

# INDIANA UNIVERSITY

University Graduate School  
2006–2007  
Academic Bulletin

## Cognitive Science

College of Arts and Sciences  
Bloomington

### Interim Director

Robert L. Goldstone (Psychology)

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## Graduate Faculty

(An asterisk [\*] denotes membership in the University Graduate School faculty with the endorsement to direct doctoral dissertations.)

### Arthur F. Bentley Professor

Elinor Ostrom\* (Political Science, Public and Environmental Affairs)

### College Professor of Cognitive Science and of Computer Science

Douglas Hofstadter\* (Informatics)

### Rudy Professor

James T. Townsend\* (Psychology)

### Luther Dana Waterman Professor

Richard M. Shiffrin\* (Psychology)

### Professors

Colin Allen (History and Philosophy of Science), Geoffrey Bingham\* (Psychology), Arthur Bradley\* (Optometry), Jerome Busemeyer\* (Psychology), Donald Cunningham\* (Education), Thomas Duffy\* (Education), J. Michael Dunn\* (Philosophy, Informatics), Joseph Farley\* (Psychology), Steven Franks\* (Linguistics, Slavic Languages and Literature), Preston Garraghty\* (Psychology), Judith Gierut\* (Speech and Hearing Sciences), Robert Goldstone\* (Psychology), Andrew Hanson\* (Informatics), Diane Kewley-Port\* (Speech and Hearing Sciences), John Kruschke\* (Psychology), Annie Lang\* (Telecommunications), David Leake\* (Informatics), Frank Lester, Jr.\* (Education), Daniel Maki\* (Mathematics), David McCarty\* (Philosophy), David MacKay\* (Business, Geography), Michael McRobbie\* (Informatics), Lawrence Moss\* (Mathematics), Robert Nosofsky\* (Psychology), Christopher Peebles\* (Anthropology), David Pisoni\* (Psychology), Robert Port\* (Linguistics, Computer Science), Yvonne Rogers\* (Library and Information Sciences, Informatics), Steven Sherman\* (Psychology), Linda Smith\* (Psychology), Joseph Steinmetz\* (Psychology), Larry Thibos\* (Optometry), William Timberlake\* (Psychology), Charles Watson\* (Emeritus, Speech and Hearing Sciences, Psychology), Wayne Winston\* (Business)

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## **Associate Professors**

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## **Assistant Professors**

Robert F. Potter (Telecommunications)

## **Associate Scientist**

Gary Kidd\* (Speech and Hearing Sciences)

## **Associate Faculty**

### **Professors**

Kathleen Bardovi-Harlig\* (Linguistics), Curtis Bonk\* (Education), Phil Connel\* (Speech and Hearing Sciences, Linguistics), William Corsaro\* (Sociology), James Craig\* (Psychology), Stuart Davis\* (Linguistics), Daniel Dinnsen\* (Linguistics, Speech and Hearing Sciences), Daniel Friedman\* (Computer Science), Roy Gardner\* (Economics), S. Lee Guth\* (Emeritus, Psychology, Optometry), Jeffrey Hart\* (Political Science), Beverly Hartford\* (Linguistics), Julia Heiman\* (Psychology), Marianne Kielian-Gilbert\* (Music), Eugene Kintgen\* (English), Eugene McGregor Jr.\* (Public and Environmental Affairs, Political Science), Timothy O'Conner\* (Philosophy), Philip Podsakoff\* (Business), Paul Purdom\* (Computer Science), Charles Reigeluth\* (Education), Luis Rocha (Informatics), Martin Siegel\* (Education), Maynard Thompson\* (Mathematics), Peter Todd (Informatics), Dirk Van Gucht\* (Computer Science), George von Furstenberg\* (Economics), Arlington Williams II\* (Economics), Larry Yaeger (Informatics)

