business management. Others go directly into professional careers as actuaries, programmer analysts, management trainees, and secondary school teachers.

While some career-oriented course sequences are listed below, students are strongly encouraged to seek faculty advice in coordinating their career plans with their academic programs. In the spring of their junior year, all students contemplating graduate studies, upon graduation or at a later date, should consult with the Department's graduate placement advisor, who assists them in choice of schools and provides information about Graduate Record Examinations, etc. Students considering secondary school mathematics teaching can major in Applied Mathematics and Statistics or in Mathematics.

Requirements for the Major and Minor in Applied Math and Statistics (AMS)

Acceptance into the Applied Mathematics and Statistics Major

Qualified freshman and transfer students who have indicated their interest in the major on their applications are accepted directly into the major upon admission to the University. Students who did not apply for the major and those who were not accepted into the major when they entered the University may apply directly to the Department only after completion of AMS 161 or MAT 132 or MAT 142 or MAT 127; AMS 210 or MAT 211 or AMS 261 or MAT 203 or MAT 205 with a GPA of 2.5 or better in these courses.

Requirements for the Major

The major in Applied Mathematics and Statistics leads to the Bachelor of Science degree. Completion of the major requires approximately 46 credits.

Study Within the Area of the Major

1. Required courses in Applied Math and Statistics
   - AMS 151, AMS 161 Applied Calculus I, II
   - AMS 210 or MAT 211 Applied Linear Algebra
   - AMS 261 or MAT 203 or MAT 205 Applied Calculus III

   Note: The following alternate calculus course sequences may be substituted for AMS 151, AMS 161 in major requirements or prerequisites: MAT 125, MAT 126, MAT 127 or MAT 131, MAT 132 or MAT 141, MAT 142

2. One of the following courses
   - CSE 101 Introduction to Computers
   - CSE 110 Introduction to Computer Science
   - CSE 114 Computer Science I
   - CSE 130 Introduction to Programming in C
   - ESG 111 C Programming for Engineering
3. 27 credits of AMS courses numbered 301 and above, or approved non-AMS upper-division mathematically oriented courses, subject to the following constraints:

(a) AMS 301 must be taken
(b) Either AMS 310 (Survey of Probability and Statistics) or AMS 311 (Probability Theory) must be taken
(c) Either AMS 315 or AMS 361 or MAT 303 or MAT 305 must be taken.
(d) At most 6 of the remaining 18 credits can be counted from the following courses: AMS 475, AMS 476, AMS 487, non-AMS upper division mathematically oriented courses. Typical non-AMS upper division mathematically oriented courses are ECO 321, ECO 348, CSE designated courses numbered 301 and above, and MAT designated courses numbered 310 and above.

4. Upper-Division Writing Requirement: AMS 300 Writing in Applied Mathematics

All degree candidates must demonstrate skill in written English at a level acceptable for Applied Mathematics and Statistics majors. AMS students must register for the writing course AMS 300, or submit a technical paper(s) written for other courses. The requirement may also be met by earning a grade of C or higher in a writing course approved by the Department or, if the student has a double major, by satisfying the requirement for the other major.

Grading

All courses taken to satisfy requirements A 1, 2, and 3 above must be taken for a letter grade and passed with a grade of C or higher.

Double Majors

The Department urges students in other majors who are considering a double major with AMS first to select individual AMS courses on the basis of their academic interests or career plans. Only after a student has taken several AMS courses should he or she decide on this as a second major.

On the other hand, AMS students are strongly encouraged to double major (or to minor) in another discipline. The most frequent choices of AMS double majors are computer science and economics.

Actuarial Science

The AMS major covers the mathematical sciences topics tested in the first actuarial examination and part of the second actuarial examination. For more information about actuarial science as well as study materials to help prepare for actuarial examinations, students should see the Department's actuarial advisor. Also see the Web site http://www.soa.org for details.

