SYMBOLIC SYSTEMS

Courses offered by the Symbolic Systems Program are listed under the subject code SYMSYS on the Stanford Bulletin's ExploreCourses web site.

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 such as 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.

Mission of the Undergraduate Program in Symbolic Systems

The undergraduate program in Symbolic Systems is an interdisciplinary program focusing on the relationships between natural and artificial systems that use symbols to communicate and to represent information. The mission of the program is to prepare majors with the vocabulary, theoretical background, and technical skills necessary to research questions about language, information, and intelligence, both human and machine. The curriculum offers a combination of traditional humanistic approaches to these questions as well as a training and familiarity with contemporary developments in the science and technology of computation. Students in the major take courses in cognitive science, computer programming, logic and computational theory, probability, cognitive psychology, philosophy of mind, linguistics, and artificial intelligence. The program prepares students for a variety of careers in the private and public sectors, especially those involving the human-facing sides of information systems/technology, as well as for further study and research in the cognitive and/or information sciences.

Learning Outcomes (Undergraduate)

The program expects its undergraduate majors to be able to demonstrate the following learning outcomes. These learning outcomes are used in evaluating students and the Symbolic Systems Program. Students are expected to demonstrate:

1. ability to apply formal, philosophical, and/or computational analysis to experimental designs and data and vice versa.

2. ability to understand multiple formal, philosophical, and/or computational frameworks and how they are related to each other.

3. ability to map real world problems or observed phenomena onto formal, philosophical and/or computational frameworks and vice versa.

Learning Outcomes (Graduate)

The purpose of the master's program is to further develop knowledge and skills in Symbolic Systems and to prepare students for a professional career or doctoral studies. This is achieved through completion of courses representing each of the core disciplines of Symbolic Systems as well as an individualized course program in support of the completion of a Master's thesis.

Bachelor of Science in Symbolic Systems

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 five 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. With the exception of the advanced small seminar requirement, courses cannot be used towards more than one area of the core requirements. For additional information, see the Symbolic Systems web site (http://symsys.stanford.edu/undergraduate_programs). *Note:* Students matriculating in the Class of 2018 or later must take SYMSYS 1 Minds and Machines (formerly SYMSYS 100) before their declaration of the Symbolic Systems undergraduate major can be approved.

1. Introductory Core Course

Students matriculating in the Class of 2018 or later must take SYMSYS 1 Minds and Machines (formerly SYMSYS 100) before their declaration of the Symbolic Systems undergraduate major can be approved.

		Units
SYMSYS 1	Minds and Machines (formerly SYMSYS 100)	4

2. Continuous Fundamentals Level 1—Single Variable Calculus

Select one of the following Series:

		Units
Series A		
10 units of Advanced Placement Calculus credit		10
Series B		
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
Series C		

Equivalent preparation in Single Variable Calculus, as judged by student

3. Continuous Fundamentals Level 2—Multivariable Calculus

		Units
Select one of the following: [1]		
CME 100	Vector Calculus for Engineers	5
CME 100A	Vector Calculus for Engineers, ACE	6
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
MATH 51A	Linear Algebra, Multivariable Calculus, and Modern Applications, ACE	6
MATH 61CM	Modern Mathematics: Continuous Methods	5
MATH 61DM	Modern Mathematics: Discrete Methods	5

[1] The following are optional but recommended and may be required for some higher level courses:
- Additional courses in the Math 50 series
  - MATH 52 Integral Calculus of Several Variables
  - MATH 53 Ordinary Differential Equations with Linear Algebra
- Or additional courses in the CME 100 series
  - CME 102 Ordinary Differential Equations for Engineers (same as ENGR 155A)
  - CME 104 Linear Algebra and Partial Differential Equations for Engineers (same as ENGR 155B)
- Or additional courses in the Math 60 CM series
  - MATH 62CM Modern Mathematics: Continuous Methods
  - MATH 63CM Modern Mathematics: Continuous Methods

4. Continuous Fundamentals Level 3—Probability and Statistics

		Units
Select one of the following:		
CS 109	Introduction to Probability for Computer Scientists	3-5
STATS 110	Statistical Methods in Engineering and the Physical Sciences	5
STATS 116	Theory of Probability	4
EE 178	Probabilistic Systems Analysis	4
MS&E 120	Probabilistic Analysis	5
CME 106/ENGR 155C	Introduction to Probability and Statistics for Engineers	4

5. Discrete Fundamentals

		Units
a. Computing Level 1		3-5
Select one of the following:		
CS 106A	Programming Methodology	3-5
CS 106AP	Programming Methodology in Python	3-5
Or equivalent preparation, as judged by student		
b. Computing Level 2		3-5
Select one of the following:		
CS 106B	Programming Abstractions	3-5
CS 106X	Programming Abstractions (Accelerated)	3-5
c. Logic and Computational Theory		3-5
Select one of the following:		
CS 103	Mathematical Foundations of Computing	3-5
PHIL 150	Mathematical Logic	4

6. Technical Depth

Two courses chosen from the list below (from either the same or different areas), appropriate to a student's concentration. Students concentrating in HCI, AI, or Computer Music must take CS 107 Computer Organization and Systems. Other concentrations may also restrict the particular courses that can be taken to fulfill this requirement.

