

# PROGRAM IN SYMBOLIC SYSTEMS

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Courses given in the Program in Symbolic Systems have the subject code SYMSYS. For a complete list of subject codes, see Appendix.

The observation that both human beings and computers can manipulate symbols lies at the heart of Symbolic Systems, an interdisciplinary program focusing on the relationship between natural and artificial systems that represent, process, and act on information. Computer programs, natural languages, the human mind, and the Internet embody concepts whose study forms the core of the Symbolic Systems curriculum, such as computation, representation, communication, and intelligence. A body of knowledge and theory has developed around these notions, from disciplines like philosophy, computer science, linguistics, psychology, statistics, neurobiology, and communication. Since the invention of computers, researchers have been working across these disciplines to study questions such as: in what ways are computers and computer languages like human beings and their languages; how can the interaction between people and computers be made easier and more beneficial?

The core requirements of the Symbolic Systems Program (SSP) include courses in symbolic logic, the philosophy of mind, formal linguistics, cognitive psychology, programming, the mathematics of computation, statistical theory, artificial intelligence, and interdisciplinary approaches to cognitive science. These courses prepare students with the vocabulary, theoretical background, and technical skills needed for study and research at the advanced undergraduate and graduate levels. Most of the courses in SSP are drawn from affiliated departments. Courses designed specifically for the program are aimed at integrating and supplementing topics covered by the department-based offerings. The curriculum includes humanistic approaches to questions about language and intelligence, as well as training in science and engineering.

SSP offers B.S. and M.S. degree programs. Both programs require students to master a common core of required courses and to choose an area of specialization.

## **UNDERGRADUATE PROGRAMS BACHELOR OF SCIENCE**

The program leading to a B.S. in Symbolic Systems provides students with a core of concepts and techniques, drawing on faculty and courses from various departments. The curriculum prepares students for advanced training in the interdisciplinary study of language and information, or for postgraduate study in any of the main contributing disciplines. It is also excellent preparation for employment immediately after graduation.

Symbolic Systems majors must complete a core of required courses plus a field of study consisting of six additional courses. All major courses are to be taken for letter grades unless an approved course is offered satisfactory/no credit only. All core courses must be passed with a grade

of 'C-' or better. Students who receive a grade lower than this in a core course must alert the program of this fact so that a decision can be made about whether the student should continue in the major.

## CORE REQUIREMENTS

In order to graduate with a B.S. in Symbolic Systems, a student must complete the following requirements. Some of these courses have other courses as prerequisites; students are responsible for completing each course's prerequisites before they take it.

