Symbolic Systems

Courses offered by the Program in Symbolic Systems are listed under the subject code SYMSYS on the (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=SYMSYS&filter-catalognumber-SYMSYS=on) Stanford Bulletin's (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=SYMSYS&filter-catalognumber-SYMSYS=on) ExploreCourses web site (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=SYMSYS&filter-catalognumber-SYMSYS=on).

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 100 Minds and Machines 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 100 Minds and Machines before their declaration of the Symbolic Systems undergraduate major can be approved.

		Units
SYMSYS 100	Minds and Machines	4

2. Continuous Fundamentals Level 1—Single Variable Calculus

		Units
Select one of the following Series:		
Series A		10
10 units of Advanced Placement Calculus credit		
Series B		10
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	
Series C		10
MATH 41 or MATH 41A	Calculus Calculus ACE	
MATH 42 or MATH 42A	Calculus Calculus ACE	
Series D		
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 and Differential Calculus of Several Variables	5
MATH 51A	Linear Algebra and Differential Calculus of Several Variables, ACE	6
MATH 51H	Honors Multivariable Mathematics	5

1 MATH 52 Integral Calculus of Several Variables and/or MATH 53 Ordinary Differential Equations with Linear Algebra, or CME 102 Ordinary Differential Equations for Engineers and/or CME 104 Linear Algebra and Partial Differential Equations for Engineers, are recommended and may be required for some optional higher level courses.

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	4-5
STATS 116	Theory of Probability	3-5
MSE 120	Probabilistic Analysis	5
EE 178	Probabilistic Systems Analysis	4
MATH 151	Introduction to Probability Theory	3
CME 106/ENGR 155C	Introduction to Probability and Statistics for Engineers	3-4

5. Discrete Fundamentals

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

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. See concentration lists at http://symsys.stanford.edu/viewing/htmldocument/16190

		Units
Area A. Computer Programming		
CS 107	Computer Organization and Systems (required for HCI, AI, or Computer Music)	3-5
Area B. Computational Theory [1]		
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	Logic and Automated Reasoning	3
PHIL 151	Metalogic	4
PHIL 152	Computability and Logic	4
PHIL 154	Modal Logic	4
Area D. Decision Theory/Game Theory		
CS 224M	Multi-Agent Systems	3
ECON 160	Game Theory and Economic Applications	5
ECON 180	Honors Game Theory	5
MSE 252	Decision Analysis I: Foundations of Decision Analysis	3-4
Area E. Probability and Statistics		
STATS 200	Introduction to Statistical Inference	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4

1 CS 156 is not offered in 2015-16 but may be used to fulfill this requirement.

7. Philosophical Foundations Level 1

		Units
Introductory Philosophy [1]		3-5
Select one of the following:		
PHIL 1	Introduction to Philosophy	
PHIL 2	Introduction to Moral Philosophy	
PHIL 60	Introduction to Philosophy of Science	
PHIL 102	Modern Philosophy, Descartes to Kant	
PHIL 135	Existentialism	
THINK 24	Evil	
All three of the following SLE (must complete all three):		
SLE 91	Structured Liberal Education	

SLE 92	Structured Liberal Education
SLE 93	Structured Liberal Education

Other introductory courses taught in the Philosophy Department, if approved by the Program Director or Associate Director

[1] SLE 91, 92, 93 (Must complete entire sequence).

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): [1]		
PHIL 107B	Plato's Metaphysics and Epistemology	
PHIL 173B	Metaethics	
PHIL 175	Philosophy of Law	
PHIL 180	Metaphysics	
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	
PHIL 181	Philosophy of Language	
PHIL 182	Truth	
PHIL 184	Epistemology	
PHIL 186	Philosophy of Mind	
PHIL 187	Philosophy of Action	

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

10. Cognition and Neuroscience

		Units
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
An additional undergraduate course in cognition and/or neurosciences [1]		
Select one of the following:		
BIO 20	Introduction to Brain and Behavior	
BIO 150	Human Behavioral Biology	
PSYCH 30	Introduction to Perception	
PSYCH 45	Introduction to Learning and Memory	
PSYCH 50	Introduction to Cognitive Neuroscience	
PSYCH 60	Introduction to Developmental Psychology	
PSYCH 70	Introduction to Social Psychology	
PSYCH 131	Language and Thought	
PSYCH 141	Cognitive Development	
PSYCH 154	Judgment and Decision-Making	

11. Natural Language

		Units
Language and Mind		4
Select one of the following:		
LINGUIST 1	Introduction to Linguistics	
LINGUIST 106	Introduction to Speech Perception	
LINGUIST 140	Language Acquisition I	
PSYCH 131	Language and Thought	
Linguistic Theory		4
Select one of the following:		
LINGUIST 105	Phonetics	
LINGUIST 110	Introduction to Phonology	
LINGUIST 120	Introduction to Syntax	
LINGUIST 121A	The Syntax of English	
LINGUIST 121B	Crosslinguistic Syntax	
LINGUIST 130A/230A	Introduction to Semantics and Pragmatics	
LINGUIST 130B	Introduction to Lexical Semantics	
LINGUIST 184	Syntactic Theory and Implementation	

12. Computation and Cognition

		Units
A course applying core technical skills to cognition		
Select one of the following:		
CS 221	Artificial Intelligence: Principles and Techniques	
CS 224M	Multi-Agent Systems	
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 229	Machine Learning	
LINGUIST 180/CS 124	From Languages to Information	
LINGUIST 182	Computational Theories of Syntax	
PSYCH 204	Computation and cognition: the probabilistic approach	
PSYCH 209	Neural network and deep learning models for cognition and cognitive neuroscience	
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science	

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 found in the course list below (other courses may be added throughout the Autumn Quarter). 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.