		Units
Area A. Computer Programming		
CS 107	Computer Organization and Systems (required for HCI, AI, or Computer Music)	3-5
CS 107E	Computer Systems from the Ground Up	3-5
Area B. Computational Theory		
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 161	Design and Analysis of Algorithms	3-5
PHIL 151A	Recursion Theory	4
Area C. Logic		
CS 157	Computational Logic	3
PHIL 151	Metalogic	4
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
Area D. Decision Theory/Game Theory		
CS 238	Decision Making under Uncertainty	3-4
ECON 160	Game Theory and Economic Applications	5
ECON 180	Honors Game Theory	5
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	3-4
Area E. Probability and Statistics		
STATS 200	Introduction to Statistical Inference	3
STATS 217	Introduction to Stochastic Processes I	2-3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 246	Mining Massive Data Sets	3-4
MS&E 221	Stochastic Modeling	3

7. Philosophical Foundations Level 1

		Units
Introductory Philosophy		3-5
Select one of the following:		
PHIL 1	Introduction to Philosophy	5
PHIL 2	Introduction to Moral Philosophy	5
PHIL 60	Introduction to Philosophy of Science	5
PHIL 102	Modern Philosophy, Descartes to Kant	4
PHIL 135	Existentialism	4
THINK 24	Evil	4
ESF 7	Education as Self-Fashioning: The Transformation of the Self	7
All 3 of the following (must complete entire sequence):		
SLE 91 & SLE 92 & SLE 93	Structured Liberal Education and Structured Liberal Education and Structured Liberal Education	
Other introductory courses taught in the Philosophy Department, if approved by the Program Director or Associate Director		

8. Philosophical Foundations Level 2

		Units
PHIL 80	Mind, Matter, and Meaning	5

9. Philosophical Foundations Level 3

Units

Select one of the following advanced undergraduate course in metaphysics/epistemology (post-PHIL 80):

PHIL 107B	Plato's Later Metaphysics and Epistemology	4
PHIL 167D	Philosophy of Neuroscience	4
PHIL 173B	Metaethics	4
PHIL 175	Philosophy of Law	4
PHIL 180	Metaphysics	4
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 181	Philosophy of Language	4
PHIL 182	Advanced Philosophy of Language	4
PHIL 184	Epistemology	4
PHIL 186	Philosophy of Mind	4
PHIL 187	Philosophy of Action	4

Note: Symbolic Systems majors must take PHIL 182 for 3 or more units.

10. Cognition and Neuroscience

		Units
Introductory Cognition and Neuroscience		
Select one of the following:		
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
An additional undergraduate course in cognition and/or neurosciences		
Select one of the following:		
BIO 150	Human Behavioral Biology	5
HUMBIO 3B	Behavior, Health, and Development	5
PSYCH 30	Introduction to Perception	4
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 60	Introduction to Developmental Psychology	3
PSYCH 70	Self and Society: Introduction to Social Psychology	4
PSYCH 141	Cognitive Development	3
PSYCH 154	Judgment and Decision-Making	3

11. Natural Language

		Units
Language and Mind		4
Select one of the following:		
LINGUIST 1	Introduction to Linguistics	4
LINGUIST 61S	Language Evolution and Change	2-3
LINGUIST 67S	The Role of Language in Perception and Cognition	3
LINGUIST 140	Learning to Speak: An Introduction to Child Language Acquisition	4
Linguistic Theory		4
Select one of the following:		
LINGUIST 105	Phonetics	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 112	Seminar in Phonology: Stress, Tone, and Accent	4
LINGUIST 120	Introduction to Syntax	4
LINGUIST 121A	The Syntax of English	4
LINGUIST 121B	Crosslinguistic Syntax	4
LINGUIST 130A/230A	Introduction to Semantics and Pragmatics	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 184		4
LINGUIST 281	Computational Models of Linguistic Formalism	1-4

12. Computation and Cognition

		Units
A course applying core technical skills to cognition		
Select one of the following:		
CS 131	Computer Vision: Foundations and Applications	3-4
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 230	Deep Learning	3-4
CS 234	Reinforcement Learning	3
EE 104	Introduction to Machine Learning	3-5
LINGUIST 180/ CS 124	From Languages to Information	3-4
LINGUIST 182	Computational Theories of Syntax	3-4
NENS 220	Computational Neuroscience	4
PSYCH 204	Computation and Cognition: The Probabilistic Approach	3
PSYCH 209	Neural Network Models of Cognition	4
PSYCH 242	Theoretical Neuroscience	3
PSYCH 249	Large-Scale Neural Network Modeling for Neuroscience	3

Advanced Small Seminar Requirement

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 SYMSYS 200 through SYMSYS 209 are acceptable, as are other courses as listed in the Advanced Small Seminar section of the Symbolic Systems website. Total enrollment must not exceed 20 students for a course to be approved as fulfilling the Advanced Small Seminar Requirement. A course taken to fulfill this requirement can also be counted toward another requirement, as part of either the core or a student's concentration, 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 five 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

Note: A course may not count toward both a core and a concentration requirement, unless it is applied to the Advanced Small Seminar area within the core. A course that is applied to the Advanced Small Seminar

requirement may also be counted toward a student's concentration or toward another core requirement, if appropriate, but not to both.

Individually Designed Concentrations (IDCs)

Individually Designed Concentrations (IDCs) consist of five courses in a coherent subject area related to symbolic systems. This relationship may be established through inclusion in an IDC of two or more courses that connect the proposed concentration to the core, i.e. courses that (a) directly apply disciplines included in the core and (b) are related by topic or methodology to the other courses in the proposed concentration.

Course selection is to be made in consultation with the student's adviser and is subject to approval by the adviser, the Associate Director, and the Director. For examples of IDCs completed by past SSP students, consult the list of alumni and apply the filter "Individually Designed Concentration".

Approval of an IDC must take place no less than two full quarters before a student plans to graduate, e.g. prior to the first day of Winter Quarter of the senior year if a student intends to graduate in June of that year. Failure to obtain approval by the required date will necessitate either completing the requirements for one of the suggested concentrations, or delaying graduation to the end of the second full quarter following approval of an IDC.

To get a proposed IDC approved, send an email message to symsys-directors at lists.stanford.edu, cc'd to your prospective concentration adviser, stating that the adviser has approved your proposal, and giving a title, one-paragraph description, and course plan for your proposed concentration.

Undergraduate Research

The program 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.

Summer Internships: students work on SSP-related faculty research projects. Application procedures are announced in the Winter Quarter for SSP majors.

Research Assistantships: other opportunities to work on faculty research projects are typically announced to SSP majors as they arise during the academic year.

Independent Study: under faculty supervision. For course credit, students should enroll in SYMSYS 196 Independent Study.