1. *Cognitive Science*: SYMBSYS 100. Introduction to Cognitive Science
2. *Computer Programming*:
  - a) CS 106A. Programming Methodology and 106B. Programming Abstractions; or 106X. Programming Methodology and Abstractions (Accelerated); and
  - b) CS 107. Programming Paradigms
3. *Logic*:
  - a) PHIL 150. Basic Concepts in Mathematical Logic; or 150X. Basic Concepts in Mathematical Logic, and CS 103A. Discrete Mathematics for Computer Science, or 103X. Discrete Structures (Accelerated); and
  - b) PHIL 151. First-Order Logic
4. *Computational Theory*:
  - a) CS 103B. Discrete Structures; or 103X. Discrete Structures (Accelerated); and
  - b) CS 154. Introduction to Automata and Complexity Theory; or PHIL 152. Computability and Logic
5. *Probability*: one of the following:
  - CME 106/ENGR 155C. Introduction to Probability and Statistics for Engineers
  - EE 178. Probabilistic Systems Analysis
  - MATH 151. Introduction to Probability Theory
  - MS&E 120. Probabilistic Analysis
  - STATS 110. Statistical Methods in Engineering and the Physical Sciences
  - STATS 116. Theory of Probability
  - STATS 121. Probability, Induction, Statistics
6. *Philosophical Foundations*:
  - a) an introductory course in Philosophy must be taken prior to the required PHIL 80, from among the following:
    - PHIL 10. God, Self, and World: An Introduction to Philosophy
    - PHIL 20. Introduction to Moral Philosophy
    - PHIL 30. Introduction to Political Philosophy
    - PHIL 60. Introduction to Philosophy of Science
    - PHIL 102. Modern Philosophy, Descartes to Kant
    - IHUM 23A,B. The Fate of Reason
 and
  - b) PHIL 80. Mind, Matter, and Meaning (WIM)
7. *Cognitive Psychology*: PSYCH 55. Introduction to Cognition and Brain; or PSYCH 40. Introduction to Cognitive Psychology
8. *Language and Mind*: one of the following:
  - LINGUIST 1. Introduction to Linguistics
  - LINGUIST 140. Language Acquisition I
  - PHIL 181. Philosophy of Language
  - PSYCH 131. Language and Thought
  - PSYCH 137. Birds to Words: Cognition, Communication, and Language
9. *Linguistic Theory*: one of the following:
  - LINGUIST 120. Introduction to Syntax
  - LINGUIST 130A. Introduction to Linguistic Meaning
  - LINGUIST 180. Introduction to Computational Linguistics
  - LINGUIST 230A. Introduction to Semantics and Pragmatics
10. *Artificial Intelligence*: CS 121. Introduction to Artificial Intelligence, or 221. Artificial Intelligence: Principles and Techniques
11. *Advanced Small Seminar*:\* an upper-division, limited-enrollment seminar drawing on material from other courses in the core. Courses listed under Symbolic Systems Program offerings with numbers from SYMBSYS 201 through 209 are acceptable, as are other courses which are announced at the beginning of each academic year.

\*A course taken to fulfill one of these requirements can also be counted toward another requirement, as part of either the core or a student's concentration (see below), but not both.

## FIELDS OF STUDY

In addition to the core requirements listed above, the Symbolic Systems major requires each student to complete a field of study consisting of six courses that are thematically related to each other. Students select concentrations from the list below or design others in consultation with their advisers. The field of study is declared on Axess; it appears on the transcript but not on the diploma.

Applied Logic  
 Artificial Intelligence  
 Cognitive Science  
 Computer Music  
 Decision Making and Rationality  
 Human-Computer Interaction  
 Learning  
 Natural Language  
 Neurosciences  
 Philosophical Foundations

## MINOR

Students may minor in Symbolic Systems by completing either item 1 or item 2 below.

1. One course in each of the following core areas (please note that several of these courses have prerequisites):
  - a) *Cognition*: SYMBSYS 100\* or PSYCH 40 or 55
  - b) *Logic and Computation*: PHIL 150 or 151, or CS 103B, 103X, or 154
  - c) *Computer Programming*: CS 106B, 106X, or 107
  - d) *Philosophical Foundations*: SYMBSYS 100\* or PHIL 80
  - e) *Formal Linguistics*: LINGUIST 120, 130A, or 130B
  - f) *Artificial Intelligence*: CS 121 or 221
2. SYMBSYS 100, plus an interdisciplinary SSP concentration listed on the SSP web site at <http://symsys.stanford.edu>. To qualify, the selection of courses used for the minor must be interdisciplinary: it must either include courses from at least three departments, or include more than one course from each of two departments.

\*SYMBSYS 100 may not be counted for both areas 'a' and 'd'.

## UNDERGRADUATE RESEARCH

The program strongly encourages all SSP majors to gain experience in directed research by participating in faculty research projects or by pursuing independent study. In addition to the Symbolic Systems Honors Program (see below), the following avenues are offered.

1. *Summer Internships*: students work on SSP-related faculty research projects. Application procedures are announced in the winter quarter for SSP majors.
2. *Research Assistantships*: other opportunities to work on faculty research projects are typically announced to SSP majors as they arise during the academic year.
3. *Independent Study*: under faculty supervision. For course credit, students should enroll in SYMBSYS 196.

Contact SSP for more information on any of these possibilities, or see <http://symsys.stanford.edu>. In addition, the Undergraduate Advising and Research office offers grants and scholarships supporting student research projects at all levels; see <http://urp.stanford.edu>.