Recommendations for Students Majoring in Applied Mathematics and Statistics

The Department encourages students to have a broad exposure to many types of mathematical reasoning and to its diverse roles in the social and natural sciences. During their first two years, students considering an AMS major are encouraged to take, in addition to the required calculus sequence, two semesters of physics numbered PHY 121 or higher; CSE 110 or CSE 113, CSE 114 or CSE 130 or ESG 111; one other computer course (competence in computer programming is essential for many professional careers); and some economics. At the end of the sophomore year or the beginning of the junior year, students begin taking upper-division AMS courses, usually starting with AMS 301 and AMS 310. At the same time, they are strongly encouraged to continue taking MAT and CSE courses and mathematically oriented courses in other departments, such as ECO 303. The following list of course sequences for certain professions is given as a preliminary guide to students with interests in these professions. Students should speak with faculty members specializing in these areas as early as possible for more information.

Statistics: AMS 301, AMS 310, AMS 311, AMS 315, AMS 316, AMS 394, AMS 412, another CSE course beyond CSE 110 or CSE 114 or CSE 130 or MEC 111; students considering graduate statistics programs should take MAT 310 and MAT 320.

Operations Research or Management Science: AMS 301, AMS 310, AMS 311, AMS 341, and AMS 342; students considering graduate operations research programs should take MAT 310 and MAT 320.

Programmer-Analyst: AMS 301, AMS 310, AMS 311, AMS 321, AMS 326, AMS 341, and CSE 214, CSE 220, and CSE 301.

Secondary Teaching: Students preparing for a career as a teacher of mathematics in the secondary schools enroll in the Mathematics Secondary Teacher Education Program. See the Education and Teacher Certification entry in the alphabetical listings of Approved Majors, Minors, and Programs.

Course Sequence in the Applied Mathematics and Statistics Major

Many students enter the University intending another major and change to the Applied Mathematics and Statistics major, or add it as a second major, toward the end of the sophomore year or in the junior year. Required courses for the major in the first two years are the calculus sequence and linear algebra—virtually the same mathematical requirements as found in the intended majors of students who subsequently switch to Applied Mathematics and Statistics.

The particular set of 300-level AMS courses taken in the junior and senior years by Applied Mathematics and Statistics majors, and the order in which they are taken, is very flexible. Normally, majors take AMS 301 and AMS 310 (the two required 300-level AMS courses) first. For assistance in 300-level AMS course sequences, majors are encouraged to speak with the undergraduate program director.

The Accelerated B.S./M.S. Program in Applied Mathematics and Statistics
The accelerated B.S./M.S. program in applied mathematics and statistics allows students with superior academic records to use up to six graduate credits toward both the B.S. and M.S. degree requirements, thus reducing the normal time required to complete both programs to five years (ten semesters). For detailed program requirements, please refer to the Graduate Bulletin.

The advantage of the accelerated program is that the M.S. degree can be earned in less time than that required by the traditional course of study. The M.S. degree in Applied Mathematics and Statistics normally requires three to four semesters of study after completion of a bachelor's degree. The in-depth training of a master's degree is required by many employers for professional positions in applied mathematics and statistics (beyond beginning programmer analyst jobs).

For more details about the B.S./M.S. program, see the undergraduate program director or graduate studies director in the Department of Applied Mathematics and Statistics.

The Combined B.S./M.P.H. Program in Applied Mathematics and Statistics

The combined B.S./M.P.H. program allows students with superior academic records to use up to 12 graduate credits toward both the B.S. in Applied Mathematics and Statistics and the M.A. in Public Health degree requirements, thus reducing the normal time required to complete both programs to five years (ten semesters). For detailed program requirements, please refer to the Graduate Bulletin or contact the undergraduate program director in Department of Applied Mathematics and Statistics or graduate studies director in the Department of Public Health.

Requirements for the Minor

The minor in Applied Mathematics and Statistics is designed for students who take a limited amount of mathematics in their major. The AMS minor must include at least 18 credits in courses that are not used to satisfy the requirements of the student's primary major; therefore, students in majors requiring a substantial amount of mathematics may find that a double major with AMS requires fewer credits.