### **Associate Professors**

Katy Borner (Information Science), J. Clancy Clements\* (Spanish and Portuguese), Theodore Frick\* (Education), Ed Hirt\* (Psychology), Yoshihisa Kitagawa\* (Linguistics), Filippo Menczer\* (Informatics), Thomas Schwen\* (Education), Dennis Senchuk\* (Philosophy, Education), Bruce Solomon\* (Mathematics), Frederick Unverzagt (Medical and Molecular Genetics, Medical Neurobiology)

### **Assistant Professors**

Theresa Burnett (Speech & Hearing Sciences), Rowan Candy\* (Optometry), Damir Cavar (Linguistics), Florin Cutu (Computer Science), Julia Fox (Telecommunications), Jason Gold\* (Psychology), Thomas W. James\* (Psychology), Sharlene Newman\* (Psychology), Leah Savion (Philosophy), Jonathan Weinberg (Philosophy), Chen Yu\* (Psychology)

### **Graduate Advisor**

Professor Michael Gasser\*, Computer Science, Lindley Hall 230H, (812) 855-7078

## **Degrees Offered**

Doctor of Philosophy and Joint Doctor of Philosophy in Cognitive Science and Another Discipline

## **Program Information**

The Cognitive Science Program comprises an interdisciplinary research program and a doctoral degree program. Students carry out intensive research projects in state-of-the-art computer-based laboratories. There are two Ph.D. degree options: a standalone Ph.D. in Cognitive Science and a joint Ph.D. in Cognitive Science and another discipline; for example, psychology, computer science, philosophy, linguistics, or speech and hearing sciences. The program is designed to train students in theory development and model building (mathematical,

formal, and computer simulation models), in empirical research, and in the development of the conceptual framework and technical skills for successful careers in research, teaching, business, and government.

## **Doctor of Philosophy Degree**

### **Admission Requirements**

Admission is by approval of the program's graduate admission committee. Applicants should have an undergraduate major in Cognitive Science, Psychology, Computer Science, Philosophy, Linguistics, Biology, or Anthropology; basic computer programming skills; and basic knowledge of mathematics for science, including calculus and statistics. In exceptional cases, the programming or mathematics admission requirements may be waived and satisfied while pursuing graduate study.

### **Course Requirements**

A minimum of 90 credit hours, including the core courses COGS-Q 520 (3 cr.), COGS Q530 (3 cr.), COGS-Q 540 (3 cr.), COGS-Q 550 (3 cr.), COGS-Q 551 (3 cr.), and COGS-Q 560 (3 cr.) and selections totaling at least 16 credit hours from offerings listed in the Program in Cognitive Science or cross-listed with other departments, divisions, or programs. A maximum of 6 of these 16 credit hours may come from pure research courses (COGS Q799, COGS Q899, or the equivalent in another department). On the basis of their undergraduate background, students may be exempted from one or more of the core courses other than COGS-Q 540, which all students must take. Exemption from any core courses requires approval by the director of graduate studies of the program. Students must also register for at least four semesters in the Colloquium Series course COGS-Q 733. In one of these semesters, the only one for which credit is received, each student will be expected to give a lecture on his or her independent research as a part of the Colloquium Series.

Each student will also select a Content Specialization, an area of study that can be approached from the perspectives of the different disciplines within cognitive science. The list of available Content Specializations currently includes Language and Speech, Modeling, Dynamical Systems, Logic, and Human-Computer Interaction, but new Specializations will be added to this list. Contact the program for an up-to-date list. Each Content Specialization has a designated faculty member in charge of maintaining a list of required and recommended courses. Students must complete at least five courses in their specialization, and these courses must be taken in at least two different departments. The Content Specialization should normally be selected by the end of the student's second year in the program, and the courses selected must be approved by the student's advisory committee.

### **Minor Requirement**

Students must complete a minor in another department or program. Courses counting toward the minor may also count toward the student's Content Specialization. The minor should normally be completed by the beginning of the student's fourth year.