## HONORS PROGRAM

Seniors in SSP may apply for admission to the Symbolic Systems honors program prior to the beginning of their final year of study. Students who are accepted into the honors program can graduate with honors by completing an honors thesis under the supervision of a faculty member. Course credit for the honors project may be obtained by registering for SYMBSYS 190, Honors Tutorial, for any quarters while a student is working on an honors project. Juniors who are interested in doing an honors project during their senior year are advised to take SYMBSYS 91, Junior Honors Seminar. SYMBSYS 191, Senior Honors Seminar, is recommended for honors students during the senior year. Contact SSP or visit the program's web site for more information on the honors program, including deadlines and policies.

## COTERMINAL BACHELOR'S AND MASTER'S DEGREES

Many SSP majors also complete coterminal M.S. or M.A. degrees in affiliated departments. In addition to the Symbolic Systems M.S. program (see below), the Department of Philosophy offers a special Symbolic Systems track for interdisciplinary graduate level work.

For University coterminal degree program rules and University application forms, see <http://registrar.stanford.edu/shared/publications.htm#Coterm>.

## GRADUATE PROGRAMS

The University's basic requirements for the M.S. and Ph.D. degrees are discussed in the "Graduate Degrees" section of this bulletin.

## MASTER OF SCIENCE

The M.S. degree in Symbolic Systems is designed to be completed in the equivalent of one academic year by coterminal students or returning students who already have a B.S. degree in Symbolic Systems, and in two years or less by other students depending upon level of preparation. Admission is competitive, providing a limited number of students with the opportunity to pursue course and project work in consultation with a faculty adviser who is affiliated with the Symbolic Systems Program. The faculty adviser may impose requirements beyond those described here.

Admission to the program as a coterminal student is subject to the policies and deadlines described in the "Undergraduate Degrees" section of this bulletin (see "Coterminal Bachelor's and Master's Degrees"). Applicants to the M.S. program are reviewed each Winter Quarter. Information on deadlines, procedures for applying, and degree requirements are available from the program's student services coordinator in the Linguistics Department office (460-127E) and at [http://symsys.stanford.edu/ssp\\_static?page=masters.html](http://symsys.stanford.edu/ssp_static?page=masters.html).

## REQUIREMENTS

A candidate for the M.S. degree in Symbolic Systems must complete a program of 45 units. At least 36 of these must be graded units, passed with an average grade of 3.0 (B) or better, and any course taken to fulfill requirements A, B, or C below must be taken for a letter grade unless the course is offered S/NC only. The 45 units may include no more than 21 units of courses from those listed below under Requirements A and B. Furthermore, none of the 45 units to be counted toward the M.S. degree may include units counted toward an undergraduate degree at Stanford or elsewhere. Course requirements are waived only if evidence is provided that similar or more advanced courses have been taken, either at Stanford or another institution. Courses that are waived rather than taken may not be counted toward the M.S. degree.

Each candidate for the M.S. degree must fulfill the following requirements:

### REQUIREMENT A

Demonstrated competence in the core requirements for the B.S. degree in Symbolic Systems. Candidates who have gone through the Symbolic Systems undergraduate program satisfy this requirement in the course of the B.S. degree in Symbolic Systems. Other students admitted as candidates for a Symbolic Systems M.S. degree must complete or show evidence of having passed equivalent courses covering all the Symbolic Systems undergraduate core requirements, with the exception of the advanced small seminar requirement.

### REQUIREMENT B

1. Submission to and approval by the Symbolic Systems Program office of these pre-project research documents:
  - a) project area statement, endorsed with a commitment from the student's prospective project adviser due no later than May 1 of the academic year prior to the expected graduation year; and
  - b) qualifying research paper due no later than the end of the Summer Quarter prior to the expected graduation year.