A. Calculus: AMS 151, AMS 161 (See Note)
B. Linear algebra: AMS 210 or MAT 211 (Students who took AMS 201 prior to declaring the AMS minor may substitute AMS 201)
C. Core AMS courses: AMS 301 and AMS 310
D. AMS electives: three additional 300-level AMS courses

Note: The following alternate calculus course sequences may be substituted for AMS 151, AMS 161 in requirements for the minor or prerequisites:
MAT 125, MAT 126, MAT 127
or MAT 131, MAT 132
or MAT 141, MAT 142

Sample Course Sequence for the Major in Applied Mathematics and Statistics

A course planning guide for this major may be found here. The major course planning guides are not part of the official Undergraduate Bulletin, and are only updated periodically for use as an advising tool. The Undergraduate Bulletin supersedes any errors or omissions in the major course planning guides.

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Notes:
** Consult the department for appropriate courses.

- The following AMS courses satisfy SBS+: AMS 316, 335, 341, and 342
- The following AMS courses satisfy EXP+: AMS 333, 394, 412, 475, and 487
- The following AMS courses satisfy ESI and CER: AMS 315, 394, and 412
- The following AMS courses satisfy WRTD: AMS 300, 318, and 333

**AMS Faculty**
Faculty information for this program can be found at http://www.ams.sunysb.edu/people/faculty.shtml
AMS

Applied Mathematics and Statistics

AMS 102: Elements of Statistics
The use and misuse of statistics in real life situations; basic statistical measures of central tendency and of dispersion, frequency distributions, elements of probability, binomial and normal distributions, small and large sample hypothesis testing, confidence intervals, chi square test, and regression. May not be taken by students with credit for AMS 110, 310, 311, 312; ECO 320; POL 201; PSY 201; or SOC 202. 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: Satisfaction of entry skill in mathematics requirement (Skill 1) or satisfactory completion of D.E.C. C or QPS; Non AMS majors only
Anti-requisite: May not be taken by students with credit for AMS 110 or AMS 310.

DEC: C  
SBC: QPS  
3 credits

AMS 103: Applied Mathematics in Modern Technology
Technologies that drive our modern world rely critically on applied mathematics. This course explores "How does it work?" for selected technologies that rely on mathematics and statistics, e.g., internet search, social networking, financial markets, online auctions, cell phones, DNA sequencing, GPS, Wii, Google maps, and more.

Prerequisite: Level 3 or higher on the mathematics placement examination

SBC: QPS, TECH  
3 credits

AMS 105: Introduction to Business Statistics
The application of current statistical methods to problems in the modern business environment. Topics include probability, random variables, sampling techniques, confidence intervals, hypothesis testing, and regression. Students analyze real data sets using standard statistical software, interpret the output, and write extensively about the results.

Prerequisite: BUS Maj/Min, CME Major, or ISE Major.
Advisory Prerequisite: BUS 110, 111, 112, 115, or MAT 122. BUS or ISE Major: BUS 210

AMS 110: Probability and Statistics in the Life Sciences
A survey of probability theory and statistical techniques with applications to biological and biomedical situations. Topics covered include Markov chain models; binomial, Poisson, normal, exponential, and chi square random variables; tests of hypotheses; confidence intervals; tests; and analysis of variance, regression, and contingency tables. May not be taken for credit in addition to AMS 310. 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: AMS 151 or MAT 125 or 131 or 141.  
Anti-requisite: May not be taken by students with credit for AMS 102 or AMS 310.