Contact SSP for more information on any of these possibilities, or see the Symbolic Systems (http://symsys.stanford.edu) web site. In addition, see the Undergraduate Advising and Research (https://undergrad.stanford.edu/opportunities/research.html) web site for information on UAR grants and scholarships supporting student research projects at all levels.

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 SYMSYS 190 Senior Honors Tutorial any quarter while a student is working on an honors project. SYMSYS 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.

Minor in Symbolic Systems

Students may minor in Symbolic Systems by completing either Option 1 or Option 2. For additional information see the Symbolic Systems minors web site (http://symsys.stanford.edu/viewing/htmldocument/13635).

Option 1

One course in each of the following core areas (please note that several of these courses have prerequisites):

		Units
a. Cognition		
Select one of the following:		
SYMSYS 1	Minds and Machines (formerly SYMSYS 100)	4
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
b. Logic and Computation		
Select one of the following:		
PHIL 150	Mathematical Logic	4
PHIL 150E	Logic in Action: A New Introduction to Logic	4
PHIL 151	Metalogic	4
CS 103	Mathematical Foundations of Computing	3-5
c. Computer Programming		
Select one of the following:		
CS 106B	Programming Abstractions	3-5
CS 106X	Programming Abstractions (Accelerated)	3-5
CS 107	Computer Organization and Systems	3-5
d. Philosophical Foundations		
Select one of the following:		
SYMSYS 1	Minds and Machines (formerly SYMSYS 100)	4
PHIL 80	Mind, Matter, and Meaning	5
e. Linguistic Theory		
Select one of the following:		
LINGUIST 105	Phonetics	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 120	Introduction to Syntax	4
LINGUIST 121A	The Syntax of English	4
LINGUIST 121B	Crosslinguistic Syntax	4
LINGUIST 130A	Introduction to Semantics and Pragmatics	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 184		4
f. Computation and Cognition		3-4
Select one of the following:		
APPPHYS 293	Theoretical Neuroscience	3
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
LINGUIST 180	From Languages to Information	3-4
LINGUIST 182	Computational Theories of Syntax	3-4
PSYCH 204	Computation and Cognition: The Probabilistic Approach	3
PSYCH 209	Neural Network Models of Cognition	4
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science	3

[1] SYMSYS 1 Minds and Machines (formerly SYMSYS 100) may not be counted for both areas 'a' and 'd'.

Option 2

SYMSYS 1 Minds and Machines (formerly SYMSYS 100), plus an interdisciplinary SSP concentration listed on the SSP (http://symsys.stanford.edu/viewing/htmldocument/16190) web site. 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.

Coterminal Master's Degrees in Symbolic Systems

Many SSP majors also complete coterminal M.S. or M.A. degrees in affiliated departments. In addition to the Symbolic Systems M.S. program, the Department of Philosophy offers a Special Program in Symbolic Systems track for interdisciplinary graduate level work leading to the Master of Arts in Philosophy (http://www.stanford.edu/dept/registrar/bulletin/6567.htm).

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

Master of Science in Symbolic Systems

The University's basic requirements for the M.S. degree are discussed in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin.

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 "Coterminal Bachelor's and Master's Degrees (http://exploredegrees.stanford.edu/cotermdegrees)" section of this bulletin. 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 the Symbolic Systems (http://symsys.stanford.edu/viewing/htmldocument/13623) web site.

Symbolic Systems also offers a Joint Degree with Law School (M.S./J.D.).

Degree 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 as part of the 45 unit program must be taken for a letter grade unless the course is offered S/NC only. 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. For additional information, see the Symbolic Systems web site (http://symsys.stanford.edu/graduate_programs).

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

1. Submission to the Symbolic Systems Program office and approval of the following pre-project research documents:
   a. Project Area Statement, endorsed with a commitment from a student's prospective project adviser 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 a coherent plan of study, to be approved by the Graduate Studies Director in consultation with the student's adviser and designed to support a student's project. An initial plan of study should be delineated on the Program Proposal Form (http://studentaffairs.stanford.edu/sites/default/files/registrar/files/progpropma.pdf) prior to the end of the student's first quarter of study, as required by the University, to be modified at the time of the Project Area Statement with the approval of a student's adviser and the Graduate Studies Director. The final version of the Program Proposal, which should specify all the courses the student has taken and proposes as fulfillment of the unit requirements for the degree, is due by the end of Finals Week in the quarter prior to the student's expected graduation quarter (i.e. end of Winter Quarter for a student graduating in the Spring). The plan of study must include courses taken for 3 units or more each that are more advanced than the Symbolic Systems undergraduate core in four main skill areas: formal, empirical, computational, and philosophical; and in at least three of the following departments: Computer Science, Linguistics, Philosophy, and Psychology. More advanced courses in each of the skill areas are defined as follows:

a) Formal: a course in logic and computational theory beyond the level of PHIL 151 Metalogic. The courses below have been approved. Other courses may be approved if appropriate.

- PHIL 252 Computability and Logic
- PHIL 254 Modal Logic
- PHIL 350A Model Theory
- PHIL 355 Logic and Social Choice
- PHIL 357 Research Seminar on Logic and Cognition
- CS 154 Introduction to Automata and Complexity Theory

- CS 157 Computational Logic
- CS 161 Design and Analysis of Algorithms

b) Empirical: a course drawing on experimental or observational data or methods, beyond the level of PSYCH 55, LINGUIST 121A, 121B or 130A. The courses below are examples of those that have been approved. Other courses may be approved if appropriate.

- CS 224N Natural Language Processing with Deep Learning
- CS 376 Human-Computer Interaction Research
- LINGUIST 230B Semantics and Pragmatics I
- LINGUIST 241 Language Acquisition II
- NBIO 206 The Nervous System
- NBIO 258 Information and Signaling Mechanisms in Neurons and Circuits
- PSYCH 204 Computation and Cognition: The Probabilistic Approach
- PSYCH 204A Human Neuroimaging Methods
- PSYCH 209 Neural Network Models of Cognition
- PSYCH 252 Statistical Methods for Behavioral and Social Sciences
- PSYCH 254 Affective Neuroscience
- STATS 200 Introduction to Statistical Inference
- SYMSYS 245 Cognition in Interaction Design

c) Computational: a course involving programming beyond the level of CS 107. The courses below have been approved. Other courses may be approved if appropriate.