### **Qualifying Examination**

In consultation with his or her advising committee, each student will select topics for three qualifying papers. Two of these topics are expected to be within the student's Content Specialization, and they should address at least two of the different methodological approaches to the content area. The third paper can deal with a topic in any other area of cognitive science. These papers will be evaluated by the committee, and the student will defend the papers orally before the committee. The student will normally write the papers during the summer following his or her second year in the program and defend them at the beginning of the following fall semester. Students failing the qualification examination may retake it once.

## **Joint Doctor of Philosophy Degree in Cognitive Science and Another Discipline**

### **Admission Requirements**

Acceptance into the Joint Cognitive Science Ph.D. program is contingent upon admission into another degree-granting program at Indiana University Bloomington, hereafter referred to as the "originating discipline" or "originating department." Students must apply to the originating department, informing it that they also intend to join the Joint Cognitive Science Ph.D Program.

## Course Requirements

A minimum of 90 credit hours, of which 32 credit hours must be in courses listed or cross-listed in cognitive science, including COGS-Q 520 (3 cr.), COGS-Q 530 (3 cr.), COGS-Q 540 (3 cr.), COGS-Q 550 (3 cr.), COGS-Q 551 (3 cr.), COGS-Q 733: three semesters at 0 credits and one semester at 1 credit when the required colloquium is given by the student, and at least 6 credit hours of breadth coursework *not* in the originating discipline and *not* among the Q-courses or pure research courses such as Q799 and Q899. A Q-course that is not cross-listed in any other unit may satisfy the breadth requirement with the approval of the student's advisory committee. The 32 credit hours may include a maximum of 6 credit hours in pure research courses (COGS-Q 799, COGS-Q 899, or the equivalent in originating departments). Strong encouragement is given to interdisciplinary diversification. Note that courses may count toward the requirements of both cognitive science and the originating department.

## Tool-Skills Requirement

Statistics PSY-K 300 or PSY-K 310 or the equivalent.

## Qualifying Examination

There are two options for the qualifying examination: (a) an examination in the originating discipline and a separate comprehensive examination in cognitive science (these may be taken at separate times); or (b) a joint examination covering relevant areas of both the originating discipline and cognitive science, as determined by the advisory committee and with permission of both the originating discipline and the Cognitive Science Program. The cognitive science examination is normally taken after completion of the cognitive science course requirements. The examination may be repeated only once.

## Public Colloquium

The student must give a colloquium as part of the COGS-Q 733 colloquium series advertised at large to the university community, and covering some aspect of the student's research in cognitive science. The research covered may be from any stage of the student's career, including (but not restricted to) the thesis research.

## Final Examination

The public and oral defense of the dissertation will be conducted jointly with the student's originating discipline.

## Ph.D. Minor in Cognitive Science

Graduate students obtaining a Ph.D. in another discipline may find that that discipline gives them the option of taking a minor in cognitive science. To obtain such a minor, students must satisfy the following requirements: (a) obtain approval from the Cognitive Science Program; and (b) complete COGS-Q 540; one of the following: COGS-Q 530, COGS-Q 560, or COGS-Q 550; at least two semesters of COGS-Q 733; and at least 6 other credit hours in cognitive science and/or cross-listed courses not in the originating discipline.

## Certificates in Cognitive Science

The Cognitive Science Program is extremely broad, ranging from psychology to business to anthropology to computer science, to name just a few. Students in other disciplines may elect to focus on an area or areas within the broad range of cognitive science. Certificates are open to students upon request; several different cognitive science certificate programs are described in the following pages. Note that certificates are not required for a joint Ph.D. degree. The student will inform the cognitive science office, the student's cognitive science advisor, and the certificate director of intent to pursue a certificate.

## General Requirements for Certificates

1. As soon as the student decides to pursue a certificate, a written proposal must be submitted to the Certificate Steering Committee giving a detailed course of study. The proposal may be a revised draft of an earlier proposal not approved or an alteration of a previously approved proposal, and may contain a request for a revision of any of the stated requirements.
2. The proposal must be approved by the Certificate Steering Committee. The student must file a copy of the approved proposal with the Cognitive Science Program office.