SBC: QPS  
3 credits

AMS 151: Applied Calculus I
A review of functions and their applications; analytic methods of differentiation; interpretations and applications of differentiation; introduction to integration. Intended for CEAS majors. Not for credit in addition to MAT 125 or 126 or 131 or 141 or 171. 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

DEC: C  
SBC: QPS  
3 credits

AMS 161: Applied Calculus II
Analytic and numerical methods of integration; interpretations and applications of integration; differential equations models and elementary solution techniques; phase planes; Taylor series and Fourier series. Intended for CEAS majors. Not for credit in addition to MAT 127, MAT 132, MAT 142, or MAT 171. 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

DEC: C  
SBC: QPS  
3 credits

AMS 210: Applied Linear Algebra

Prerequisite: AMS 151 or MAT 131 or 141 or corequisite MAT 126 or level 7 or higher on the mathematics placement exam

SBC: STEM+  
3 credits

AMS 261: Applied Calculus III
Vector algebra and analytic geometry in two and three dimensions; multivariable differential calculus and tangent planes; multivariable integral calculus; optimization and Lagrange multipliers; vector calculus including Green's and Stokes's theorems. May not be taken for credit in addition to MAT 203 or 205.

Prerequisite: AMS 161 or MAT 127 or 132 or 142 or MPE level 9

SBC: STEM+  
4 credits

AMS 300: Writing in Applied Mathematics
See Requirements for the Major in Applied Mathematics and Statistics, Upper Division Writing Requirement.

Prerequisites: WRT 102; AMS major; U3 or U4 standing

SBC: SPK, WRTD  
1 credit, S/U grading

AMS 301: Finite Mathematical Structures
An introduction to graph theory and combinatorial analysis. The emphasis is on solving applied problems rather than on theorems and proofs. Techniques used in problem solving include generating functions, recurrence relations, and network flows. This course develops the type of mathematical thinking that is fundamental to computer science and operations research.

Prerequisite: AMS 210 or MAT 211 or AMS 361 or MAT 303

SBC: STEM+  
3 credits

AMS 303: Graph Theory
Paths and circuits, trees and tree based algorithms, graph coloring, digraphs, network flows, matching theory, matroids, and games with graphs.
AMS 310: Survey of Probability and Statistics
A survey of data analysis, probability theory, and statistics. Stem and leaf displays, box plots, schematic plots, fitting straight line relationships, discrete and continuous probability distributions, conditional distributions, binomial distribution, normal and t distributions, confidence intervals, and significance tests. May not be taken for credit in addition to ECO 320. 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: AMS 161 or MAT 132 or MAT 126 or MAT 142  
SBC: STEM+  
3 credits

AMS 311: Probability Theory  
Probability spaces, random variables, moment generating functions, algebra of expectations, conditional and marginal distributions, multivariate distributions, order statistics, law of large numbers.
Prerequisites: AMS 301 and 310 or permission of instructor  
Corequisites: MAT 203 or 205 or AMS 261  
3 credits

AMS 315: Data Analysis  
A continuation of AMS 310 that covers two sample t-tests, contingency table methods, the one-way analysis of variance, and regression analysis with one and multiple independent variables. Student projects analyze data provided by the instructor and require the use of a statistical computing package such as SAS or SPSS. An introduction to ethical and professional standards of conduct for statisticians will be provided.
Prerequisite: AMS 310  
SBC: CER, ESI  
3 credits

AMS 316: Introduction to Time Series Analysis  
Trend and seasonal components of time series models, autoregressive and moving average (ARMA) models, Box-Jenkins methodology, Portmanteau test, unit-root, generalized autoregressive conditionally heteroskedasticity (GARCH) models, exponential GARCH, stochastic volatility models. This course is offered as both AMS 316 and AMS 586.
Prerequisite: AMS 311 and AMS 315  
SBC: SBS+  
3 credits

AMS 318: Financial Mathematics  
This course will focus on accumulation functions, yield rates, annuities, loan repayment, term structure of interest rates/spot rates/forward rates, options, duration/convexity. This course follows the syllabus for the Society of Actuaries and prepares students to pass the FM Exam.
Prerequisite: AMS 310  
SBC: WRTD  
3 credits

AMS 320: Introduction to Quantitative Finance  
The course introduces the main classes of financial securities, the mathematical tools employed to model their prices, and common models for risk and investment management. Building realistic models relies on having a working knowledge of the empirical properties of financial asset returns which is another focus of the course. R is used as an environment for modeling.
Prerequisite: AMS 311  
3 credits

