MATHEMATICAL AND COMPUTATIONAL SCIENCE

Chair: Bradley Efron

Committee in Charge: Takeshi Amemiya (Economics), Gunnar Carlsson (Mathematics), Richard Cottle (Management Science and Engineering), Thomas M. Cover (Statistics, and Electrical Engineering), Bradley Efron (Statistics), Gene Golub (Computer Science), George Papanicolaou (Mathematics), David Rogosa (Education), David Siegmund (Statistics), Leon Simon (Mathematics), Carlo Tomasi (Computer Science), Arthur F. Veinott Jr. (Management Science and Engineering)

Program Administrator: Helen Tombropoulos

This interdepartmental, interschool undergraduate program is designed as a major for students interested in the mathematical and computational sciences, or in the use of mathematical ideas and analysis in problems in the social or management sciences. It provides a core of mathematics basic to all of the mathematical sciences and an introduction to the concepts and techniques of automatic computation, optimal decision-making, probabilistic modeling, and statistical inference. It also provides an opportunity for elective work in any of the mathematical science disciplines at Stanford.

The program utilizes the faculty and courses of the departments of Computer Science, Management Science and Engineering, Mathematics, and Statistics. It prepares students for graduate study or employment in the mathematical and computational sciences or in those areas of applied mathematics which center around the use of high-speed computers and are concerned with the problems of the social and management sciences.

UNDERGRADUATE PROGRAMS

BACHELOR OF SCIENCE

The requirement for the bachelor's degree, beyond the University's basic requirements, is an approved course program of 76 to 80 units, distributed as follows:

Course No. and Subject	*Qtr.*	*and Units*
Mathematics: 33-34 units		
Math. 41, 42. Single Variable Calculus	A,W	10
or Math. 19	A,W	3
and Math. 20	W,S	3
and Math. 21	S	3
Math. 51. Linear Equations and Differential Calculus	A,W,S	5
Math. 52. Integral Calculus of Several Variables	A,W,S	5
Math. 109. Applied Modern Algebra (WIM) (not given 2000-01)		3
or Math. 110. Applied Number Theory and Field Theory (WIM)	S	3
or Math. 120. Modern Algebra (WIM)	A	3
Math. 113. Linear Algebra and Matrix Theory	A,W	3
or Math. 104. Matrix Theory and Its Applications	S	3
Math. 130. Ordinary Differential Equations	A,W	3
or Math. 53. Ordinary Differential Equations with Linear Algebra	A,W,S	5
One of the following:		
Comp. Sci. 137. Introduction to Scientific Computing	A	4
Math. 115. Fundamental Concepts of Analysis	A,W	3
Math. 160A. First Order Logic (enroll in Philosophy)	W	4
Computer Science (CS): 16-18 units		
CS 106X. Programming Methodology and Abstractions (Accelerated) *or* CS 106A and B may be substituted	A,W,S	5
CS 103A. Discrete Mathematics for Computer Science	A,W	3
CS 103B. Discrete Structures	W,S	3
CS 103X. Discrete Structures (Accelerated)	S	4
Two of the following:		
CS 107. Programming Paradigms	A,S	5
CS 137. Introduction to Scientific Computing	A	4
CS 154. Introduction to Automata and Complexity Theory	W,S	4
CS 161. Design and Analysis of Algorithms	A,W	4
CS 260. Concrete Mathematics (not given 2000-01)		3
Management Science and Engineering (MS&E): 8-9 units		
Engr. 62. Introduction to Optimization	A,S	4
MS&E 121. Introduction to Stochastic Modeling	S	4
or three of the following:		
MS&E 211. Linear and Nonlinear Optimization	A	4
MS&E 212. Network and Integer Programming	A	3
MS&E 224. Stochastic Models in Operations Research (not given 2000-01)		3
MS&E 251. Stochastic Decision Models	W	3
Statistics: (11 units)		
Stat. 116. Theory of Probability	A,S	5
Stat. 200. Introduction to Statistical Inference	W	3
Stat. 201. Statistical Methods	W	3
or Stat. 203. Analysis of Variance (not given 2000-01)		3

ELECTIVES (9 units)

Three courses in mathematical and computational science, 100-level or above, and at least 3 units each. At least one must be chosen from the following:

Course No. and Subject	*Qtr.*	*and Units*
Econ. 160. Game Theory and Economic Applications (prereq. Econ. 51)	A	5
Econ. 171-172. Intermediate Econometrics II-III	W,S	5
Econ. 181. Optimization and Economic Analysis	S	5
Elect. Engr. 261. The Fourier Transform and Its Applications	A,W	3
MS&E 211. Linear and Nonlinear Optimization	A	4
MS&E 212. Network and Integer Programming	A	3
MS&E 224. Stochastic Models in Operations Research (not given 2000-01)		3
MS&E 251. Stochastic Decision Models	W	3
Math. & Comp. Sci. 100. Mathematics of Sports (enroll in Stat. 50; not given 2000-01)		3
Math. 106. Introduction to Theory of Functions of a Complex Variable	A	3
Math. 116. Complex Analysis	W	3
Math. 131. Partial Differential Equations I	W,S	5
Math. 132. Partial Differential Equations II	S	3
Stat. 202. Data Analysis II	S	3
Stat. 217. Introduction to Stochastic Processes	W	3

For Computer Science (CS), suggested electives include those courses not taken under item 3 of the above Computer Science list and the following:

CS 108. Object Oriented Systems Design	A,W	4
CS 110. Introduction to Computer Systems and Assembly Language Programming	S	4
CS 112. Computer Organization and Design (enroll in Elect. Engr. 182)	A,S	4
CS 140. Operating Systems	A,W	4
CS 143. Compilers	A,S	4
CS 157. Logic and Automated Reasoning	A,S	4
CS 161. Design and Analysis of Algorithms	A,W	4
CS 194. Software Project (prereq. CS 108)	W,S	3
CS 211. Logic Design (enroll in Elect. Engr. 275)	A,W	3
CS 212. Computer Architecture and Organization (enroll in Elect. Engr. 282)	A,W	3
CS 221. Artificial Intelligence: Principles and Techniques	A	4
CS 223A. Introduction to Robotics	W	3
CS 223B. Introduction to Computer Vision	W	3
CS 225A. Experimental Robotics	S	3
CS 228. Knowledge Representation and Reasoning under Uncertainty	W	3
CS 229. Machine Learning	W	3
CS 237A. Numerical Linear Algebra	A	3
CS 243. Advanced Compiling Techniques	W	4

With the adviser's approval, courses other than those offered by the sponsoring departments may be used to fulfill part of the elective requirement. These may be in biology, economics, electrical engineering, industrial engineering, medicine, and so on, that might be relevant to a mathematical sciences major, depending on the particular interest of the student.

1. At least three quarters before graduation, majors must file with their advisers a plan for completing degree requirements.
2. All courses used to fulfill major requirements must be taken for a letter grade with the exception of courses offered satisfactory/no credit only.
3. A course used to fulfill the requirements of one section of the program may not be applied toward the fulfillment of the requirements of another section.

4. The student must have a grade point average (GPA) of 'C' or better in all course work used to fulfill the major requirement.

MINORS

The minor in Mathematical and Computational Science is intended to provide an experience of the four constituent areas: computer science (CS), mathematics, management science and engineering (MS&E), and statistics. Four basic courses are required:

1. CS 106X. Programming Methodology and Abstractions
   or CS 106A,B. Programming Methodology
2. Math. 51. Linear Equations and Differential Calculus
   or Math. 103. Matrix Theory and Its Applications
3. Engr. 62. Introduction to Optimization
   or MS&E 121. Introduction to Stochastic Modeling
4. Stat. 116. Theory of Probability
   or Stat. 190. Statistics for Social Scientists

In addition to the above, the minor requires three courses (total) from the following, two of which must be in different departments:

CS 107. Programming Paradigms
CS 137. Introduction to Scientific Computing
CS 138. MATLAB and MAPLE for Science and Engineering Applications
CS 154. Introduction to Automata and Complex Theory
CS 260. Concrete Mathematics

Elect. Engr. 261. The Fourier Transform and its Applications

Econ. 160. Game Theory and Economic Applications (prereq. Econ 51)
Econ. 171-172. Intermediate Econometrics II-III
Econ. 181. Optimization and Economic Analysis

MS&E 211. Linear and Nonlinear Optimization/Programming
MS&E 212. Network and Integer Programming
MS&E 224. Stochastic Models in Operations Research
MS&E 251. Stochastic Design Models

Math. 104. Matrix Theory and Its Applications
Math. 106. Introduction to Theory of Functions of a Complex Variable
Math. 109. Applied Modern Algebra
Math. 110. Applied Number Theory and Field Theory
Math. 115. Fundamental Concepts of Analysis *or* Math. 171
Math. 131. Partial Differential Equations I
Math. 132. Partial Differential Equations II
Math. 160A. First Order Logic

Stat. 200. Introduction to Statistical Inference
Stat. 201. Statistical Methods
Stat. 202. Data Analysis II
Stat. 203. Analysis of Variance
Stat. 217. Introduction to Stochastic Processes

Other upper-division courses appropriate to the program major may be substituted with the permission of the program director. Undergraduate majors in the constituent programs cannot count courses in their own departments.

HONORS PROGRAM

The honors program is designed to encourage a more intensive study of mathematical sciences than the Bachelor of Science program. In addition to meeting all requirements for the B.S. in Mathematical and Computational Science, the student must:

1. Maintain an average letter grade equivalent in mathematical sciences courses of at least a 3.4.
2. Complete at least 15 units in mathematical sciences in addition to the requirements for the major listed above. These courses should form a sustained effort in one area and constitute a program approved by the committee in charge of the Mathematical and Computational Science Program.
3. Include in the above 15 units at least one of the following:
   a) an approved higher-level graduate course
   b) participation in a small group seminar
   c) at least three units of directed reading

Students interested in doing honors work should consult with their advisers by the last quarter of the junior year to prepare a program of study for submission to the committee in charge for their approval. Honors work may be concentrated in a wide variety of fields outside of the Mathematical and Computational Science programs, for example, biological sciences, medicine, physics.

COURSES

100. Mathematics of Sports—The use of mathematics, statistics, and probability in the analysis of athletic performance, sports records, strategy, etc. Topics: mathematical analysis of the physical and biological aspects of human performance, the effects of variations in technique and equipment, the determination of optimal strategies, traditional sports statistics and the development of new statistics, calculation of probabilities of various outcomes, etc. Different sports are considered. Prerequisite: Mathematics 51. Corequisite: Statistics 116.

3 units (Cover) alternate years, given 2001-02