3. The Certificate Steering Committee must attest that the approved course of study has been completed successfully. At this time, the University Graduate School will be notified of the certificate completion. Ideally, requirements and course work for certificates should be completed at the time of nomination to candidacy.
4. The certificate is awarded upon completion of requirements 1 through 3 and completion of the joint Ph.D. Achievement of the certificate will be noted on official transcripts.

## **Graduate Certificate in Dynamical Systems in Cognitive Science**

Students will develop an understanding of problems introduced by a dynamical perspective on cognitive phenomena and of the theoretical and methodological means of addressing those problems as found in dynamical systems. Each student will apply this understanding and analysis to a content area of their choice including study of perception, cognition, motor behavior, neural networks, language, and development.

### **Specific Requirements**

1. Prerequisites. Students should have taken courses in calculus (two to three semesters) at the very least. In addition, courses in differential equations, linear algebra, and (point set) topology would be helpful.
2. Required course. Students must take COGS-Q 580 Introduction to Dynamical Systems in Cognitive Science.
3. Additional advanced electives. Students must complete an additional four courses selected from among the following: COGS-Q 550 Models in Cognitive Science; PSY-P 651 Perception/Action; LING-L541 Phonetics; LING-L 641 Advanced Phonetics; PHIL-P 561 Philosophy of Mind; CSCI-B 551 Element of Artificial Intelligence; CSCI-B 552 Knowledge-Based Computation; CSCI-B 553 Biomorphing Computation; CSCI-B 651 Natural Language Processing; CSCI-B 652 Computer Models of Symbolic Learning; CSCI-B 657 Computer Vision; CSCI-B 659 Topics in Artificial Intelligence; PSY-P717 Evolutionary Basis of Learning; PSY-P 615 Developmental Psychology; COGS-Q 750 Neural Networks as Models of Cognition.
4. Qualifying exams. At least one question on dynamical systems must be included on the student's qualifying exams.
5. Dissertation. The student's dissertation must include application of dynamical systems to the specific problem under study.

## **Graduate Area Certificate in Human-Computer Interaction**

### **Requirements for the Cognitive Science Certificate in HCI (12 cr.)**

Students will demonstrate proficiency in a broad range of courses involving the applied cognitive analysis of human-computer interaction (HCI). The program will emphasize the theoretical and methodological issues associated with designing and evaluating cognitively compatible user interfaces to interactive technologies.

### **Specific Requirements**

1. The student must submit a written proposal to the Certificate Steering Committee giving a detailed course of study. The proposal may be a revised draft of an earlier proposal, or an alteration of a previously approved proposal, and may contain a request for a revision of any of the stated requirements. The proposal must be approved by the Steering Committee. Students must take SLIS-L 542 Introduction to HCI (or equivalent).

Students for the Cognitive Science Certificate must complete an additional four courses selected from among the following to ensure courses are taken from at least two departments other than the student's home department:

**CSCI-A 546 User Interface Programming**

**CSCI-B 581 Advanced Computer Graphics**

**CSCI-B 582 Image Synthesis**

**CSCI-B 665/B666 Software Engineering Management/Implementation**

**CSCI-B 669 Topics in Database and Information Systems**

**CSCI-B 689 Topics in Graphics and Human Computer Interaction**  
**INFO-I 502 Prototyping**  
**INFO-I 590 Pervasive and Ubiquitous Computing**  
**INFO-I 590 HCI Design I**  
**INFO-I 590 HCI II**  
**INFO-I 590 Usability**  
**SLIS-L 578 User Interface Design for Information Systems**  
**SLIS-L 579 Information Visualizations**  
**SLIS-L 642 Information Usage and the Cognitive Artifact**  
**SLIS-L 697 Advanced Topics in Information Systems**  
**EDUC-P 544 Applied Cognition and Learning Strategies**  
**CSCI-P 565-566 Software Engineering I-II**  
**EDUC-R 685 Human-Computer Interface Design**  
**EDUC-P 600 Topical Seminar in Learning Cognition and Instruction**  
**EDUC-P 544 Applied Cognition and Learning Strategies**  
**SPHS-S 522 Digital Signal Processing**  
**BUS-S 601 MIS Research Topics in Applications Systems Design**  
**BUS-S 602 MIS Research Topics in Administration and Technology**  
**TEL-T 571 Applied Emotional and Cognitive Psychology Theory**  
**TEL-T 602 Seminar in Processes and Effects: The Information Processing of Media**

2. The student's dissertation must address issues related to human-computer interaction.

The Cognitive Science Certificate in HCI is awarded upon completion of the above requirements and completion of the requirements for the Ph.D. (either as a joint major in Cognitive Science and a home department, or as a Cognitive Science minor and a major in a home department).

## **Graduate Area Certificate in Language and Speech**

Students will demonstrate proficiency in a broad range of topics that focus on issues related to language and speech. The program of study will emphasize mastery of language structure, language processing, and computational approaches to linguistic analysis. An independent research project exploring some facet of language and speech will be required.

### **Specific Requirements**

1. Students must complete at least five approved graduate courses in the area of language and speech.
2. Courses in language and speech must be taken in at least two different departments.
3. Courses must include at least one dealing with language structure and at least one dealing with language processing or acquisition. Courses in language structure include most linguistics courses, PHIL-P 520, and PHIL-P 720. Courses in processing and acquisition include PSY-P 623, CSCI-B 651, and periodic seminars on language-related topics in these departments.
4. Students must demonstrate familiarity with computer modeling. This requirement can be met through course work LING-L 545, LING-L 645, CSCI-B651 or another similar course approved by the certificate steering committee, or a written report of research on language or speech that includes a computer program written by the student. This report could be a master's or Ph.D. thesis.
5. The student's cognitive science qualifying examination must include at least one section on a topic in language and speech.
6. The student's dissertation must address issues related to language and speech.

## **Graduate Area Certificate in Logic, Language, and Computation**

The area covered by this certificate is applied logic; i.e., logic as applied to information processing. It is an area of research that is of increasing importance in artificial intelligence and computer science. Students will demonstrate their mastery of courses having to do with symbolic information processing.

### **Specific Requirements**

The requirements include at least 18 credit hours of course work (including research and seminars). At least two courses must be taken outside the student's home department. Each proposal for certification would need to demonstrate both breadth and depth in the general area of logic, language, and computation.

1. Prerequisites. Students should demonstrate mathematical maturity by having taken one or more courses in the following: set theory, discrete mathematics, abstract algebra, linear algebra, topology, and mathematical logic.
2. Students must take PHIL-P 505 Logical Theory I or CSCI-B 510 Intro to Applied Logic, and also PHIL-P 506 Logical Theory I-II, or demonstrate equivalent knowledge of completeness for first-order logic, together with the Gödel incompleteness and undecidability results. If students demonstrate knowledge of this material, they may take other courses from the lists of advanced courses given as follows.
3. Students must select at least two or more advanced courses from a list that includes CSCI-B 501 Theory of Computing; CSCI-P 514 Specification and Variation; PHIL P550 Systems of Modal Logic; PHIL-P 551 Philosophy and the Foundations of Mathematics; PHIL-P 552 Philosophy of Logic; LING-L 546 Semantics; LING-L 640 Quantitative Linguistics; MATH-M 682 Model Theory; and MATH-M 584 Recursion Theory.
4. Students must take a research seminar, either one generally designated as such. Some examples: PHIL-P 750 Seminar Logic, PHIL-P 751 Seminar Logic, or MATH-M 781-782 Selected Topics in Mathematical Logic), or another seminar approved by the Logic Certificate Committee.
5. Students will be expected to take active part in the weekly Logic Seminar.
6. The student's dissertation must address issues in the general area of logic, language, and computation.