- CS 108 Object-Oriented Systems Design
- CS 110 Principles of Computer Systems
- CS 124 From Languages to Information
- CS 142 Web Applications
- CS 143 Compilers
- CS 148 Introduction to Computer Graphics and Imaging
- CS 221 Artificial Intelligence: Principles and Techniques
- CS 224N Natural Language Processing with Deep Learning
- CS 224W Analysis of Networks

d) Philosophical: a course in the area of Philosophy of Mind/Language/Science/Epistemology or Metaphysics at the 200 level or above, certified by the instructor as worthy of graduate credit. The courses below are examples of those that have been approved. Other courses may be approved if appropriate.

- PHIL 264 Central Topics in the Philosophy of Science: Theory and Evidence
- PHIL 267B Philosophy, Biology, and Behavior
- PHIL 267D Philosophy of Neuroscience
- PHIL 281 Philosophy of Language
- PHIL 281C Slurs and derogatory language
- PHIL 283 Self-knowledge and Metacognition
- PHIL 285B Philosophy of Perception
- PHIL 286 Philosophy of Mind
- PHIL 287
- PHIL 383B What's an Inference?

3. Completion of three quarters of SYMSYS 291 Master's Program Seminar.

4. Completion of a substantial project appropriate to the program plan, represented by the M.S. Thesis, the last of the the M.S research documents (http://symsys.stanford.edu/viewing/htmldocument/13678). 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. A copy of the thesis must be submitted (in both print and electronic forms) to the Associate Director of Symbolic Systems, with the print version including the signatures of each reader indicating approval of the thesis for the degree of Master of Science, no later than 12 noon on the day of the University Dissertation/Thesis Submission Deadline (https://studentaffairs.stanford.edu/registrar/students/dissertation-thesis) for the quarter of a student's graduation.

Graduate Advising Expectations

The Symbolic Systems Program is committed to providing academic advising in support of graduate student scholarly and professional development. When most effective, this advising relationship entails collaborative and sustained engagement by both the adviser and the advisee. As a best practice, advising expectations should be periodically discussed and reviewed to ensure mutual understanding. Both the adviser and the advisee are expected to maintain professionalism and integrity.

Faculty advisers guide students in key areas such as selecting courses, designing and conducting research, developing of teaching pedagogy, navigating policies and degree requirements, and exploring academic opportunities and professional pathways.

Graduate students are active contributors to the advising relationship, proactively seeking academic and professional guidance and taking responsibility for informing themselves of policies and degree requirements for their graduate program.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)" section of this bulletin.

Faculty

Director: Kenneth A. Taylor

Director of Graduate Studies: Kenneth A. Taylor

Associate Director: Todd Davies

Program Committee: Jeremy Bailenson, Michael Bernstein, Ray Briggs, Todd Davies, Judith Degen, Michael C. Frank, Noah Goodman, Thomas Icard, Daniel Jurafsky, Daniel Lassiter, Krista Lawlor, Christopher Manning, James McClelland, Stanley Peters, Christopher Potts, Mehran Sahami, Kenneth A. Taylor, Johan van Benthem, Thomas A. Wasow

Program Faculty:

Aeronautics and Astronautics: Mykel Kochenderfer (Assistant Professor)

Biology: Deborah Gordon (Professor)

Classics: Reviel Netz (Professor)

Communication: Jeremy Bailenson (Professor), Jeff Hancock (Professor), Byron Reeves (Professor), Frederick Turner (Professor)

Computer Science: Maneesh Agrawala (Professor), Michael Bernstein (Assistant Professor), David Dill (Professor, emeritus), Michael Genesereth (Associate Professor), Oussama Khatib (Professor), Daphne Koller (Adjunct Professor), James Landay (Professor), Jean-Claude Latombe (Professor, emeritus), Marc Levoy (Professor, emeritus), Christopher Manning (Professor), Andrew Ng (Adjunct Professor), Nils Nilsson (Professor, emeritus), Vaughan Pratt (Professor, emeritus), Eric Roberts (Professor, emeritus), Mehran Sahami (Professor, Teaching), Yoav Shoham (Professor, emeritus), Sebastian Thrun (Adjunct Professor), Terry Winograd (Professor, emeritus)

Economics: Muriel Niederle (Professor)

Education: Raymond P. McDermott (Professor, emeritus), Roy Pea (Professor), Daniel Schwartz (Professor)

Electrical Engineering: Krishna Shenoy (Professor)

French and Italian: Jean-Pierre Dupuy (Professor)

Genetics: Russ B. Altman (Professor)

Graduate School of Business: Baba Shiv (Professor)

History: Jessica G. Riskin (Professor)

Linguistics: Arto Anttila (Associate Professor), Joan Bresnan (Professor, emerita), Eve Clark (Professor, emerita), Cleo Condoravdi (Professor Research), Judith Degen (Assistant Professor), Penelope Eckert (Professor), Daniel Jurafsky (Professor), Ronald Kaplan (Adjunct Professor), Lauri Karttunen (Adjunct Professor), Martin Kay (Professor), Paul Kiparsky (Professor), Daniel Lassiter (Assistant Professor), Beth Levin (Professor), Christopher Manning (Professor), Stanley Peters (Professor, emeritus), Christopher Potts (Professor), Meghan Sumner (Associate Professor), Thomas A. Wasow (Professor, emeritus), Annie Zaenen (Adjunct Professor)

Management Science and Engineering: Sharad Goel (Assistant Professor), Pamela Hinds (Professor)

Mathematics: Persi Diaconis (Professor)

Mechanical Engineering: Sean Follmer (Assistant Professor)

Medicine: Russ B. Altman (Professor), Mark Musen (Professor)