		Units
LINGUIST 236	Seminar in Semantics: Modality and Conditionals	4
MUSIC 220C	Research Seminar in Computer-Generated Music	2-4
PHIL 194D	Capstone Seminar: Analyticity	4
PHIL 348	Evolution of Signalling	2-4
PHIL 359	Topics in Logic, Information and Agency	2-4
PHIL 385D	Topics in Philosophy of Language	2-4
PSYCH 145	Seminar on Infant Development	1-2
PSYCH 169	Advanced Seminar on Memory	3

PSYCH 232	Brain and Decision Making	3
PSYCH 251	Affective Neuroscience	3
SYMSYS 201	ICT, Society, and Democracy	3
SYMSYS 206	Philosophy of Neuroscience	4
SYMSYS 245	Cognition in Interaction Design	3

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) 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 Associated 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, the Undergraduate Advising and Research office offers grants and scholarships supporting student research projects at all levels; see http://ual.stanford.edu/OO/research_opps/Grants.

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 100	Minds and Machines [1]	
PSYCH 45	Introduction to Learning and Memory	
PSYCH 50	Introduction to Cognitive Neuroscience	
b. Logic and Computation		
Select one of the following:		3-5
PHIL 150	Mathematical Logic	
PHIL 150E	Logic in Action: A New Introduction to Logic	
PHIL 151	Metalogic	
CS 103	Mathematical Foundations of Computing	
c. Computer Programming		
Select one of the following:		3-5
CS 106B	Programming Abstractions	
CS 106X	Programming Abstractions (Accelerated)	
CS 107	Computer Organization and Systems	
d. Philosophical Foundations		
Select one of the following:		
SYMSYS 100	Minds and Machines [1]	
PHIL 80	Mind, Matter, and Meaning	
e. Linguistic Theory		
Select one of the following:		
LINGUIST 105	Phonetics	

LINGUIST 110	Introduction to Phonology
LINGUIST 120	Introduction to Syntax
LINGUIST 121A	The Syntax of English
LINGUIST 121B	Crosslinguistic Syntax
LINGUIST 130A	Introduction to Semantics and Pragmatics
LINGUIST 130B	Introduction to Lexical Semantics
LINGUIST 184	Syntactic Theory and Implementation

f. Computation and Cognition 3-4

Select one of the following:

CS 221	Artificial Intelligence: Principles and Techniques
CS 224M	Multi-Agent Systems
CS 228	Probabilistic Graphical Models: Principles and Techniques
CS 229	Machine Learning
LINGUIST 180	From Languages to Information
LINGUIST 182	Computational Theories of Syntax
PSYCH 204	Computation and cognition: the probabilistic approach
PSYCH 209	Neural network and deep learning models for cognition and cognitive neuroscience
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science

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

Option 2

SYMSYS 100 Minds and Machines, 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 three quarters prior to the first graduate quarter, or later, are eligible for consideration for transfer to the graduate career. 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 is 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.

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
- CS 154 Introduction to Automata and Complexity Theory
- CS 157 Logic and Automated Reasoning
- CS 161 Design and Analysis of Algorithms
- CS 364A Algorithmic Game Theory

b) empirical: a course drawing on experimental or observational data or methods, beyond the level of Psych 55, Ling 120, or Ling 130A. The courses below are examples of those that have been approved. Other courses may be approved if appropriate.

- COMM 268. Experimental Research in Advanced User Interfaces (same as COMM 168, COMM 368, ME 468)
- COMM 269. Computers and Interfaces: Psychological and Social Issues (same as COMM 169)
- CS 224N Natural Language Processing
- CS 376 Human-Computer Interaction Research
- LINGUIST 230B Semantics and Pragmatics I
- LINGUIST 241 Language Acquisition II
- LINGUIST 274C Linguistic Field Methods: Syntax
- 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 and Deep Learning Models for Cognition and Cognitive Science
- PSYCH 252 Statistical Methods for Behavioral and Social Sciences
- PSYCH 254 Lab in Experimental Methods
- 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
- CS 224W Social Information and Network Analysis
- CS 249A Object-Oriented Programming from a Modeling and Simulation Perspective

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 280 Metaphysics
- PHIL 281 Philosophy of Language
- PHIL 285B Philosophy of Perception
- PHIL 286 Philosophy of Mind
- PHIL 287 Philosophy of Action
- PHIL 383B What's an Inference?
- SYMSYS 206 Philosophy of Neuroscience

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.

