MATHEMATICAL AND COMPUTATIONAL SCIENCE

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Courses given in Mathematical and Computational Science have the subject code MCS. For a complete list of subject codes, see Appendix B.

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 computers and are concerned with the problems of the social and management sciences.

A biology track for students interested in applications of mathematics, statistics and computer science to the biological sciences (bioinformatics, computational biology, statistical genetics, neurosciences, etc.) is now offered.

UNDERGRADUATE PROGRAMS

BACHELOR OF SCIENCE

The requirement for the bachelor's degree, beyond the University's basic requirements, is an approved course program of 72 to 77 units, distributed as follows:

		Qtr. and Units
Mathematics (MATH): 29-31 units		
41. Calculus	A	5
and 42. Calculus	A,W	5
51. Linear Algebra & Differential Calculus of Several Variables	A,W,S	5
or 51H. Honors Advanced Calculus	A	5
52. Integral Calculus of Several Variables	A,W,S	5
or 52H. Honors Advanced Calculus	W	5
53. Ordinary Differential Equations with Linear Algebra	A,W,S	5
or 53H. Honors Advanced Calculus	S	5
109. Applied Group Theory (WIM)	W	3
or 110. Applied Number Theory and Field Theory (WIM)	S	3
or 120. Modern Algebra (WIM)	A,S	3
113. Linear Algebra and Matrix Theory	A,W	3
Computer Science (CS): 16-18 units		
103A. Discrete Mathematics for Computer Science	A,W	3
103B. Discrete Structures	W,S	3
or 103X. Discrete Structures (Accelerated)	A	3-4
106X. Programming Methodology and Abstractions (Accel.)	A,W	3-5
or 106A. Programming Methodology	A,W,S	3-5
and 106B. Programming Abstractions	W,S	3-5
And two of the following (CS):		
107. Programming Paradigms	A,S	3-5
137. Introduction to Scientific Computing	W	3-4
154. Introduction to Automata and Complexity Theory	A,S	3-4
161. Design and Analysis of Algorithms	A,W	3-4
260. Concrete Mathematics (not given 2003-04)		3
Management Science and Engineering (MS&E): 8-9 units		
Both:		
111. Introduction to Optimization (enroll in ENGR 62)	A,S	3-4
121. Introduction to Stochastic Modeling	W	4
or three of the following:		
211. Linear and Nonlinear Optimization	A	3-4
212. Network and Integer Programming	W	3
221. Stochastic Modeling	W	3
251. Stochastic Decision Models	W	3
Statistics (STATS): (11 units)		
116. Theory of Probability	A,S	3-5
191. Introduction to Applied Statistics	S	3-4
or 203. Intro. to Regression Models and Analysis of Variance	W	3
200. Introduction to Statistical Inference	W	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:

	Qtr. and Units	
ECON 102C. Advanced Topics in Econometrics	S	5
ECON 140. Introduction to Financial Economics	A,S	5
ECON 160. Game Theory and Economic Applications (prerequisite ECON 51)	S	5
ECON 179. Experimental Economics	S	5
ECON 181. Optimization and Economic Analysis (not given 2003-04)		5
EE 261. The Fourier Transform and its Applications	A,W	3
MS&E 211. Linear and Nonlinear Optimization	A	3-4
MS&E 212. Network and Integer Programming	W	3
MS&E 221. Stochastic Modeling	W	3
MS&E 251. Stochastic Decision Models	W	3
MCS 100. Mathematics of Sports (same as STATS 50)	S	3
MATH 106. Functions of a Complex Variable	A	3
MATH 108. Introduction to Combinatorics and its Applications	A	3
MATH 115. Functions of a Real Variable	A,W	3
MATH 116. Complex Analysis	S	3
MATH 131. Partial Differential Equations I	A,W	3
MATH 132. Partial Differential Equations II	W,S	3
MATH 135. Nonlinear Dynamics and Chaos	S	3
PHIL 160A. First-Order Logic	W	4
STATS 202. Data Analysis	A	3
STATS 217. Introduction to Stochastic Processes	W	3

For Computer Science (CS), electives can include courses not taken as units under the CS list above and the following:

CS 108. Object-Oriented Systems Design	A,W	3-4
CS 110. Introduction to Computer Systems and Assembly Language Programming (not given 2003-04)		3-4
CS 140. Operating Systems and Systems Programming	A,W	3-4
CS 143. Compilers	A,S	3-4
CS 157. Logic and Automated Reasoning	A,S	3-4
CS 161. Design and Analysis of Algorithms	A,W	3-4
CS 194. Software Project (prerequisite CS 108)	W,S	3
CS 221. Artificial Intelligence: Principles and Techniques	A	3-4
CS 223A. Introduction to Robotics	W	3
CS 223B. Introduction to Computer Vision	W	3
CS 225A. Experimental Robotics	S	3
CS 228. Probabilistic Models in Artificial Intelligence	W	3
CS 229. Machine Learning	W	3
CS 237A. Numerical Linear Algebra	A	3
CS 243. Advanced Compiling Techniques	W	3-4
EE 275. Logic Design	A,W	3
EE 282. Computer Architecture and Organization	A,W	3

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, etc., 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 2.0 or better in all course work used to fulfill the major requirement.