2. Completion of two additional skill requirements:
  - a) *Computer Programming*: CS 108, Object-Oriented Systems Design; and
  - b) *Empirical Methods*: one of the following:
    - COMM 206. Communication Research Methods
    - COMM 239. Questionnaire Design for Surveys and Laboratory Experiments: Social and Cognitive Perspectives
    - COMM 268. Experimental Research in Advanced User Interfaces
    - LINGUIST 280/CS 224N. Natural Language Processing
    - PSYCH 110. Research Methods and Experimental Design
    - PSYCH 252. Statistical Methods for Behavioral and Social Science (for 3 or more units)
    - PSYCH 253. Statistical Theory, Models, and Methodology (for 3 units)
    - STATS 191. Introduction to Applied Statistics
    - STATS 200. Introduction to Statistical Inference a Statistics course numbered higher than 200
3. Completion of three quarters of the Symbolic Systems Program M.S. Seminar (SYMSYS 291).

### REQUIREMENT C

Completion of an approved specialization track. All tracks of the Symbolic Systems M.S. program require students to do a substantial project. The course requirements for each track are designed to prepare a student to undertake such a project. The nature of the project depends on the student's focus, but it should be academic in nature (contributing to generalizable knowledge) and it should relate to the subject matter of symbolic systems more or equally appropriately as it does to other master's degree programs at Stanford. In all cases, a written thesis or paper describing the project is required. The project normally takes three quarters, and work on the project may account for up to 15 units of a student's program. The thesis must be read and approved for the master's degree in Symbolic Systems by two qualified readers approved by the program, at least one of whom must be a member of the academic council. Each track of the Symbolic Systems M.S. program has its own core requirements, as well as unit requirements from a set of elective courses. The tracks and their requirements are as follows.

*The Human-Computer Interaction (HCI) Track*—The HCI Core: a course in Computer Science numbered 141-179 (excluding 147), or CS 241-279 (excluding 247A), or CS 295, Software Engineering; and CS 147, Introduction to Human-Computer Interaction Design; and CS 247A, Human-Computer Interaction: Interaction Design Studio; and CS 376, Research Topics in Human-Computer Interaction.

For HCI electives, at least 9 additional units of HCI courses, chosen in consultation with the student's adviser. The following are examples of themes around which an elective program might be built: animation, business systems, computer-aided design, computer graphics, data interfaces, decision systems, design for disabilities, design principles, dialogue systems, digital art, digital media, education technology, game design, history of computers, information retrieval, intelligent interfaces, interaction design, Internet design, medical informatics, multimedia design, object-oriented design, philosophy of computation, social aspects of computing, usability analysis, virtual reality, and workplace computing.

*The Natural Language Technology (NLT) Track*—For the NLT core, in addition to the courses below, students must complete LINGUIST 280/CS 224N, Natural Language Processing, which can be used as the empirical methods course for Requirement B above.

- 1) An in-depth theory of English grammar course such as LINGUIST 221A, Foundations of English Grammar
- 2) A graduate-level semantics course (if not already taken as part of Requirement A) such as LINGUIST 232A, Lexical Semantics, or 230B, Semantics and Pragmatics
- 3) A two-course sequence in Computational Linguistics:
  - LINGUIST 180. Introduction to Computer Speech and Language Processing, and
  - LINGUIST 283. Programming and Algorithms for Natural Language Processing



For NLT electives, at least 9 additional units of natural language technology courses, chosen in consultation with the student's adviser.

*The Individually Designed Option*—Students wishing to design their own M.S. curriculum in Symbolic Systems must present a project plan as part of their application. This plan must be endorsed by the student's adviser prior to admission to the Symbolic Systems M.S. program. The application must also specify at least 20 units of course work that the student will take in support of the project.

Students are admitted under this option only if they present well-developed plans whose interdisciplinary character makes them inappropriate for any departmental master's program, but appropriate for Symbolic Systems.

## COURSES

**SYMBSYS 10. Symbolic Systems Forum**—A weekly lecture series, featuring different speakers who report on research of general interest to Symbolic Systems students and faculty. Regular attendance required for credit. May be repeated for credit.