### **Graduate Area Certificate in Modeling in Cognitive Science**

Students will demonstrate their mastery with a broad selection of courses involving mathematical and computer simulation approaches to modeling, with a specialization in at least one area of modeling, and with a research project involving modeling. The program will emphasize both basic techniques and applications in particular content areas.

### **Specific Requirements**

1. Students must fulfill 18 credit hours of courses in the modeling area. Required course: COGS-Q 550 Models in Cognitive Science, and at least five additional courses in modeling (15 credits minimum).
2. These courses must demonstrate both breadth and specialization, and a grasp of both methods and applications. The course options given below provide examples of courses currently appropriate to accomplish these goals.

The courses should include at least one course in basic techniques and methods (PSY-P 605 Introduction to Mathematical Psychology; COGS-Q 580 Introduction to Dynamic Systems in Cognitive Science; MATH-M 447- MATH-M 448 Mathematical Models and Applications; PHIL-P 550 Systems of Modal Logic); and at least one course in applications (COGS-Q 750 Neural Networks as Models of Cognition; CSCI-B 651 Natural Language Processing; CSCI-B 652 Computer Models of Symbolic Learning; LING-L 611 Models of Linguistic Structure; PSY-P 648 Choice Behavior).

The selected courses must be taken from at least two departments, excluding courses listed only in the Cognitive Science Program. These courses may not include a course whose content consists almost entirely of a research project (such courses and projects are separately covered as follows).

3. Students must demonstrate a grasp of modeling in research, either through course work (COGS-Q 689 Computer Simulation Project; PSY-P 556 Independent Computer Project), or through a written report of research involving modeling (includes master's or Ph.D. projects).
4. The Ph.D. qualifying examination in the Cognitive Science Program must contain at least one section on a modeling-related topic.



## Courses

**COGS-Q 520 Mathematics and Logic for Cognitive Science (3 cr.)** Covers the mathematical backgrounds of contemporary work in cognitive science. Includes basic material on both the symbolic and connectionist approaches: machines, logics, networks, games, and probability.

**COGS-Q 530 Programming Methods in Cognitive Science (3 cr.)** P: some programming experience. An introduction to computer programming methods for artificial intelligence and computer simulation of cognitive models. Emphasis on the necessary data structures and their applications to cognitive science. Programming projects may be related to state-space search for problem solving and game playing, production systems, and cognitive modeling tasks including memory models and neural simulations.

**COGS-Q 540 Philosophical Foundations of the Cognitive and Information Sciences (3 cr.)** Causal issues: cognitive architecture, physical embodiment, neuroscience, networks, dynamic systems. Semantic issues: meaning, interpretation, representation, information flow. The role of both in language, logic, reasoning, action, perception, learning, categorization, and consciousness. Emphasis on writing, analysis, and exposition.

**COGS-Q 550 Models in Cognitive Science (3 cr.)** P: Q530 and Q560. An introduction to modeling in various areas of cognitive science, including computer simulation models of complex cognition, models within artificial intelligence, models based on neural mechanisms and networks, and formal and mathematical models in areas such as psychology, linguistics, and philosophy.

**COGS-Q 551 The Brain and Cognition (3 cr.)** An introduction to neural mechanisms underlying complex cognition, and a survey of topics in neuroscience related to cognition. It provides a solid background in human biopsychology.

**COGS-Q 560 Experimental Methods in Cognitive Science (3 cr.)** Specific goals of this course include: a) an understanding of experimental design and the resources for future studies; b) an understanding of converging measures and programmatic research; c) discussion of current controversies in experimental design; and d) hands-on experience in designing, conducting, and critiquing experiments.

**COGS-Q 580 Introduction to Dynamic Systems in Cognitive Science (3 cr.)** Introduction to linear and nonlinear dynamic systems including catastrophe and chaos theory. Main aspects include: a) understanding the basic quantitative theory and techniques of dynamic systems, b) illustration of major concepts and systems behavior with the aid of computer graphics and numerical software, and c) examples from cognitive science.