MATHEMATICAL AND COMPUTATIONAL BIOLOGY TRACK

Replace MATH 109/110 with either:

	Qtr.	*and Units*
BIOSCI 221. Methods of Theoretical Population Biology	A	4
or MATH 135. Nonlinear Dynamic Systems	S	3

Replace STATS 191/203 by

STATS/BIOSCI 141. Biostatistics	A,W	4-5

Replace MS&E 121/STATS 217 by

STATS 215. Statistical Models in Biology (not given 2003-04)		3

Take at least 2 courses from the Biological Sciences core:

		Units
BIOSCI 41. Genetics and Biochemistry	A	5
BIOSCI 42. Cell Biology and Animal Physiology	W	5
BIOSCI 43. Plant Biology, Evolution, and Ecology	S	5

Take a third course either from the Core or

BIOSCI 133. Genetics of Prokaryotes	A	3
BIOSCI 134. Replication of DNA	W	3
BIOSCI 136. Evolutionary Paleobiology	W	4
or BIOSCI 203. Advanced Genetics	A	4
STATS 166. Statistical Methods in Computational Genetics (WIM)	A	3

Honors students should take 3 of the following:

ANTHSCI 180. Intro. to Anthropological Genetics (not given 2003-04)		5
ANTHSCI 181. Genes and Culture through Time and Space (not given 2003-04)		5
ANTHSCI 187. The Genetic Structure of Populations	S	5
ANTHSCI 188. Research in Anthropological Genetics	A	1-5
BIOSCI 113. Fundamentals of Molecular Evolution	W	4
BIOSCI 146. Population Studies	W	1
BIOSCI 221. Methods of Theoretical Population Biology	A	4
BIOSCI 283. Theoretical Population Genetics	A	3
STATS 166. Statistical Methods in Computational Genetics	A	3

MINORS

The minor in Mathematical and Computational Science is intended to provide an experience of the 4 constituent areas: Computer Science (CS), Mathematics (MATH), Management Science and Engineering (MS&E), and Statistics (STATS). Four basic courses are required:

CS 106X. Programming Methodology and Abstractions (Accelerated)
or CS 106A,B. Programming Methodology
MATH 51. Linear Algebra and Differential Calculus of Several Variables
or MATH 103. Matrix Theory and its Applications
ENGR 62. Introduction to Optimization
or MS&E 121. Introduction to Stochastic Modeling
STATS 116. Theory of Probability
or STATS 191. Introduction to Applied Statistics

In addition to the above, the minor requires a total of 3 courses 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 Complexity Theory
CS 260. Concrete Mathematics
EE 261. The Fourier Transform and its Applications
ECON 102C. Advanced Topics in Econometrics
ECON 160. Game Theory and Economic Applications (prerequisite ECON 51)
ECON 181. Optimization and Economic Analysis
MS&E 211. Linear and Nonlinear Optimization
MS&E 212. Network and Integer Optimization
MS&E 221. Stochastic Modeling
MS&E 251. Stochastic Decision Models
MATH 103. Matrix Theory and Its Applications
MATH 106. Functions of a Complex Variable
MATH 108. Introduction to Combinatorics and its Applications
MATH 109. Applied Group Theory
MATH 110. Applied Number Theory and Field Theory
MATH 115. Functions of a Real Variable
or MATH 171. Fundamental Concepts of Analysis
MATH 131. Partial Differential Equations I
MATH 132. Partial Differential Equations II
MATH 135. Nonlinear Dynamics and Chaos
PHIL 160A. First-Order Logic
STATS 200. Introduction to Statistical Inference
STATS 202. Data Analysis
STATS 203. Introduction to Regression Models and Analysis of Variance
STATS 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

MCS 100. Mathematics of Sports—(Same as STATS 50.) The use of mathematics, statistics, and probability in the analysis of sports performance, sports records, and strategy. Topics include mathematical analysis of the physics of sports and the determinations of optimal strategies. New diagnostic statistics and strategies for each sport. Corequisite: STATS 116.

3 units, Spr (Cover)