AMS 321: Computer Projects in Applied Mathematics  
The simulation methodology for a variety of applied mathematical problems in numerical linear and nonlinear algebra, statistical modeling, and numerical differentiation and integration. Graphical representation of numerical solutions.
Prerequisites: AMS 210 or 261 or MAT 203; prior programming experience in C, FORTRAN, or Java  
3 credits

AMS 326: Numerical Analysis  
Prerequisites: CSE 101; AMS 161; basic skills in using a high-level programming language (C, C++, or Java). Advisory prerequisite: AMS 210  
3 credits

AMS 332: Computational Modeling of Physiological Systems  
Introduces students to the fundamental principles underlying computational modeling of complex physiological systems. A major focus of the course will be on the process by which a model of a biological system is developed. Students will be introduced to the mathematical methods required for the modeling of complex systems (including stochastic processes and both temporal and spatial dynamics) as well as to tools for computational simulation. Roughly one half of the class will focus on models for general cellular physiology, while the remaining half will focus on the development of higher-level models of a particular physiological system (for example, the neurobiological systems underlying learning). This course is offered as both AMS 332 and BIO 332.
Prerequisite: MAT 127 or MAT 132 or higher and any one of the following: BIO 202 or BIO 203 or CHE 132 or CHE 331 or PHY 127 or PHY 132  
3 credits

AMS 333: Mathematical Biology  
This course introduces the use of mathematics and computer simulation to study a wide range of problems in biology. Topics include the modeling of populations, the dynamics of signal transduction and gene-regulatory networks, and simulation of protein structure and dynamics. A computer laboratory component allows students to apply their knowledge to real-world problems.
Prerequisites: AMS 161 or MAT 132; BIO 202; U3 or U4 standing; or permission of the instructor  
SBC: EXP+, WRTD  
3 credits

AMS 335: Game Theory  
Introduction to game theory fundamentals with special emphasis on problems from economics and political science. Topics include strategic games and Nash equilibrium, games in coalitional form and the core, bargaining theory, measuring power in voting systems, problems of fair division, and optimal and stable matching. This course is offered as both AMS 335 and ECO 355.
Prerequisites: MAT 126 or 131 or 141 or AMS 151; C or higher in ECO 303  
SBC: SBS+  
3 credits

AMS 341: Operations Research I: Deterministic Models  
Linear programming with a view toward its uses in economics and systems analysis. Linear algebra and geometric foundations of linear programming; simplex method and its variations; primal dual programs;
formulation and interpretation of linear programming models, including practical problems in transportation and production control. Optional computer projects. AMS 341 and 342 may be taken in either order, though it is recommended that AMS 341 be taken first. 
**Prerequisites:** AMS 210 or MAT 211

**SBC:** SBS+
3 credits

### AMS 342: Operations Research II: Stochastic Models

Methods and techniques for stochastic modeling and optimization, with applications to queueing theory, Markov chains, inventory theory, games, and decisions. AMS 341 and 342 may be taken in either order, though it is recommended that AMS 341 be taken first. 
**Prerequisites:** AMS 210 or MAT 211; AMS 311

**SBC:** SBS+
3 credits

### AMS 345: Computational Geometry

The design and analysis of efficient algorithms to solve geometric problems that arise in computer graphics, robotics, geographical information systems, manufacturing, and optimization. Topics include convex hulls, triangulation, Voronoi diagrams, visibility, intersection, robot motion planning, and arrangements. This course is offered as both AMS 345 and CSE 355. 
**Prerequisites:** AMS 301; programming knowledge of C or C++ or Java
3 credits

### AMS 351: 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:** AMS 210 or MAT 211
**Advisory Prerequisite:** MAT 200 or CSE 113
3 credits

### AMS 361: Applied Calculus IV: Differential Equations

Homogeneous and inhomogeneous linear differential equations; systems of linear differential equations; solution with power series and Laplace transforms; partial differential equations and Fourier series. May not be taken for credit in addition to the equivalent MAT 303. 
**Prerequisite:** AMS 161 or MAT 127 or 132 or 142 or MPE level 9