*1 unit, Aut, Win, Spr (Davies, T)*

**SYMBSYS 100. Introduction to Cognitive Science**—(Same as LINGUIST 144, PHIL 190, PSYCH 130.) The history, foundations, and accomplishments of the cognitive sciences, including presentations by leading Stanford researchers in artificial intelligence, linguistics, philosophy, and psychology. Overview of the issues addressed in the Symbolic Systems major. GER:DB-SocSci

*4 units, Spr (Davies, T)*

**SYMBSYS 145. Cognition in Interaction Design**—Interactive systems from the standpoint of human cognition. Topics include skill acquisition, complex learning, reasoning, language, perception, methods in usability testing, special computational techniques such as intelligent and adaptive interfaces, and design for people with cognitive disabilities. Students conduct analyses of real world problems of their own choosing and redesign/analyze a project of an interactive system. GER:DB-SocSci

*3 units, Win (Shrager, J)*

**SYMBSYS 170/270. Decision Behavior: Theory and Evidence**—(Graduate students register for 270.) Introduction to the study of judgment and decision making, relating theory and evidence from disciplines such as psychology, economics, statistics, neuroscience, and philosophy. The development and critique of Homo economicus as a model of human behavior, and more recent theories based on empirical findings. Recommended: background in formal reasoning.

*3-4 units, not given this year (Davies, T)*

**SYMBSYS 205. Systems: Theory, Science, and Metaphor**—Systems science explores abstract properties of systems such as network connectivity, complexity, and emergence, with applications in natural, social, and artificial domains. How useful are these theories? Are their claims testable or generalizable? Do they change the way people think and talk? Topics announced during the previous quarter on course web site. Limited enrollment. Prerequisites: Symbolic Systems undergraduate core course in each of philosophy, psychology or linguistics, and computer science.

*3 units, not given this year (Davies, T)*

**SYMBSYS 206. Topics in the Philosophy of Neuroscience**—Does understanding the brain or computational models of the brain allow understanding of the mind? Recent literature on neurophilosophical and neuroskeptical approaches to the mind including perception, neurophenomenology, sensorimotor accounts, computational models, and eliminativism. Prerequisites: PHIL 80, and familiarity with philosophy or neuroscience, or consent of instructor. May be repeated for credit.

*3 units, Aut (Skokowski, P)*

**SYMBSYS 209. Battles Over Bits**—The changing nature of information in the Internet age and its relationship to human behavior. Philosophical assumptions underlying practices such as open source software development, file sharing, common carriage, and community wireless networks, contrasted with arguments for protecting private and commercial interests such as software patents, copy protection, copyright infringement lawsuits,

and regulatory barriers. Theory and evidence from disciplines including psychology, economics, computer science, law, and political science. Prerequisite: PSYCH 40, 55, 70, or SYMBSYS 202.

*3 units, Aut (Davies, T)*

**SYMBSYS 210. Learning Facial Emotions: Art versus Psychology**—Differences between art and psychology approaches to learning to recognize, feel, and empathetically respond to facial expressions. Computational learning theory, motivation measurement, and emotion and empathetic response measurement. Experiments with human subjects. Art lab. Prerequisites: Psychology or Computer Science course in learning, emotions, or HCI.

*3 units, Win (Wilkins, D; Davis-Kivelson, P)*

## RESEARCH

**SYMBSYS 91. Junior Honors Seminar**—Recommended for juniors doing an honors project during the following year. Defining a topic, choosing an adviser, considering overall goals. Resources at Stanford and some experiences of seniors discussed with guest speakers.

*2 units, Win (Davies, T)*

**SYMBSYS 190. Senior Honors Tutorial**—Under the supervision of their faculty honors adviser, students work on their senior honors project. May be repeated for credit.

*1-5 units, Aut, Win, Spr, Sum (Staff)*

**SYMBSYS 191. Senior Honors Seminar**—Recommended for seniors doing an honors project. Under the leadership of the Symbolic Systems program coordinator, students discuss, and present their honors project.

*2 units, Aut (Davies, T)*

**SYMBSYS 196. Independent Study**—Independent work under the supervision of a faculty member. Can be repeated for credit.