Director: Thomas A. Wasow

Director of Graduate Studies: Thomas A. Wasow

Associate Director: Todd Davies

Program Committee Michael Bernstein, Herbert Clark, Todd Davies, Michael C. Frank, Daniel Jurafsky, Krista Lawlor, Christopher Manning, James McClelland, Stanley Peters, Christopher Potts, Eric Roberts, Kenneth A. Taylor, Johan van Benthem, Thomas A. Wasow, Daniel Lassiter, Thomas Icard

Program Faculty:

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Art and Art History: Scott Bukatman (Professor)

Classics: Reviel Netz (Professor)

Civil and Environmental Engineering: John Kunz (Program Consultant)

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

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French and Italian: Jean-Pierre Dupuy (Professor)

Genetics: Russ B. Altman (Professor)

Graduate School of Business: Baba Shiv (Professor)

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

Management Science and Engineering: Pamela Hinds (Associate Professor)

Mathematics: Persi Diaconis (Professor), Solomon Feferman (Professor, emeritus)

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

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

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

Philosophy: Michael Bratman (Professor), Alexis Burgess (Assistant Professor), Mark Crimmins (Associate Professor), John Etchemendy (Professor), Solomon Feferman (Professor, emeritus), Dagfinn Føllesdal (Professor, emeritus), Thomas Icard III (Assistant Professor), Krista Lawlor (Associate 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, Research)

Psychology: Herbert H. Clark (Professor), Anne Fernald (Associate Professor), Michael C. Frank (Assistant Professor), Noah Goodman (Assistant Professor), Kalanit Grill-Spector (Associate Professor), Hyowon Gweon (Assistant Professor), Brian Knutson (Associate Professor), Ellen Markman (Professor), James McClelland (Professor), Samuel McClure (Assistant Professor), Barbara Tversky (Professor, emerita), Anthony Wagner (Professor), Brian Wandell (Professor)

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

Symbolic Systems: Todd Davies (Lecturer), Jeff Shrager (Consulting Professor), Paul Skokowski (Consulting 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
BIO 20	Introduction to Brain and Behavior	3
CME 100	Vector Calculus for Engineers	5
CME 100A	Vector Calculus for Engineers, ACE	6
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 109	Introduction to Probability for Computer Scientists	3-5
CS 124	From Languages to Information	3-4
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 157	Logic and Automated Reasoning	3
CS 161	Design and Analysis of Algorithms	3-5
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 224M	Multi-Agent Systems	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
ECON 160	Game Theory and Economic Applications	5
EE 178	Probabilistic Systems Analysis	4
ENGR 155C	Introduction to Probability and Statistics for Engineers	4
ETHICSOC 20	Introduction to Moral Philosophy	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 140	Language Acquisition I	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 240	Language Acquisition I	4
LINGUIST 282	Computational Theories of Syntax	3-4
MATH 19	Calculus	3
MATH 20	Calculus	3
MATH 21	Calculus	4
MATH 41	Calculus	5
MATH 41A	Calculus ACE	6

MATH 42	Calculus	5
MATH 42A	Calculus ACE	6
MATH 51	Linear Algebra and Differential Calculus of Several Variables	5
MATH 51A	Linear Algebra and Differential Calculus of Several Variables, ACE	6
MATH 151	Introduction to Probability Theory	3
MATH 162	Philosophy of Mathematics	4
MSE 120	Probabilistic Analysis	5
MSE 252	Decision Analysis I: Foundations of Decision Analysis	3-4
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 150	Mathematical Logic	4
PHIL 151	Metalogic	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 180	Metaphysics	4
PHIL 180A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 181	Philosophy of Language	4
PHIL 182	Truth	2-4
PHIL 184	Epistemology	4
PHIL 184F	Feminist Theories of Knowledge	4
PHIL 184P	Probability and Epistemology	4
PHIL 185	Memory	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
PSYCH 30	Introduction to Perception	3
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 60	Introduction to Developmental Psychology	4
PSYCH 70	Introduction to Social Psychology	4
PSYCH 131	Language and Thought	4
PSYCH 141	Cognitive Development	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 204	Computation and cognition: the probabilistic approach	3-4
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science	3
PSYCH 262	Language and Thought	4
STATS 110	Statistical Methods in Engineering and the Physical Sciences	4-5
STATS 116	Theory of Probability	3-5
STATS 200	Introduction to Statistical Inference	3
SYMSYS 184	Syntactic Theory and Implementation	4

Note: Symbolic Systems majors must take PHIL 182 Truth 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	Logic and Automated Reasoning	3
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 225A	Experimental Robotics	3
CS 225B	Robot Programming Laboratory	3-4
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
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	Network Information Theory	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	3-4
LINGUIST 288	Natural Language Understanding	3-4
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	Logic and Automated Reasoning	3
LINGUIST 230A	Introduction to Semantics and Pragmatics	4
MATH 161	Set Theory	3
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 and the Foundations of Mathematics	1-3

Philosophical Foundations

		Units
MATH 162	Philosophy of Mathematics	4
PHIL 9N	Philosophical Classics of the 20th Century	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	4
PHIL 166	Probability: Ten Great Ideas About Chance	4
PHIL 167B	Philosophy, Biology, and Behavior	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	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