**SBC:** STEM+
4 credits

### AMS 394: Statistical Laboratory

Designed for students interested in statistics and their applications. Basic statistical techniques including sampling, design, regression, and analysis of variance are introduced. Includes the use of statistical packages such as SAS and R. Students translate realistic research problems into a statistical context and perform the analysis. 
**Prerequisite:** AMS 310 or AMS 315

**SBC:** CER, ESI, EXP+
3 credits

### AMS 410: Actuarial Mathematics

Integrates calculus and probability with risk assessment and insurance in a quantitative manner to prepare students for the first actuarial examination. 
**Prerequisites:** AMS 261 or MAT 203 or 205; AMS 310; AMS 311 or 315
3 credits

### AMS 412: Mathematical Statistics

Estimation, confidence intervals, Neyman Pearson lemma, likelihood ratio test, hypothesis testing, chi square test, regression, analysis of variance, nonparametric methods. 
**Prerequisite:** AMS 311

**SBC:** CER, ESI, EXP+
3 credits

### AMS 441: Business Enterprise

Explores the strategy and technology of business enterprises. Integrates the practice of engineering and quantitative methods with the operations of a business in today's globalized environment, whether in product development, financial management, or e-commerce. 
**Prerequisite:** Junior or Senior Standing
3 credits

### AMS 458: Speak Effectively Before an Audience

A zero credit course that may be taken in conjunction with AMS 475 course that provides opportunity to achieve the learning outcomes of the Stony Brook Curriculum's SPK learning objective. 
**Pre- or corequisite:** WRT 102 or equivalent; permission of the instructor

**SBC:** SPK
0 credit, S/U grading

### AMS 459: Write Effectively in Applied Mathematics

A zero credit course that may be taken in conjunction with AMS 487, with permission of the instructor. The course provides opportunity to practice the skills and techniques of effective academic writing and satisfies the learning outcomes of the Stony Brook Curriculum's WRTD learning objective. 
**Prerequisite:** WRT 102; permission of the instructor

**SBC:** WRTD
0 credit, S/U grading

### AMS 475: Undergraduate Teaching Practicum

Students assist the faculty in teaching by conducting recitation or laboratory sections that supplement a lecture course. The student receives regularly scheduled supervision from the faculty advisor. May be used as an open elective only and repeated once. 
**Prerequisites:** U4 standing as an undergraduate major within the college; a minimum g.p.a. of 3.00 in all Stony Brook courses and the grade of B or better in the course in which the student is to assist; permission of department

**SBC:** EXP+, SPK
3 credits

### AMS 476: Undergraduate Teaching Practicum

Students assist the faculty in teaching by conducting recitation or laboratory sections that supplement a lecture course. The student receives regularly scheduled supervision from the faculty advisor. May be used as an open elective only and repeated once. 
**Prerequisites:** U4 standing as an undergraduate major within the college; a minimum g.p.a. of 3.00 in all Stony Brook courses and the grade of B or better in the course in which the student is to assist; permission of department

**SBC:** EXP+, SPK
3 credits

### AMS 487: Research in Applied Mathematics

An independent research project with faculty supervision. Permission to register requires a B average and the agreement of a faculty member to supervise the research. May be repeated once. Only 3 credits of research electives (AMS 487, CSE 487, MEC 499, ESE 499, ESM 499, EST 499, ISE 487) may be counted toward engineering technical elective requirements. 
**Prerequisites:** Permission of instructor and department

**SBC:** EXP+, WRTD
AMS 492: Topics in Applied Mathematics

Treatment of an area of applied mathematics that expands upon the undergraduate curriculum. Topics may include applied mathematics, statistics, or operations research and change from semester to semester. Semester supplements to this Bulletin contain specific description when course is offered. May be repeated once, as the topic changes.

Prerequisite: Permission of instructor

3 credits