Music: Jonathan Berger (Professor), Christopher Chafe (Professor), Eleanor Selfridge-Field (Adjunct Professor), Ge Wang (Associate Professor)

Neurobiology: William T. Newsome (Professor), Jennifer Raymond (Professor)

Philosophy: Michael Bratman (Professor), Ray Briggs (Professor), Mark Crimmins (Associate Professor), John Etchemendy (Professor), Dagfinn Føllesdal (Professor, emeritus), Thomas Icard III (Assistant Professor), Krista Lawlor (Professor), Anna-Sara Malmgren (Assistant Professor), John Perry (Professor, emeritus), Brian Skyrms (Professor), Kenneth Taylor (Professor), Johan van Benthem (Professor), Thomas A. Wasow (Professor, emeritus)

Psychiatry and Behavioral Sciences: Vinod Menon (Professor)

Psychology: Herbert H. Clark (Professor, emeritus), Anne Fernald (Associate Professor), Michael C. Frank (Associate Professor), Justin Gardner (Assistant Professor), Noah Goodman (Associate Professor), Kalanit Grill-Spector (Professor), Hyowon Gweon (Assistant Professor), Brian Knutson (Professor), Ellen Markman (Professor), James McClelland (Professor), Russell Poldrack (Professor), Barbara Tversky (Professor, emerita), Anthony Wagner (Professor), Brian Wandell (Professor), Daniel Yamins (Assistant Professor), Jamil Zaki (Assistant Professor)

Statistics: Persi Diaconis (Professor), Susan P. Holmes (Professor)

Symbolic Systems: Todd Davies (Associate Director), Jeff Shrager (Adjunct Professor), Paul Skokowski (Adjunct Professor)

Other Affiliates: David Barker-Plummer (CSLI Engineering Research Associate), Keith Devlin H-STAR Operation Senior Researcher), Daniel Flickinger (CSLI Research and Development Engineer)

Cognate Courses for the Bachelor's Degree

The following is a list of cognate courses that may be applied to the B.S. in Symbolic Systems. Click on the course or see ExploreCourses for course descriptions and General Education Requirements (GER) information. Courses taken for a Symbolic Systems degree or Minor must be taken for 3 units (or more). See Degree Requirements for details.

Core

		Units
APPPHYS 293	Theoretical Neuroscience	3
BIO 150	Human Behavioral Biology	5
CME 100	Vector Calculus for Engineers	5
CME 100A	Vector Calculus for Engineers, ACE	6
CME 106	Introduction to Probability and Statistics for Engineers	4
CS 103	Mathematical Foundations of Computing	3-5
CS 106A	Programming Methodology	3-5
CS 106B	Programming Abstractions	3-5
CS 106X	Programming Abstractions (Accelerated)	3-5
CS 107	Computer Organization and Systems	3-5
CS 107E	Computer Systems from the Ground Up	3-5
CS 109	Introduction to Probability for Computer Scientists	3-5
CS 124	From Languages to Information	3-4
CS 131	Computer Vision: Foundations and Applications	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 157	Computational Logic	3
CS 161	Design and Analysis of Algorithms	3-5
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 238	Decision Making under Uncertainty	3-4
CS 246	Mining Massive Data Sets	3-4
ECON 160	Game Theory and Economic Applications	5
ECON 180	Honors Game Theory	5
EE 178	Probabilistic Systems Analysis	4
ENGR 155C	Introduction to Probability and Statistics for Engineers	4
ESF 7	Education as Self-Fashioning: The Transformation of the Self	7
ETHICSOC 20	Introduction to Moral Philosophy	5
HUMBIO 3B	Behavior, Health, and Development	5
LINGUIST 1	Introduction to Linguistics	4
LINGUIST 105	Phonetics	4
LINGUIST 106	Introduction to Speech Perception	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 120	Introduction to Syntax	4
LINGUIST 121A	The Syntax of English	4
LINGUIST 121B	Crosslinguistic Syntax	4
LINGUIST 130A	Introduction to Semantics and Pragmatics	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 140	Learning to Speak: An Introduction to Child Language Acquisition	4

LINGUIST 180	From Languages to Information	3-4
LINGUIST 182	Computational Theories of Syntax	3-4
LINGUIST 230A	Introduction to Semantics and Pragmatics	4
LINGUIST 281	Computational Models of Linguistic Formalism	1-4
LINGUIST 282	Computational Theories of Syntax	3-4
MATH 19	Calculus	3
MATH 20	Calculus	3
MATH 21	Calculus	4
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
MATH 51A	Linear Algebra, Multivariable Calculus, and Modern Applications, ACE	6
MATH 151	Introduction to Probability Theory	3
MS&E 120	Probabilistic Analysis	5
MS&E 220	Probabilistic Analysis	3-4
MS&E 221	Stochastic Modeling	3
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	3-4
NENS 220	Computational Neuroscience	4
PHIL 1	Introduction to Philosophy	5
PHIL 2	Introduction to Moral Philosophy	5
PHIL 60	Introduction to Philosophy of Science	5
PHIL 80	Mind, Matter, and Meaning	5
PHIL 102	Modern Philosophy, Descartes to Kant	4
PHIL 107B	Plato's Later Metaphysics and Epistemology	4
PHIL 135	Existentialism	4
PHIL 150	Mathematical Logic	4
PHIL 150E	Logic in Action: A New Introduction to Logic	4
PHIL 151	Metalogic	4
PHIL 151A	Recursion Theory	4
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
PHIL 162	Philosophy of Mathematics	4
PHIL 164	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 166	Probability: Ten Great Ideas About Chance	4
PHIL 167B	Philosophy, Biology, and Behavior	4
PHIL 169	Evolution of the Social Contract	4
PHIL 173B	Metaethics	4
PHIL 175	Philosophy of Law	4
PHIL 180	Metaphysics	4
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 181	Philosophy of Language	4
PHIL 182	Advanced Philosophy of Language	4
PHIL 184	Epistemology	4
PHIL 184F	Feminist Theories of Knowledge	4
PHIL 184P	Probability and Epistemology	4
PHIL 185	Theory of Understanding	4
PHIL 186	Philosophy of Mind	4
PHIL 187	Philosophy of Action	4
PHIL 188	Personal Identity	4
PHIL 189	Examples of Free Will	4
PHIL 280A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 289	Examples of Free Will	4
POLISCI 152	Introduction to Game Theoretic Methods in Political Science	3-5
PSYCH 30	Introduction to Perception	4
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 60	Introduction to Developmental Psychology	3
PSYCH 70	Self and Society: Introduction to Social Psychology	4
PSYCH 141	Cognitive Development	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 204	Computation and Cognition: The Probabilistic Approach	3
PSYCH 209	Neural Network Models of Cognition	4
SLE 91	Structured Liberal Education	8
SLE 92	Structured Liberal Education	8
SLE 93	Structured Liberal Education	8
STATS 110	Statistical Methods in Engineering and the Physical Sciences	5
STATS 116	Theory of Probability	4
STATS 200	Introduction to Statistical Inference	3
STATS 217	Introduction to Stochastic Processes I	3
THINK 24	Evil	4