**COGS-Q 689 Computer Simulation Project (3 cr.)** The student will develop and test a computer simulation of some aspect of cognition. The student will produce a working, documented computer program, and a paper describing both the workings of the program and tests of the program (either theoretical tests, tests of the program against data, or both).

**COGS-Q 700 Seminar in Cognitive Science (3 cr.)** Intensive study of specific topics in cognitive science. Topics and instructors will change regularly. May be repeated.

**COGS-Q 733 Colloquium Series (0-1 cr.)** Three semesters at zero credits and one semester at one credit when the required colloquium is given by the student. The class will meet every week. At some meetings, invited speakers will present colloquia; at others, students will present their own work. Each student will be required to make a presentation at least once during the year the course is taken for credit.

**COGS-Q 750 Neural Networks as Models of Cognition (3 cr.)** Topical seminar featuring analysis of models based on neural networks. Will usually feature extensive exploration of one or more examples of models of this type.

**COGS-Q 799 Readings and Research in Cognitive Science (1-6 cr.)** Tutorial research and study in specialized topics in cognitive science.



**COGS-Q 899 Dissertation Research (1-12 cr.)** Dissertation research in specialized topics in cognitive science.

## **Cross-Listed Courses**

The following courses may be used to satisfy the credit hour requirements of the Cognitive Science Program. Additional courses whose content in a given year is sufficiently relevant to cognitive science (including seminars, new courses, or courses with topical content) may also be used to satisfy the requirements, conditional upon acceptance by the Cognitive Science Program of a petition including justification.