Cognitive Science

		Units
BIO 20	Introduction to Brain and Behavior	3
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 205A	Mathematical Methods for Robotics, Vision, and Graphics	3
CS 224N	Natural Language Processing	3-4
CS 229	Machine Learning	3-4
ECON 160	Game Theory and Economic Applications	5
EE 376A	Information Theory	3
EE 376B	Network Information Theory	3
HUMBIO 21	Introduction to Brain and Behavior	3
HUMBIO 160	Human Behavioral Biology	5
LINGUIST 105	Phonetics	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 140	Language Acquisition I	4
LINGUIST 180	From Languages to Information	3-4
LINGUIST 205A	Phonetics	4
LINGUIST 240	Language Acquisition I	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 280	From Languages to Information	3-4
LINGUIST 284	Natural Language Processing	3-4
MATH 113	Linear Algebra and Matrix Theory	3
MUSIC 251	Psychophysics and Music Cognition	1-5
NBIO 206	The Nervous System	7-8
NBIO 218	Neural Basis of Behavior	5
NBIO 220	Central Mechanisms in Vision-based Cognition	2-4
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 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	3
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 70	Introduction to Social Psychology	4
PSYCH 75	Introduction to Cultural Psychology	5
PSYCH 104	Uniquely Human	3
PSYCH 110	Research Methods and Experimental Design	5
PSYCH 131	Language and Thought	4
PSYCH 141	Cognitive Development	3
PSYCH 143	Developmental Anomalies	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 202	Cognitive Neuroscience	3
PSYCH 204A	Human Neuroimaging Methods	3
PSYCH 204B	Computational Neuroimaging: Analysis Methods	1-3
PSYCH 205	Foundations of Cognition	1-3
PSYCH 221	Applied Vision and Image Systems	1-3
PSYCH 226	Models and Mechanisms of Memory	1-3
PSYCH 232	Brain and Decision Making	3
PSYCH 250	High-Level Vision: Object Representation	3
PSYCH 251	Affective Neuroscience	3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
PSYCH 262	Language and Thought	4
PSYCH 272	Special Topics in Psycholinguistics	1-3
PSYCH 279	Topics in Cognitive Control	1-3
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 74N	Digital Dilemmas	3
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	3
CS 224M	Multi-Agent Systems	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 261	Optimization and Algorithmic Paradigms	3
CS 364A	Algorithmic Game Theory	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 135	Finance for Non-MBAs	3
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 153	Economics of the Internet	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 60	Engineering Economy	3
ENGR 62	Introduction to Optimization	4
MSE 111	Introduction to Optimization	4
MSE 120	Probabilistic Analysis	5
MSE 121	Introduction to Stochastic Modeling	4
MSE 180	Organizations: Theory and Management	4
MSE 197	Ethics, Technology, and Public Policy	5
MSE 201	Dynamic Systems	3-4
MSE 250A	Engineering Risk Analysis	3
MSE 250B	Project Course in Engineering Risk Analysis	3
MSE 252	Decision Analysis I: Foundations of Decision Analysis	3-4
MSE 254	The Ethical Analyst	1-3
MSE 299	Voluntary Social Systems	1-3
MSE 352	Decision Analysis II: Professional Decision Analysis	3-4
MSE 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 123	Politics and Public Policy	4-5
POLISCI 152	Introduction to Game Theoretic Methods in Political Science	3-5
POLISCI 344U	Political Culture	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	Introduction to Social Psychology	4
PSYCH 75	Introduction to Cultural Psychology	5
PSYCH 80	Introduction to Personality and Affective Science	3
PSYCH 110	Research Methods and Experimental Design	5
PSYCH 152	Mediation for Dispute Resolution	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 158	Emotions: History, Theories, and Research	1-3
PSYCH 167	Seminar on Aggression	3
PSYCH 179	The Psychology of Everyday Morality	4
PSYCH 205	Foundations of Cognition	1-3
PSYCH 212	Social Psychology	1-3
PSYCH 215	Mind, Culture, and Society	3
PSYCH 223	Social Norms	3
PSYCH 232	Brain and Decision Making	3
PSYCH 245	Social Psychological Perspectives on Stereotyping and Prejudice	3
PSYCH 251	Affective Neuroscience	3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
PSYCH 253	Statistical Theory, Models, and Methodology	3
PSYCH 270	The Psychology of Everyday Morality	4
PSYCH 279	Topics in Cognitive Control	1-3
PUBLPOL 102	Organizations and Public Policy	4-5
PUBLPOL 202	Organizations and Public Policy	4-5
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	5
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	5
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	2-3
STATS 218	Introduction to Stochastic Processes	3
STATS 310A	Theory of Probability	2-4
STATS 310B	Theory of Probability	2-3
STATS 310C	Theory of Probability	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	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 124	Introduction to Lexical Function Grammar	2-4
LINGUIST 130A	Introduction to Semantics and Pragmatics	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 140	Language Acquisition I	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 224	Introduction to Lexical Function Grammar	2-4
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 240	Language Acquisition I	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 280	From Languages to Information	3-4
LINGUIST 281	Computational Models of Linguistic Formalism	1-4
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 131	Language and Thought	4
PSYCH 134	Seminar on Language and Deception	3
PSYCH 262	Language and Thought	4

Learning

		Units
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 224M	Multi-Agent Systems	3
CS 224N	Natural Language Processing	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
EDUC 218	Topics in Cognition and Learning: Executive Function	3
EDUC 333A	Understanding Learning Environments	3
EDUC 342	Child Development and New Technologies	3
EE 376A	Information Theory	3
LINGUIST 140	Language Acquisition I	4
LINGUIST 240	Language Acquisition I	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 284	Natural Language Processing	3-4
PSYCH 7Q	Language Understanding by Children and Adults	3
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	3-4
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science	3
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3