Note: Symbolic Systems majors must take PHIL 182 Advanced Philosophy of Language for 3 or more units.

Artificial Intelligence

		Units
CS 124	From Languages to Information	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 157	Computational Logic	3
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 225A	Experimental Robotics	3
CS 227B	General Game Playing	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	3
CS 274	Representations and Algorithms for Computational Molecular Biology	3-4
CS 329	Topics in Artificial Intelligence	3
ECON 160	Game Theory and Economic Applications	5
EE 263	Introduction to Linear Dynamical Systems	3
EE 364A	Convex Optimization I	3
EE 364B	Convex Optimization II	3
EE 376A	Information Theory	3
EE 376B	Topics in Information Theory and Its Applications	3
ENGR 205	Introduction to Control Design Techniques	3
ENGR 209A	Analysis and Control of Nonlinear Systems	3
LINGUIST 180	From Languages to Information	3-4
LINGUIST 188	Natural Language Understanding	3-4

LINGUIST 280	From Languages to Information	3-4
LINGUIST 284	Natural Language Processing with Deep Learning	3-4
LINGUIST 285	Spoken Language Processing	2-4
LINGUIST 288	Natural Language Understanding	3-4
MATH 113	Linear Algebra and Matrix Theory	3
MS&E 251	Introduction to Stochastic Control with Applications	3
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3

Applied Logic

		Units
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 157	Computational Logic	3
LINGUIST 230A	Introduction to Semantics and Pragmatics	4
MATH 161	Set Theory	3
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
PHIL 155	General Interest Topics in Mathematical Logic	4
PHIL 350A	Model Theory	3
PHIL 351A	Recursion Theory	3
PHIL 354	Topics in Logic	1-3
PHIL 391	Research Seminar in Logic	1-3

Philosophical Foundations

		Units
LINGUIST 110	Introduction to Phonology	4
PHIL 14N	Belief and the Will	3
PHIL 102	Modern Philosophy, Descartes to Kant	4
PHIL 143	Quine	4
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
PHIL 157	Topics in Philosophy of Logic	3
PHIL 162	Philosophy of Mathematics	4
PHIL 164	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 165	Philosophy of Physics: Space, Time and Motion	4
PHIL 166	Probability: Ten Great Ideas About Chance	4
PHIL 167B	Philosophy, Biology, and Behavior	4
PHIL 170	Ethical Theory	4
PHIL 180	Metaphysics	4
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 181	Philosophy of Language	4
PHIL 184	Epistemology	4
PHIL 184P	Probability and Epistemology	4
PHIL 252	Computability and Logic	4
PHIL 254	Modal Logic	4
PHIL 264	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 265	Philosophy of Physics: Space, Time and Motion	4
PHIL 266	Probability: Ten Great Ideas About Chance	4
PHIL 267B	Philosophy, Biology, and Behavior	4
PHIL 280A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 350A	Model Theory	3

Cognitive Science

		Units
BIO 150	Human Behavioral Biology	5
COMM 106	Communication Research Methods	4-5
CS 124	From Languages to Information	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 229	Machine Learning	3-4
ECON 160	Game Theory and Economic Applications	5
EE 376A	Information Theory	3
EE 376B	Topics in Information Theory and Its Applications	3
HUMBIO 160	Human Behavioral Biology	5
LINGUIST 105	Phonetics	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 140	Learning to Speak: An Introduction to Child Language Acquisition	4
LINGUIST 180	From Languages to Information	3-4
LINGUIST 205A	Phonetics	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 247	Seminar in Psycholinguistics: Advanced Topics	2-4
LINGUIST 280	From Languages to Information	3-4
LINGUIST 284	Natural Language Processing with Deep Learning	3-4
MATH 113	Linear Algebra and Matrix Theory	3
MUSIC 251	Psychophysics and Music Cognition	1-5
NBIO 206	The Nervous System	6
NBIO 218	Neural Basis of Behavior	5
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
PHIL 164	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 180	Metaphysics	4
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 181	Philosophy of Language	4
PHIL 184	Epistemology	4
PHIL 184P	Probability and Epistemology	4
PHIL 186	Philosophy of Mind	4
PHIL 187	Philosophy of Action	4
PHIL 188	Personal Identity	4
PHIL 189	Examples of Free Will	4
PHIL 264	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 280A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 289	Examples of Free Will	4
PSYCH 1	Introduction to Psychology	5
PSYCH 30	Introduction to Perception	4

PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 70	Self and Society: Introduction to Social Psychology	4
PSYCH 75	Introduction to Cultural Psychology	5
PSYCH 141	Cognitive Development	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 202	Cognitive Neuroscience	3
PSYCH 204A	Human Neuroimaging Methods	3
PSYCH 204B	Computational Neuroimaging	1-3
PSYCH 205	Foundations of Cognition	3
PSYCH 221	Image Systems Engineering	1-3
PSYCH 227	Seminar in Psycholinguistics: Advanced Topics	2-4
PSYCH 232	Brain and Decision	3
PSYCH 250	High-level Vision: From Neurons to Deep Neural Networks	1-3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
STATS 191	Introduction to Applied Statistics	3-4
STATS 200	Introduction to Statistical Inference	3