*1-15 units, Aut, Win, Spr, Sum (Staff)*

**SYMBSYS 290. Master's Degree Project**

*1-15 units, Aut, Win, Spr, Sum (Staff)*

**SYMBSYS 291. Master's Program Seminar**—Enrollment limited to students in the Symbolic Systems M.S. degree program. May be repeated for credit.

*1 unit, Aut, Win, Spr (Davies, T)*

## COGNATE COURSES

See respective department listings for course descriptions and General Education Requirements (GER) information. See degree requirements above or the program's student services office for applicability of these courses to a major or minor program.

**BIOSCI 150/250. Human Behavioral Biology**—(Same as HUMBIO 160)

*5 units, Spr (Sapolsky, R), alternate years, not given next year*

**CME 106. Introduction to Probability and Statistics for Engineers**—(Same as ENGR 155C.)

*3-4 units, Win, Sum (Khayms, V)*

**COMM 106/206. Communication Research Methods**

*4-5 units, Win (Gauthier, L; Groom, V)*

**COMM 169/269. Computers and Interfaces**

*4-5 units, Win (Nass, C)*

**CS 103A. Discrete Mathematics for Computer Science**

*3 units, Aut, Win (Plummer, R)*

**CS 103B. Discrete Structures**

*3 units, Win, Spr (Sahami, M)*

**CS 103X. Discrete Structures (Accelerated)**

*3-4 units, Win (Koltun, V)*

**CS 106A. Programming Methodology**—(Same as ENGR 70A.)

*3-5 units, Aut (Sahami, M), Win, Spr (Young, P), Sum (Staff)*

- CS 106B. Programming Abstractions**—(Same as ENGR 70B.)  
3-5 units, Aut (Staff), Win (Zelenski, J), Spr, Sum (Staff)
- CS 106X. Programming Abstractions (Accelerated)**—(Same as ENGR 70X.)  
3-5 units, Aut (Zelenski, J), Win (Cain, G)
- CS 107. Programming Paradigms**  
3-5 units, Aut, Spr (Cain, G)
- CS 108. Object-Oriented Systems Design**  
3-4 units, Aut, Win (Parlante, N)
- CS 121. Introduction to Artificial Intelligence**  
3 units, Spr (Latombe, J), Sum (Staff)
- CS 147. Introduction to Human-Computer Interaction Design**  
3-4 units, Aut (Klemmer, S)
- CS 154. Introduction to Automata and Complexity Theory**  
3-4 units, Aut (Dill, D), Spr (Motwani, R), Sum (Staff)
- CS 161. Design and Analysis of Algorithms**  
3-4 units, Aut (Plotkin, S), Win (Roughgarden, T), Sum (Staff)
- CS 201. Computers, Ethics, and Social Responsibility**  
3-4 units, Win (Johnson, M)
- CS 205A. Mathematical Methods for Robotics, Vision, and Graphics**  
3 units, Aut (Fedkiw, R)
- CS 221. Artificial Intelligence: Principles and Techniques**  
3-4 units, Aut (Ng, A)
- CS 223A. Introduction to Robotics**  
3 units, Win (Khatib, O)
- CS 223B. Introduction to Computer Vision**  
3 units, Win (Kosecka, J)
- CS 224M. Multi-Agent Systems**  
3 units, Win (Shoham, Y)
- CS 228. Probabilistic Models in Artificial Intelligence**  
3 units, Win (Koller, D)
- CS 229. Machine Learning**  
3 units, Aut (Ng, A)
- CS 247. Human-Computer Interaction Design Studio**  
3-4 units, Win (Winograd, T)