Neurosciences

		Units
BIO 20	Introduction to Brain and Behavior	3
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 163	Neural Systems and Behavior	4
BIO 222	Exploring Neural Circuits	3
CS 205A	Mathematical Methods for Robotics, Vision, and Graphics	3
CS 223A	Introduction to Robotics	3
CS 229	Machine Learning	3-4
EE 373B	Adaptive Neural Networks	3
HUMBIO 21	Introduction to Brain and Behavior	3
HUMBIO 163	Neural Systems and Behavior	4
MATH 113	Linear Algebra and Matrix Theory	3
NBIO 206	The Nervous System	7-8
NBIO 218	Neural Basis of Behavior	5
NENS 220	Computational Neuroscience	4
PHIL 186	Philosophy of Mind	4
PSYCH 30	Introduction to Perception	3
PSYCH 45	Introduction to Learning and Memory	3
PSYCH 50	Introduction to Cognitive Neuroscience	4
PSYCH 110	Research Methods and Experimental Design	5
PSYCH 120	Cellular Neuroscience: Cell Signaling and Behavior	4
PSYCH 121	Ion Transport and Intracellular Messengers	1-3
PSYCH 143	Developmental Anomalies	3
PSYCH 204A	Human Neuroimaging Methods	3
PSYCH 204B	Computational Neuroimaging: Analysis Methods	1-3
PSYCH 221	Applied Vision and Image Systems	1-3
PSYCH 226	Models and Mechanisms of Memory	1-3