Decision Making and Rationality

		Units
BIO 150	Human Behavioral Biology	5
BIOMEDIN 251	Outcomes Analysis	4
COMM 106	Communication Research Methods	4-5
COMM 172	Media Psychology	4-5
COMM 206	Communication Research Methods	4-5
COMM 272	Media Psychology	4-5
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 161	Design and Analysis of Algorithms	3-5
CS 181	Computers, Ethics, and Public Policy	4
CS 204	Legal Informatics	2-3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 261	Optimization and Algorithmic Paradigms	3
ECON 50	Economic Analysis I	5
ECON 51	Economic Analysis II	5
ECON 102B	Applied Econometrics	5
ECON 102C	Advanced Topics in Econometrics	5
ECON 136	Market Design	5
ECON 137	Decision Modeling and Information	5
ECON 141	Public Finance and Fiscal Policy	5
ECON 150	Economic Policy Analysis	4-5
ECON 155	Environmental Economics and Policy	5
ECON 160	Game Theory and Economic Applications	5
ECON 179	Experimental Economics	5
ECON 286	Game Theory and Economic Applications	2-5
ECON 288	Computational Economics	2-5
ECON 289	Advanced Topics in Game Theory and Information Economics	2-5
ECON 290	Multiperson Decision Theory	3
EDUC 247	Moral and Character Education	3
EDUC 375A	Seminar on Organizational Theory	5
ENGR 62	Introduction to Optimization	3-4
MS&E 111	Introduction to Optimization	3-4
MS&E 120	Probabilistic Analysis	5
MS&E 121	Introduction to Stochastic Modeling	4
MS&E 180	Organizations: Theory and Management	4
MS&E 201	Dynamic Systems	3-4
MS&E 234	Data Privacy and Ethics	3
MS&E 250A	Engineering Risk Analysis	3
MS&E 250B	Project Course in Engineering Risk Analysis	3
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	3-4
MS&E 254	The Ethical Analyst	1-3
MS&E 352	Decision Analysis II: Professional Decision Analysis	3-4
MS&E 355	Influence Diagrams and Probabilistics Networks	3
PHIL 154	Modal Logic	4
PHIL 164	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 166	Probability: Ten Great Ideas About Chance	4
PHIL 167B	Philosophy, Biology, and Behavior	4
PHIL 170	Ethical Theory	4
PHIL 194C	Time and Free Will	4
PHIL 194R	Epistemic Paradoxes	4
PHIL 264	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 266	Probability: Ten Great Ideas About Chance	4
PHIL 267B	Philosophy, Biology, and Behavior	4
PHIL 270	Ethical Theory	4
PHIL 355	Logic and Social Choice	4
PHIL 366	Evolution and Communication	4
PHIL 387	Intention and Normative Judgment	2-4
POLISCI 152	Introduction to Game Theoretic Methods in Political Science	3-5
POLISCI 344U	Political Culture	3-5
POLISCI 351A	Foundations of Political Economy	3
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 70	Self and Society: Introduction to Social Psychology	4
PSYCH 75	Introduction to Cultural Psychology	5
PSYCH 80	Introduction to Personality and Affective Science	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 168	Emotion Regulation	3
PSYCH 205	Foundations of Cognition	3
PSYCH 212	Classic and contemporary social psychology research	1-3
PSYCH 215	Mind, Culture, and Society	3
PSYCH 223	Social Norms	3
PSYCH 232	Brain and Decision	3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
PSYCH 253	High-Dimensional Methods for Behavioral and Neural Data	3
PSYCH 268	Emotion Regulation	3
PUBLPOL 302B	Economic Analysis of Law	3
SOC 114	Economic Sociology	4

SOC 115	Topics in Economic Sociology	5
SOC 120	Interpersonal Relations	4
SOC 121	The Individual in Social Structure: Foundations in Sociological Social Psychology	5
SOC 126	Introduction to Social Networks	4
SOC 127	Bargaining, Power, and Influence in Social Interaction	5
SOC 160	Formal Organizations	4
SOC 214	Economic Sociology	4
SOC 220	Interpersonal Relations	4
SOC 226	Introduction to Social Networks	4
SOC 227	Bargaining, Power, and Influence in Social Interaction	5
SOC 260	Formal Organizations	4
STATS 200	Introduction to Statistical Inference	3
STATS 211	Meta-research: Appraising Research Findings, Bias, and Meta-analysis	3
STATS 217	Introduction to Stochastic Processes I	3
STATS 218	Introduction to Stochastic Processes II	3
STATS 310A	Theory of Probability I	2-4
STATS 310B	Theory of Probability II	2-3
STATS 310C	Theory of Probability III	2-4
SYMSYS Majors must take for 3 or more units		

Natural Language

		Units
CS 124	From Languages to Information	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 229	Machine Learning	3-4
CS 276	Information Retrieval and Web Search	3
LINGUIST 105	Phonetics	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 116	Morphology	4
LINGUIST 130A	Introduction to Semantics and Pragmatics	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 140	Learning to Speak: An Introduction to Child Language Acquisition	4
LINGUIST 180	From Languages to Information	3-4
LINGUIST 188	Natural Language Understanding	3-4
LINGUIST 205B	Advanced Phonetics	2-4
LINGUIST 210A	Phonology	3-4
LINGUIST 210B	Advanced Phonology	2-4
LINGUIST 221A	Foundations of English Grammar	1-4
LINGUIST 221B	Studies in Universal Grammar	1-4
LINGUIST 222A	Foundations of Syntactic Theory I	3-4
LINGUIST 224B	Advanced Topics in Lexical Functional Grammar	1-4
LINGUIST 230A	Introduction to Semantics and Pragmatics	4
LINGUIST 230B	Semantics and Pragmatics I	2-4
LINGUIST 232A	Lexical Semantics	2-4
LINGUIST 241	Language Acquisition II	4
LINGUIST 247	Seminar in Psycholinguistics: Advanced Topics	2-4
LINGUIST 280	From Languages to Information	3-4
LINGUIST 281	Computational Models of Linguistic Formalism	1-4
LINGUIST 285	Spoken Language Processing	2-4
LINGUIST 286	Information Retrieval and Web Search	3
LINGUIST 288	Natural Language Understanding	3-4
PHIL 154	Modal Logic	4
PHIL 181	Philosophy of Language	4
PSYCH 227	Seminar in Psycholinguistics: Advanced Topics	2-4