- CS 249B. Advanced Object-Oriented Programming**  
3 units, Win (Cheriton, D)
- ECON 51. Economic Analysis II**  
5 units, Aut (Tendall, M), Win (Einav, L), Sum (Staff)
- ECON 160. Game Theory and Economic Applications**  
5 units, Win (Cojoc, D)
- EDUC 218. Topics in Cognition and Learning: Play**  
3 units, Aut (Schwartz, D)
- EE 178. Probabilistic Systems Analysis**  
3 units, Win (El Gamal, A)
- EE 376A. Information Theory**  
3 units, Win (Cover, T)
- ENGR 62. Introduction to Optimization**—(Same as MS&E 111.)  
4 units, Aut (Goel, A), Spr (Van Roy, B)
- FRENGEN 295. Science, Technology, and Society in Europe and the U.S.: Ethical Debates and Controversies**  
3-5 units, Win (Dupuy, J)
- LINGUIST 1. Introduction to Linguistics**  
4 units, Aut (Eckert, P; Sag, I), Spr (Staff)
- LINGUIST 105/205A. Phonetics**  
4 units, Spr (Staff)
- LINGUIST 110. Introduction to Phonetics and Phonology**  
4 units, Spr (Anttila, A)
- LINGUIST 120. Introduction to Syntax**  
4 units, Aut (Wasow, T)
- LINGUIST 124A/224A. Introduction to Formal Universal Grammar**  
4 units, Spr (Bresnan, J)
- LINGUIST 130A. Introduction to Linguistic Meaning**  
4 units, Spr (Staff)
- LINGUIST 130B. Introduction to Lexical Semantics**  
4 units, Win (Fong, V)
- LINGUIST 140/240. Language Acquisition I**  
4 units, Aut (Clark, E)
- LINGUIST 180. Introduction to Computational Linguistics**  
4 units, Aut (Jurafsky, D)
- LINGUIST 187/287. Grammar Engineering**  
1-4 units, Win (Flickinger, D; Oepen, S)
- LINGUIST 210A. Phonology**  
4 units, Aut (Anttila, A)
- LINGUIST 210B. Advanced Phonology**  
4 units, Win (Anttila, A)
- LINGUIST 222A. Foundations of Syntactic Theory I**  
2-4 units, Aut (Levin, B)
- LINGUIST 230A. Introduction to Semantics and Pragmatics**  
2-4 units, Win (Peters, S)
- LINGUIST 232A. Lexical Semantics**  
2-4 units, Spr (Levin, B)
- LINGUIST 241. Language Acquisition II**  
1-4 units, Win (Clark, E)
- MATH 103. Matrix Theory and Its Applications**  
3 units, Aut (Milanov, T), Win, Spr (Nedelec, L), Sum (Staff)
- MATH 113. Linear Algebra and Matrix Theory**  
3 units, Aut (Vasy, A), Win (Cohen, R)
- MATH 151. Introduction to Probability Theory**  
3 units, Win (Liu, T)
- ME 115. Human Values in Design**  
3 units, Win (Boyle, B)
- MS&E 120. Probabilistic Analysis**  
5 units, Aut (Shachter, R)
- MS&E 121. Introduction to Stochastic Modeling**  
4 units, Win (Glynn, P)
- MS&E 201. Dynamic Systems**  
3-4 units, Spr (Tse, E)
- MUSIC 151. Psychophysics and Cognitive Psychology for Musicians**  
4 units, Spr (Berger, J)
- MUSIC 220A. Fundamentals of Computer-Generated Sound**  
2-4 units, Aut (Chafe, C; Wang, G)
- MUSIC 220B. Compositional Algorithms, Psychoacoustics, and Spatial Processing**  
2-4 units, Win (Wang, G)
- MUSIC 250A. HCI Theory and Practice**  
3-4 units, Aut, Win (Staff)