### **Anthropology**

**ANTH-L 580 Semiotics and Human Ethology (2 cr.)**

**ANTH-L 840 Ethnolinguistic Seminar (1-2 cr.)**

### **Kelley School of Business**

**BUS-S 505 Introduction to Management Information Systems (3 cr.)**

**BUS-S 535 Advanced Topics in Management Information Systems (3 cr.)**

**BUS-S 560 Management Information Systems Design and Applications (3 cr.)**

**BUS-S 600 Research Design and Methods in Management Information Systems (3 cr.)**

**BUS-S 601 Management Information Systems Research: Topics in Application Systems Development (3 cr.)**

**BUS-S 602 Management Information Systems Research: Topics in Administration and Technology (3 cr.)**

### **Computer Science**

**CSCI-B 501 Theory of Computing (3 cr.)**

**CSCI-B 502 Computational Complexity (3 cr.)**

**CSCI-B 510 Introduction to Applied Logic (3 cr.)**

**CSCI-B 521 Programming Language Principles (3 cr.)**

**CSCI-B 522 Programming Language Foundations (3 cr.)**

**CSCI-B 551 Elements of Artificial Intelligence (3 cr.)**

**CSCI-B 552 Knowledge-Based Computation (3 cr.)**

**CSCI-B 553 Biomorphic Computation (3 cr.)**

**CSCI-B 621 Advanced Concepts in Programming Languages (3 cr.)**

**CSCI-B 622 Programming Language Type Systems (3 cr.)**

**CSCI-B 651 Natural Language Processing (3 cr.)**

**CSCI-B 652 Computer Models of Symbolic Learning (3 cr.)**

**CSCI-B 657 Computer Vision (3 cr.)**

**CSCI-B 659 Topics in Artificial Intelligence (1-6 cr.)**

### **Economics**

**ECON-E 626 Game Theory (3 cr.)**

### **School of Education**

**EDUC-H 650 Theory of Knowledge and the Educational Process (3 cr.)**

**EDUC-P 530 Instructional Psychology (3 cr.)**

**EDUC-P 540 Learning and Cognition in Education (3 cr.)**

**EDUC-P 544 Applied Cognition and Learning Strategies (3 cr.)**

**EDUC-P 550 Cognition and Semiotics (3 cr.)**

**EDUC-P 591 Cognitive Assessment and Intervention (3 cr.)**

**EDUC-P 600 Topical Seminar in Learning, Cognition, and Instruction (3 cr.)**

**EDUC-P 640 Thinking and Learning in Social Contexts (3 cr.)**

**EDUC-R 542 Instructional Graphics Design (3 cr.)**

**EDUC-R 561 Evaluation and Change in the Instructional Development Process (3 cr.)**

**EDUC-R 586 Practicum in Instructional Systems Technology (1-3 cr.)**

**EDUC-R 611 Instructional Technology Foundations (1 cr.)**

**EDUC-R 622 Learning Environments Design (3 cr.)**

**EDUC-R 630 Learner Analysis in the Instructional Technology Process (3 cr.)**

**EDUC-R 695 Topical Inquiry Seminar in Instructional Systems Technology (3 cr.)**  
**EDUC-Y 530 Topics in Computer Analysis of Educational Data (1-3 cr.)**

#### **Folklore and Ethnomusicology**

**FOLK-F 714 Paradigms of Ethnomusicology (3 cr.)**  
**FOLK-F 722 Colloquium in Theoretical Folklore/Ethnomusicology (3 cr.)**  
**FOLK-F 738 Psychological Issues in Folklore (3 cr.)**

#### **French and Italian**

**FRIT-F 576 French Linguistics I (Phonology) (3 cr.)**  
**FRIT-F 577 French Linguistics II (Syntax and Semantics) (3 cr.)**  
**FRIT-F 580 Introduction to French Applied Linguistics (3 cr.)**  
**FRIT-F 603-F604 History of the French Language (3 cr.)**  
**FRIT-F 670 Phonological Structure of French (3 cr.)**  
**FRIT-F 671 Syntactic Structure of French (3 cr.)**  
**FRIT-F 672 French Sociolinguistics and Dialectology (3 cr.)**  
**FRIT-F 673 Topics in the Learning and Teaching of French (3 cr.)**  
**FRIT-F 675 Studies in French Linguistics (3 cr.)**  
**FRIT-F 676 Structure and Sociolinguistics of Haitian Creole (3 cr.)**  
**FRIT-F 677 French Lexicology and Lexicography (3 cr.)**  
**FRIT-F 678 French Morphology (3 cr.)**

#### **School of Health, Physical Education, and Recreation**

**HPER-K 542 Neuromuscular Control of Movement (3 cr.)**

#### **History and Philosophy of Science**

**HPSC-X 551 Survey of the Philosophy of Science (3 cr.)**  
**HPSC-X 552 Modern Philosophy of Science (3 cr.)**  
**HPSC-X 755 Special Topics in the Philosophy of Science (2-5 cr.)**

#### **Informatics**

**INFO-I 502 Prototyping**  
**INFO-I 590 Topics in Informatics (When Appropriate)**

#### **School of Library and Information Science**

**SLIS-L 542 Introduction to Human-Computer Interaction (HCI) (3 cr.)**  
**SLIS-L 570 Online Information Retrieval (3 cr.)**  
**SLIS-L 578 User Interface Design for Information Systems (1-3 cr.)**  
**SLIS-L 579 Information Visualization (3 cr.)**  
**SLIS-L 597 Topics in Library and Information Science (1-4 cr.)**  
**SLIS-L 642 Information Usage and the Cognitive Artifact (3 cr.)**

#### **Linguistics**

**LING L 503 Survey of Linguistics I (3 cr.)**  
**LING L 530 Introduction to Historical Linguistics (3 cr.)**  
**LING L 541 Introductory Phonetics (4 cr.)**  
**LING L 542 Phonological Analysis (3 cr.)**  
**LING L 543 Syntactic Analysis (3 cr.)**  
**LING L 544 Morphological Analysis (3 cr.)**  
**LING L 545 Computation and Linguistic Analysis (3 cr.)**  
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