PSYCH 232	Brain and Decision Making	3
PSYCH 250	High-Level Vision: Object Representation	3
PSYCH 251	Affective Neuroscience	3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
PSYCH 279	Topics in Cognitive Control	1-3
STATS 141	Biostatistics	3-5
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	3-4
COMM 206	Communication Research Methods	4-5
COMM 220	Digital Media in Society	4-5
COMM 269	Computers and Interfaces	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	Logic and Automated Reasoning	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	3
CS 205A	Mathematical Methods for Robotics, Vision, and Graphics	3
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 223A	Introduction to Robotics	3
CS 224M	Multi-Agent Systems	3
CS 224N	Natural Language Processing	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 225A	Experimental Robotics	3
CS 225B	Robot Programming Laboratory	3-4
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 364A	Algorithmic Game Theory	0
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	Finance for Non-MBAs	3
ECON 136	Market Design	5
ECON 137	Decision Modeling and Information	5
ECON 141	Public Finance and Fiscal Policy	5
ECON 153	Economics of the Internet	5
ECON 155	Environmental Economics and Policy	5
ECON 160	Game Theory and Economic Applications	5
ECON 179	Experimental Economics	5
ECON 190	Introduction to Financial Accounting	5
ECON 289	Advanced Topics in Game Theory and Information Economics	2-5
EDUC 218	Topics in Cognition and Learning: Executive Function	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
EE 364B	Convex Optimization II	3
EE 376A	Information Theory	3
ENGR 155C	Introduction to Probability and Statistics for Engineers	4
ENGR 205	Introduction to Control Design Techniques	3
ENGR 209A	Analysis and Control of Nonlinear Systems	3
LINGUIST 106	Introduction to Speech Perception	4
LINGUIST 110	Introduction to Phonology	4
LINGUIST 116	Morphology	4
LINGUIST 120	Introduction to Syntax	4
LINGUIST 130B	Introduction to Lexical Semantics	3-4
LINGUIST 205A	Phonetics	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 224	Introduction to Lexical Function Grammar	2-4
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 240	Language Acquisition I	4
LINGUIST 241	Language Acquisition II	4
LINGUIST 280	From Languages to Information	3-4
LINGUIST 281	Computational Models of Linguistic Formalism	1-4
LINGUIST 282	Computational Theories of Syntax	3-4
LINGUIST 284	Natural Language Processing	3-4
LINGUIST 286	Information Retrieval and Web Search	3
LINGUIST 288	Natural Language Understanding	3-4
MATH 113	Linear Algebra and Matrix Theory	3
MATH 151	Introduction to Probability Theory	3
MATH 161	Set Theory	3
ME 115A	Introduction to Human Values in Design	3
ME 115B	Product Design Methods	3
MUSIC 128	Stanford Laptop Orchestra: Composition, Coding, and Performance	1-5
MUSIC 220A	Fundamentals of Computer-Generated Sound	2-4
MUSIC 220B	Compositional Algorithms, Psychoacoustics, and Computational Music	2-4
MUSIC 220C	Research Seminar in Computer-Generated Music	2-4
MUSIC 250A	Physical Interaction Design for Music	3-4
MUSIC 251	Psychophysics and Music Cognition	1-5
MUSIC 253	Symbolic Musical Information	2-4
MUSIC 254	Music Query, Analysis, and Style Simulation	2-4
NBIO 206	The Nervous System	7-8
NBIO 218	Neural Basis of Behavior	5
NBIO 220	Central Mechanisms in Vision-based Cognition	2-4
NENS 220	Computational Neuroscience	4
PHIL 102	Modern Philosophy, Descartes to Kant	4
PHIL 184P	Probability and Epistemology	4
PHIL 185	Memory	4
PHIL 194C	Time and Free Will	4
PHIL 194R	Epistemic Paradoxes	4
PHIL 243	Quine	4
PHIL 250	Mathematical Logic	4
PHIL 251	Metalogic	4
PHIL 252	Computability and Logic	4
PHIL 254	Modal Logic	4
PHIL 257	Topics in Philosophy of Logic	3
PHIL 262	Philosophy of Mathematics	4
PHIL 264	Central Topics in the Philosophy of Science: Theory and Evidence	4
PHIL 265	Philosophy of Physics	4
PHIL 266	Probability: Ten Great Ideas About Chance	4
PHIL 267B	Philosophy, Biology, and Behavior	4
PHIL 270	Ethical Theory	4
PHIL 280	Metaphysics	4
PHIL 280A	Realism, Anti-Realism, Irrealism, Quasi-Realism	4
PHIL 281	Philosophy of Language	4
PHIL 282	Truth	2-4
PHIL 284	Epistemology	4
PHIL 284F	Feminist Theories of Knowledge	4
PHIL 286	Philosophy of Mind	4
PHIL 287	Philosophy of Action	4
PHIL 288	Personal Identity	4
PHIL 289	Examples of Free Will	4
PHIL 350A	Model Theory	3
PHIL 351A	Recursion Theory	3
PHIL 354	Topics in Logic	1-3
PHIL 355	Logic and Social Choice	4
PHIL 366	Evolution and Communication	4
PHIL 387	Intention and Normative Judgment	2-4
PHIL 391	Research Seminar in Logic and the Foundations of Mathematics	1-3
POLISCI 351A	Foundations of Political Economy	3
POLISCI 352	Introduction to Game Theoretic Methods in Political Science	3-5
PSYCH 104	Uniquely Human	3
PSYCH 110	Research Methods and Experimental Design	5
PSYCH 120	Cellular Neuroscience: Cell Signaling and Behavior	4
PSYCH 134	Seminar on Language and Deception	3
PSYCH 141	Cognitive Development	3
PSYCH 143	Developmental Anomalies	3
PSYCH 152	Mediation for Dispute Resolution	3
PSYCH 154	Judgment and Decision-Making	3
PSYCH 167	Seminar on Aggression	3
PSYCH 202	Cognitive Neuroscience	3
PSYCH 204	Computation and cognition: the probabilistic approach	3-4
PSYCH 204A	Human Neuroimaging Methods	3
PSYCH 204B	Computational Neuroimaging: Analysis Methods	1-3
PSYCH 205	Foundations of Cognition	1-3
PSYCH 212	Social Psychology	1-3
PSYCH 215	Mind, Culture, and Society	3
PSYCH 221	Applied Vision and Image Systems	1-3
PSYCH 223	Social Norms	3
PSYCH 226	Models and Mechanisms of Memory	1-3
PSYCH 228	Ion Transport and Intracellular Messengers	1-3
PSYCH 232	Brain and Decision Making	3
PSYCH 239	Formal and Computational Approaches in Psychology and Cognitive Science	3
PSYCH 245	Social Psychological Perspectives on Stereotyping and Prejudice	3
PSYCH 250	High-Level Vision: Object Representation	3
PSYCH 251	Affective Neuroscience	3
PSYCH 252	Statistical Methods for Behavioral and Social Sciences	1-6
PSYCH 253	Statistical Theory, Models, and Methodology	3
PSYCH 259	Emotions: History, Theories, and Research	1-3
PSYCH 262	Language and Thought	4
PSYCH 270	The Psychology of Everyday Morality	4
PSYCH 272	Special Topics in Psycholinguistics	1-3
PSYCH 279	Topics in Cognitive Control	1-3
PUBLPOL 201	Politics and Public Policy	4-5
PUBLPOL 202	Organizations and Public Policy	4-5
PUBLPOL 204	Economic Policy Analysis	4-5

PUBLPOL 302B	Economic Analysis of Law	3
SOC 121	The Individual in Social Structure: Foundations in Sociological Social Psychology	5
SOC 214	Economic Sociology	4
SOC 220	Interpersonal Relations	4
SOC 226	Introduction to Social Networks	5
SOC 227	Bargaining, Power, and Influence in Social Interaction	5
STATS 110	Statistical Methods in Engineering and the Physical Sciences	4-5
STATS 116	Theory of Probability	3-5
STATS 141	Biostatistics	3-5
STATS 191	Introduction to Applied Statistics	3-4
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	2-3
STATS 218	Introduction to Stochastic Processes	3
STATS 310A	Theory of Probability	2-4
STATS 310B	Theory of Probability	2-3
STATS 310C	Theory of Probability	2-4
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3

Courses

SYMSYS 100. Minds and Machines. 4 Units.
An overview of the interdisciplinary study of cognition, information, communication, and language, with an emphasis on foundational issues: What are minds? What is computation? What are rationality and intelligence? Can we predict human behavior? Can computers be truly intelligent? How do people and technology interact, and how might they do so in the future? Lectures focus on how the methods of philosophy, mathematics, empirical research, and computational modeling are used to study minds and machines. Undergraduates considering a major in symbolic systems should take this course as early as possible in their program of study.
Same as: LINGUIST 144, PHIL 99, PSYCH 35

