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:

Course No. and Subject		*Qtr. and Units*
Mathematics (MATH): 29-31 units		
41. Single Variable Calculus	A	5
and 42. Single Variable Calculus	A,W	5
51. Linear Equations and Differential Calculus	A,W,S	5
or 51H. Linear Equations and Differential Calculus	A	5
52. Integral Calculus of Several Variables	A,W,S	5
or 52H. Integral Calculus of Several Variables	W	5
53. Ordinary Differential Equations with Linear Algebra	A,W,S	5
or 53H. Ordinary Diff. Equations with Linear Algebra	S	5
109. Applied Modern Algebra (WIM)	W	3
or 110. Applied Number Theory and Field Theory (WIM)	S	3
or 120. Modern Algebra (WIM)	A	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)	W	4
106X. Programming Methodology & Abstractions (Accel.)	A,S	5
or 106A. Programming Methodology	A,W,S	5
and 106B. Programming Abstraction	W,S	5

And two of the following (CS):

107. Programming Paradigms	A,S	5
137. Introduction to Scientific Computing	W	4
154. Introduction to Automata and Complexity Theory	W	4
161. Design and Analysis of Algorithms	A,S	4
260. Concrete Mathematics (not given 2002-03)		3
Management Science and Engineering (MS&E): 8-9 units		
Both:		
111. Introduction to Optimization	A,Sum	4
121. Introduction to Stochastic Modeling	W	4
or three of the following:		
211. Linear and Nonlinear Optimization	A	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	5
191. Introduction to Regression Analysis & Applied Statistics	S	3
or 203. 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:

Course No. and Subject		*Qtr. and Units*
ECON 102C. Adv. Topics in Econometrics (not given 2002-03)		5
ECON 160. Game Theory and Economic Applications (prereq. ECON 51)	A	5
ECON 181. Optimization and Econ. Analysis (not given 2002-03)		5
EE 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	W	3
MS&E 251. Stochastic Decision Models	W	3
MATH 106. Intro. to Theory of Functions and Complex Variables	A	3
MATH 108. Introduction to Combinatorics and its Applications	A	3
MATH 115. Fundamental Concepts of Analysis	A,W	3
MATH 116. Complex Analysis (not given 2002-03)		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	W	3
MCS 100. Mathematics of Sports (not given 2002-03)		3
PHIL 160A. First-Order Logic	W	4
STATS 202. Data Analysis II	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	4
CS 110. Introduction to Computer Systems and Assembly Language Programming	S	4
CS 140. Operating Systems	A,W	4
CS 143. Compilers	A,W	4
CS 157. Logic and Automated Reasoning	A,S	4
CS 161. Design and Analysis of Algorithms	A,S	4
CS 194. Software Project (prereq. CS 108)	W,S	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 (not given 2002-03)		3
CS 229. Machine Learning	S	3
CS 237A. Numerical Linear Algebra	A	3
CS 243. Advanced Compiling Techniques	W	4
EE 182. Computer Organization and Design	A,S	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, 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 'C' or better in all course work used to fulfill the major requirement.

MATHEMATICAL AND COMPUTATIONAL BIOLOGY TRACK

Replace MATH 109/110 with either

BIOSCI 221. Methods of Theoretical Population Biology	A	4
or MATH 135. Nonlinear Dynamic Systems	W	3

Replace STATS 191/203 by

STATS/BIOSCI 141. Biostatistics	A	4

Replace MS&E 121/STATS 217 by

STATS 215. Intro. to Stochastic Modeling in Biology	S	3

Take at least 2 courses from the Biological Sciences core:

Course No. and Subject		*Units*
BIOSCI 41. Evolution, Genetics, Genomes & Biochemistry	A	5
BIOSCI 42. Molecular Cell Biology, Dev. Bio., Neurobiology	W	5
BIOSCI 43. Physiology, Ecology, & Behavioral Biology	S	5

Take a third course either from the Core or

BIOSCI 133. Genetics of Prokaryotes	A	3
BIOSCI 134. Replication of DNA	A	3
BIOSCI 136. Evolutionary Paleobiology (not given 2002-03)		4
or		
BIOSCI 203. Advanced Genetics.	A	4
STATS 166. Statistical and Computational Genetics (WIM)	A	3

Honors students should take 3 of the following:

ANTHSCI 180. Human Evolutionary Genetics	W	4-5
ANTHSCI 181. Genes and Culture through Time and Space (not given 2002-03)		5
ANTHSCI 189. Research Methods in Anthropological Genetics (not given 2002-03)		5
BIOSCI 113. Molecular Evolution		3
BIOSCI 146. Colloquium on Population Studies	W	1
BIOSCI 221. Methods of Theoretical Population Biology	A	4
BIOSCI 283. Theoretical Population Genetics	A	3
STATS 166. Statistical and 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
or CS 106A,B. Programming Methodology
MATH 51. Linear Equations and Differential Calculus
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 Regression Analysis and 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 Complex 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 (prereq. Econ 51)
ECON 181. Optimization and Economic Analysis
MS&E 211. Linear and Nonlinear Optimization/Programming
MS&E 212. Network and Integer Programming
MS&E 221. Stochastic Modeling
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 108. Introduction to Combinatorics and its Applications
MATH 109. Applied Modern Algebra
MATH 110. Applied Number Theory and Field Theory
MATH 115. Fundamental Concepts of Analysisn *or* MATH 171
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 II
STATS 203. 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—The use of mathematics, statistics, and probability in the analysis of athletic performance, sports records, strategy. 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. Different sports are considered. Prerequisite: MATH 51. Corequisite: STATS 116.

3 units (Cover) alternate years, given 2003-04