Learning

		Units
EDUC 230	Learning Experience Design	3
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
EDUC 124	Collaborative Design and Research of Technology-integrated Curriculum	3-4
EDUC 218	Topics in Cognition and Learning: Technology and Multitasking	3
EDUC 333A	Understanding Learning Environments	3
EDUC 342	Child Development and New Technologies	3
EE 376A	Information Theory	3
LINGUIST 140	Learning to Speak: An Introduction to Child Language Acquisition	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 284	Natural Language Processing with Deep Learning	3-4
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 141	Cognitive Development	3
PSYCH 202	Cognitive Neuroscience	3
PSYCH 204	Computation and Cognition: The Probabilistic Approach	3
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3

Neurosciences

		Units
BIO 150	Human Behavioral Biology	5
BIO 153	Cellular Neuroscience: Cell Signaling and Behavior	4
BIO 154	Molecular and Cellular Neurobiology	4
BIO 158	Developmental Neurobiology	4
BIO 222	Exploring Neural Circuits	3
CS 223A	Introduction to Robotics	3
CS 229	Machine Learning	3-4
MATH 113	Linear Algebra and Matrix Theory	3
NBIO 206	The Nervous System	6
NBIO 218	Neural Basis of Behavior	5
NENS 220	Computational Neuroscience	4
PHIL 186	Philosophy of Mind	4

PSYCH 30	Introduction to Perception	4
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 120	Cellular Neuroscience: Cell Signaling and Behavior	4
PSYCH 121	Ion Transport and Intracellular Messengers	3
PSYCH 204A	Human Neuroimaging Methods	3
PSYCH 204B	Computational Neuroimaging	1-3
PSYCH 221	Image Systems Engineering	1-3
PSYCH 232	Brain and Decision	3
PSYCH 250	High-level Vision: From Neurons to Deep Neural Networks	1-3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
STATS 141	Biostatistics	5
STATS 191	Introduction to Applied Statistics	3-4
STATS 200	Introduction to Statistical Inference	3

Cognate Courses for the Master's Degree

The following is a list of cognate courses that may be applied to the M.S. in Symbolic Systems. Click on the course or see ExploreCourses for course descriptions and General Education Requirements (GER) information. Courses taken for a Symbolic Systems degree or Minor must be taken for 3 units (or more). See Degree Requirements for details.

		Units
BIO 153	Cellular Neuroscience: Cell Signaling and Behavior	4
BIO 154	Molecular and Cellular Neurobiology	4
BIO 222	Exploring Neural Circuits	3
BIO 258	Developmental Neurobiology	4
BIO 263	Neural Systems and Behavior	4
BIOMEDIN 251	Outcomes Analysis	4
CME 100	Vector Calculus for Engineers	5
CME 100A	Vector Calculus for Engineers, ACE	6
CME 106	Introduction to Probability and Statistics for Engineers	4
CME 108	Introduction to Scientific Computing	3
COMM 206	Communication Research Methods	4-5
COMM 220	Digital Media in Society	4-5
COMM 272	Media Psychology	4-5
CS 103	Mathematical Foundations of Computing	3-5
CS 106A	Programming Methodology	3-5
CS 106X	Programming Abstractions (Accelerated)	3-5
CS 107	Computer Organization and Systems	3-5
CS 108	Object-Oriented Systems Design	3-4
CS 109	Introduction to Probability for Computer Scientists	3-5
CS 142	Web Applications	3
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 148	Introduction to Computer Graphics and Imaging	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 157	Computational Logic	3
CS 161	Design and Analysis of Algorithms	3-5
CS 170	Stanford Laptop Orchestra: Composition, Coding, and Performance	1-5
CS 181	Computers, Ethics, and Public Policy	4
CS 204	Legal Informatics	2-3
CS 205A		
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 225A	Experimental Robotics	3
CS 225B		
CS 227B	General Game Playing	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 247	Human-Computer Interaction Design Studio	3-4
CS 261	Optimization and Algorithmic Paradigms	3
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	3
CS 274	Representations and Algorithms for Computational Molecular Biology	3-4
CS 276	Information Retrieval and Web Search	3
CS 294H	Research Project in Human-Computer Interaction	3
CS 376	Human-Computer Interaction Research	3-4
CS 377	Topics in Human-Computer Interaction	2-3
CS 448B	Data Visualization	3
ECON 102B	Applied Econometrics	5
ECON 102C	Advanced Topics in Econometrics	5
ECON 135		
ECON 136	Market Design	5
ECON 137	Decision Modeling and Information	5
ECON 141	Public Finance and Fiscal Policy	5
ECON 153		
ECON 155	Environmental Economics and Policy	5
ECON 160	Game Theory and Economic Applications	5
ECON 179	Experimental Economics	5
ECON 190		
ECON 289	Advanced Topics in Game Theory and Information Economics	2-5
EDUC 218	Topics in Cognition and Learning: Technology and Multitasking	3
EDUC 247	Moral and Character Education	3
EDUC 298	Seminar on Teaching Introductory Computer Science	1
EDUC 333A	Understanding Learning Environments	3
EDUC 342	Child Development and New Technologies	3
EDUC 375A	Seminar on Organizational Theory	5
EE 263	Introduction to Linear Dynamical Systems	3
EE 364A	Convex Optimization I	3
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