SYMSYS 122. Artificial Intelligence: Philosophy, Ethics, & Impact. 3-4 Units.
Recent advances in computing may place us at the threshold of a unique turning point in human history. Soon we are likely to entrust management of our environment, economy, security, infrastructure, food production, healthcare, and to a large degree even our personal activities, to artificially intelligent computer systems. The prospect of "turning over the keys" to increasingly autonomous systems raises many complex and troubling questions. How will society respond as versatile robots and machine-learning systems displace an ever-expanding spectrum of blue- and white-collar workers? Will the benefits of this technological revolution be broadly distributed or accrue to a lucky few? How can we ensure that these systems respect our ethical principles when they make decisions at speeds and for rationales that exceed our ability to comprehend? What, if any, legal rights and responsibilities should we grant them? And should we regard them merely as sophisticated tools or as a newly emerging form of life? The goal of this course is to equip students with the intellectual tools, ethical foundation, and psychological framework to successfully navigate the coming age of intelligent machines.

SYMSYS 130. Research Methods in the Cognitive and Information Sciences. 3 Units.
Understanding the different methodological approaches used in disciplines that study cognition and information. Emphasis is on philosophical/analytical, formal/mathematical, empirical, and computational thinking styles, with some attention to other methods as well. What assumptions underlie these methods? How can they be combined? How do practitioners of each discipline think differently about problems, and what are the challenges involved in studying or working across them?.

SYMSYS 150. CRYPTOCURRENCIES SEMINAR. 2 Units.
A weekly seminar allowing students the opportunity to discuss and explore cryptocurrencies from a variety of domains and view points:nn1) Explore the history of fiat currencies, both economically and philosophically. How does Bitcoin mesh in here? What are advantages and disadvantages compared to traditional fiat currencies? (~2 weeks) n2) Contextualize and juxtapose decentralized currencies with respect to TCP/IP, Napster, and other relevant decentralized and cloud protocols. (~2 weeks)n3) Work through and understand Satoshiiquest;s initial protocol and proof-of-work mining system. What problem did she solve? How? Why was it important? How can we prove it mathematically? What are significant game theoretic and cryptographic weaknesses? What do alternative cryptocurrencies look like? Is there a `bestiquest; alternative? (~3 weeks)n4) What does iquest;Bitcoin as a protocoliquest; mean? What can be built on top of it? Whatiquest;s being built around it? What does regulation look like? What are hypotheses for the future of digital currencies? How do we explain investor confidence, given regulatory hesitation? (~3 weeks).

SYMSYS 161. Applied Symbolic Systems in Venture Capital + Entrepreneurship. 2 Units.
A weekly seminar allowing students the opportunity to discuss and explore applied Symbolic Systems in technology, entrepreneurship, and venture capital. We will explore popular conventions and trends through the lens of numerous deductive and applied Symbolic Systems.
Same as: SYMSYS 261

SYMSYS 170. Decision Behavior: Theory and Evidence. 3-4 Units.
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.
Same as: SYMSYS 270

SYMSYS 184. Syntactic Theory and Implementation. 4 Units.
Analysis and implementation of grammatical phenomena of English. Introduction to a theory of formal grammar, and its computational realization. Practical experience in forming linguistic hypotheses and testing them via implementation using state-of-the-art language technology.
Same as: LINGUIST 184

SYMSYS 190. Senior Honors Tutorial. 1-5 Unit.
Under the supervision of their faculty honors adviser, students work on their senior honors project. May be repeated for credit.

SYMSYS 191. Senior Honors Seminar. 1 Unit.
Recommended for seniors doing an honors project. Under the leadership of the Symbolic Systems program coordinator, students discuss, and present their honors project.

SYMSYS 196. Independent Study. 1-15 Unit.
Independent work under the supervision of a faculty member. Can be repeated for credit.

SYMSYS 200. Symbolic Systems in Practice. 2-3 Units.
Applying a Symbolic Systems education at Stanford and outside. The basics of research and practice. Students develop and present a project, and investigate different career paths, including academic, industrial, professional, and public service, through interviews with alumni.

SYMSYS 201. ICT, Society, and Democracy. 3 Units.
The impact of information and communication technologies on social and political life. Interdisciplinary. Classic and contemporary readings focusing on topics such as social networks, virtual versus face-to-face communication, the public sphere, voting technology, and collaborative production. Prerequisite: Completion of a course in psychology, communication, human-computer interaction, or a related discipline, or consent of the instructor.

SYMSYS 203. Cognitive Science Perspectives on Conflict, Violence, Peace, and Justice. 3 Units.
In recent years, cognitive scientists have turned more attention to questions that have traditionally been investigated bynhistorians, political scientists, sociologists, and anthropologists, e.g. What are the sources of conflict and disagreement betweennpeople?, What drives or reduces violence and injustice?, and What brings about or is conducive to peace and justice? In this advancednsmall seminar, we will read and discuss works by psychologists, neuroscientists, philosophers, and others, which characterize thisngrowing research area among those who study minds, brains, and behavior.nRequired: Completion of a course in psychology beyond the level of Psych 1, or consent of the instructor.