- MUSIC 253. Musical Information: An Introduction**  
1-4 units, Win (Selfridge-Field, E)
- MUSIC 254. Applications of Musical Information: Query, Analysis, and Style Simulation**  
1-4 units, Spr (Selfridge-Field, E)
- NBIO 206. The Nervous System**  
7-8 units, Win (Clandinin, T)
- NBIO 218. Neural Basis of Behavior**  
4 units, Spr (Raymond, J; Knudsen, E), alternate years, not given next year
- PHIL 20. Introduction to Moral Philosophy**—(Same as ETHICSOC 20)  
5 units, Spr (Schapiro, T)
- PHIL 30. Introduction to Political Philosophy**—(Same as ETHICSOC 30, POLISCI 3.)  
5 units, Aut (Hussain, N)
- PHIL 60. Introduction to Philosophy of Science**—(Same as HPS 60)  
5 units, Aut (Longino, H)
- PHIL 80. Mind, Matter, and Meaning**—WIM for Symbolic Systems majors.  
5 units, Win (Lawlor, K), Spr (Burgess, A)
- PHIL 102. Modern Philosophy, Descartes to Kant**  
4 units, Aut (Dunlop, K)
- PHIL 150/250. Basic Concepts in Mathematical Logic**  
4 units, Aut (Wasow, T)
- PHIL 150X. Basic Concepts in Mathematical Logic**  
2 units, Aut (Wasow, T)
- PHIL 151. First-Order Logic**—(Same as PHIL 251)  
4 units, Win (Pauly, M)
- PHIL 152/252. Computability and Logic**  
4 units, Spr (Pauly, M)
- PHIL 154/254. Modal Logic**  
4 units, Aut (Mints, G)
- PHIL 162/262. Philosophy of Mathematics**—(Same as MATH 161.)  
4 units, Spr (Feferman, S)
- PHIL 164/264. Central Topics in the Philosophy of Science: Theory and Evidence**  
4 units, Aut (Ryckman, T)
- PHIL 167B/267B. Philosophy, Biology, and Behavior**  
4 units, Win (Longino, H)
- PHIL 181/281. Philosophy of Language**  
4 units, Win (Føllesdal, D)
- PHIL 184/284. Theory of Knowledge**  
4 units, Spr (Lawlor, K)
- PHIL 186/286. Philosophy of Mind**  
4 units, Win (Perry, J)
- PHIL 358. Rational Agency and Intelligent Interaction**—(Same as CS 222.)  
3 units, Spr (Shoham, Y; van Benthem, J)
- PSYCH 30. Introduction to Perception**  
3 units, Win (Grill-Spector, K)
- PSYCH 45. Introduction to Learning and Memory**  
3 units, Spr (Wagner, A)
- PSYCH 55. Introduction to Cognition and the Brain**  
4 units, Win (Boroditsky, L)
- PSYCH 70. Introduction to Social Psychology**  
4 units, Spr (Tormala, T)
- PSYCH 120. Cellular Neuroscience: Cell Signaling and Behavior**—(Same as BIOSCI 153.)  
4 units, Aut (Wine, J)
- PSYCH 131/262. Language and Thought**  
4 units, Aut (Clark, H)
- PSYCH 137/239A. Birds to Words: Cognition, Communication, and Language**—(Same as HUMBIO 145.)  
4 units, Aut (Fernald, A; Ramscar, M)
- PSYCH 143. Developmental Anomalies**  
3 units, Spr (Johnson, S)
- PSYCH 202. Cognitive Neuroscience**  
3 units, Spr (Wandell, B; Grill-Spector, K)
- PSYCH 204A. Computational Neuroimaging**  
1-3 units, Spr (Wandell, B)
- PSYCH 250. High-level Vision**  
1-3 units, Spr (Grill-Spector, K), alternate years, not given next year
- PSYCH 251. Affective Neuroscience**  
3 units, Win (Knutson, B)
- PSYCH 252. Statistical Methods for Behavioral and Social Sciences**—(Same as NENS 202.)  
1-6 units, Aut (Thomas, E)
- PSYCH 272. Special Topics in Psycholinguistics**  
1-3 units, Spr (Clark, H)
- SOC 126/226. Introduction to Social Networks**  
5 units, Aut (Hillmann, H)
- STATS 110. Statistical Methods in Engineering and the Physical Sciences**  
4-5 units, Aut (Srinivasan, B), Sum (Staff)
- STATS 116. Theory of Probability**  
3-5 units, Aut (Donoho, D), Spr (Wong, W), Sum (Staff)
- STATS 191. Introduction to Applied Statistics**  
3-4 units, Win (Zhang, N)
- STATS 200. Introduction to Statistical Inference**  
3 units, Win (Romano, J), Sum (Staff)

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