SYMSYS 204. Philosophy of Linguistics. 4 Units.
Philosophical issues raised by contemporary work in linguistics. Topics include: the subject matter of linguistics (especially internalism vs. externalism), methodology and data (especially the role of quantitative methods and the reliance on intuitions), the relationship between language and thought (varieties of Whorfianism and anti-Whorfianism), nativist arguments about language acquisition, and language evolution.
Same as: LINGUIST 204, PHIL 369

SYMSYS 206. Philosophy of Neuroscience. 4 Units.
Can problems of mind be solved by understanding the brain, or models of the brain? The views of philosophers and neuroscientists who believe so, and others who are skeptical of neurophilosophical approaches to the mind. Historical and recent literature in philosophy and neuroscience. Topics may include perception, memory, neural accounts of consciousness, neurophenomenology, neuroscience and physics, computational models, and eliminativism. (Not open to freshmen.).
Same as: PHIL 167D, PHIL 267D

SYMSYS 209. Battles Over Bits. 3 Units.
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.

SYMSYS 210. Learning Facial Emotions: Art and Psychology. 3 Units.
Artistic and psychological learning approaches for emotion recognition from facial expressions. The advantages of learning by image-based microexpressions, subtle expressions, macro expressions, art drawing and actor mimicry when there are cognitive deficits due to conditions such as autism. Comparative analysis uses brain studies, learning theory, and human-computer interaction. Studio component conveys the artistic and psychological approaches. Prerequisites: PSYCH 1, SYMSYS 100 or consent of instructor. Go to www.stanford.edu/~dwilkins/Symsys210Enroll.doc to sign up for a Permission Number.

SYMSYS 211. Learning Facial Emotions: Art, Psychology, Human-Computer Interaction. 3 Units.
Learning to recognize facial emotions by drawing a live model versus the psychology method of using classified images of subtle and micro expressions. Dimensions of analysis include cognitive modeling and neuroscience. The design of human-computer interaction systems for people with cognitive deficits such as autism and Aspergers, which integrate the art and psychology approaches using methods such as robot heads, avatars, and facial recognition software. Prerequisites: PSYCH 1 or consent of instructor.

SYMSYS 245. Cognition in Interaction Design. 3 Units.
Note: Same course as 145 which is no longer active. 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. Limited enrollment seminar taught in two sections of approximately ten students each. Admission to the course is by application to the instructor, with preference given to Symbolic Systems students of advanced standing. Recommended: a course in cognitive psychology or cognitive anthropology.

SYMSYS 255. Building Digital History: Social Movements and Protest at Stanford. 3-5 Units.
A project-based course focused on developing a collaborative history website based on oral and archival history research. Thematic focus is the history of student activism at Stanford. How have political activities such as demonstrations, assemblies, educational events, and nonviolent civil disobedience been organized on campus, and how have they affected Stanford? What lessons can be drawn from the past for students interested in social change? Students will choose historical periods and/or specific social movements for research. Course will feature guest appearances by representatives from a range of social movements at Stanford the past fifty years, and the building of an online repository and community for the collaborative representation and discussion of history.

SYMSYS 255A. Building Digital History: Social Movements and Protest at Stanford. 1 Unit.
Lectures-only version of Symsys 255.

SYMSYS 261. Applied Symbolic Systems in Venture Capital + Entrepreneurship. 2 Units.
A weekly seminar allowing students the opportunity to discuss and explore applied Symbolic Systems in technology, entrepreneurship, and venture capital. We will explore popular conventions and trends through the lens of numerous deductive and applied Symbolic Systems.
Same as: SYMSYS 161

SYMSYS 270. Decision Behavior: Theory and Evidence. 3-4 Units.
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.
Same as: SYMSYS 170

SYMSYS 280. Symbolic Systems Research Seminar. 1 Unit.
A mixture of public lectures of interest to Symbolic Systems students (the Symbolic Systems Forum) and student-led meetings to discuss research in Symbolic Systems. Can be repeated for credit. Open to both undergraduates and Master's students.

SYMSYS 290. Master's Degree Project. 1-15 Unit.
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SYMSYS 291. Master's Program Seminar. 1 Unit.
Enrollment limited to students in the Symbolic Systems M.S. degree program. May be repeated for credit.

SYMSYS 296. Independent Study. 1-15 Unit.
Independent work under the supervision of a faculty member. Can be repeated for credit.

SYMSYS 298. Peer Advising in Symbolic Systems: Practicum. 1 Unit.
Optional for students selected as Undergraduate Advising Fellows in the Symbolic Systems Program. AFs work with program administrators to assist undergraduates in the Symbolic Systems major or minor, in course selection, degree planning, and relating the curriculum to a career or life plan, through advising and events. Meeting with all AFs for an hour once per week under the direction of the Associate Director. Requires a short reflective paper at the end of the quarter on what the AF has learned about advising students in the program. Repeatable for credit. May not be taken by students who receive monetary compensation for their work as an AF.

SYMSYS 299. Curricular Practical Training. 1 Unit.
Students obtain employment in a relevant research or industrial activity to enhance their professional experience consistent with their degree programs. Meets the requirements for curricular practical training for students on F-1 visas. Students submit a concise report detailing work activities, problems worked on, and key results. May be repeated for credit. Prerequisite: qualified offer of employment and consent of advisor.