

## Architectural Engineering (ARE)

### 5400. Building Energy Management. 3.

A rigorous treatment of issues related to the judicious use of energy in the design and use of buildings is provided. Energy-efficient HVAC systems and system control, energy-conscious building design, building energy analysis, auditing, building envelope, energy-efficient lighting design, energy management programs, energy sources and conservation, rate schedules, waste-heat recovery, passive solar heating/cooling and daylighting. *Prerequisites:* ARE 3430, 4460.

## Department of Computer Science

4083 Engineering Building, 766-5190

FAX: (307) 766-4036

Web site: [www.cs.uwyo.edu](http://www.cs.uwyo.edu)

Department Head: Jerry Hamann

### Professors:

**THOMAS A. BAILEY, JR.**, B.S. Alma College 1964; M.S. University of Colorado 1969; Ph.D. Michigan State University 1978; Professor of Computer Science 1998, 1980.

**JOHN R. COWLES**, B.A. University of Wyoming 1968; M.A. University of Nebraska 1970; Ph.D. Pennsylvania State University 1975; Professor of Computer Science 1992, 1978.

**JEFFREY VAN BAALEN**, B.S. University of Wyoming 1977; M.S. 1980; Ph.D. Massachusetts Institute of Technology 1988; Head of the Department of Computer Science 2000; Professor of Computer Science 2002, 1991.

### Associate Professors:

**JAMES L. CALDWELL**, B.S. State University of New York 1984; M.S. 1988; M.S. Cornell University 1995; Ph.D. 1998; Associate Professor of Computer Science 2004, 1998.

**RUBEN GAMBOA**, B.S. Angelo State University 1984; M.S. Texas A&M University 1986; Ph.D. The University of Texas 1999; Associate Professor of Computer Science 2007, 2002.

**JERRY C. HAMANN**, B.S. University of Wyoming 1984; M.S. 1988; Ph.D. University of Wisconsin-Madison 1993; Associate Professor of Electrical and Computer Engineering 1999, 1993.

### Assistant Professors:

**JOHN M. HITCHCOCK**, B.S. Iowa State University 1999; M.S. 2001; Ph.D. 2003; Assistant Professor of Computer Science 2003.

**LIQIANG WANG**, B.S. Hebei Normal University 1995; M.Eng. Sichuan University 1998; M.S. SUNY Stony Brook 2003; Ph.D. 2006; Assistant Professor of Computer Science 2006.

### Lecturers:

Anderson, Buckner, Ward

### Professor Emeritus:

Henry R. Bauer III

### Lecturer Emeritus:

Jeri R. Hanly

The Department of Computer Science offers graduate work leading to the master of science degree in computer science and the doctor of philosophy in computer science.

### Program Specific Admission Requirement

Applicants must meet the minimum standards of the university.

Acceptance will be based on the student's academic records.

For the master's degree and the Ph.D. program, the following courses or their equivalent are considered preparatory for graduate work in computer science: COSC 3020, COSC 4100 or 4200, COSC 4740, and COSC 4780 or 4785. Students admitted to the program must show proficiency in these courses.

An applicant whose previous studies are in a field significantly removed from computer science may be admitted to the regular master's degree or the Ph.D. program on the condition that he or she take additional courses to remove deficiencies in his or her computer science background.

Admission to the master's degree program or the conferring of a master's degree will not constitute a de facto admission to the Ph.D. program.

The curriculum is divided into four areas of study. These areas represent current areas of interest and expertise on the part of the faculty and are subject to change.

**Computer Theory** includes the theoretical and structural study of algorithms, automata, computability, computational complexity, information, formal languages, models, mathematical logic, recursive functions and sequential machines.

**Parallel Computing and Systems** includes the design, development and evaluation of computing machines, computing languages, language processors, operating systems and special purpose systems. It is further concerned with the analysis of complex problems into subparts that can be handled by multiple processors located at one or more sites and coordinated so as to produce a complete solution.

**Mathematical Computation and Modeling** includes numerical solution of algebraic equations and systems of equations, numerical differentiation and integration, interpolation, optimization and linear programming, matrix computation, eigenvalues and eigenvectors, numerical solution of differential equations and approximation theory.

**Machine Intelligence** is concerned with endowing machines with such manifestations of human intelligence as vision, spoken language recognition, knowledge representation, task planning, the application of search procedures to problem solving, question answering, inference, and the dispensing of expert knowledge and advice.

### Program Specific Degree Requirements

All students must complete COSC 5050 (Research Writing for Computer Science).

At least 15 hours applied to the degree program must be in courses offered by the computer science department, not including the 14 hours of courses considered preparatory and not including seminars, individual projects, COSC 5050 or reading courses. Courses cross listed with computer science department courses will be considered computer science department courses.

No more than 6 hours from the 4000 level preparatory coursework may be counted toward the total credit requirement. At most 2 hours from the 4000 level preparatory coursework may be counted toward an area requirement. All required preparatory coursework will be listed on the program of study with the corresponding increase in total hours required.

The student must complete at least one 5000-level computer science course, not including seminars, individual projects or reading courses, offered by the computer science department in the following areas: a) Computer Theory and b) Parallel Computing and Systems.

The student must complete at least 8 hours of courses in each of two areas of study. These two areas will be called major areas. The 8 credit hours in each of two areas of study must be completed from the current list of courses designated to satisfy the area of study requirements. "Current list" is defined to mean the list in effect when the student enters the graduate program or any succeeding list.

The graduate examination, which serves as the Ph.D. qualifying examination, will also be administered to Plan B master's students, who will be required to pass two areas in order to receive their degrees. Passing criteria will be determined by the student's graduate committee. In addition, both Plan A and Plan B students are required to formally defend their papers before their graduate committees. Plan A students must give a public colloquium on their research prior to their formal defense. All defenses must be open and announced three weeks in advance.

### Master's Program Plan A (thesis)

The student must complete a minimum of 29 hours of courses, including at least two COSC 5000 seminars.

The student must complete a minimum of 4 hours of 5960, Thesis Research.

At least two-thirds of the coursework (20 hours) must consist of computer science department courses.

### Plan B (non-thesis)

The student must complete a minimum of 33 hours of courses, including at least two COSC 5000 seminars, and present a paper as described in the general requirements for Plan B.

### Doctoral Program

Each doctoral student will have a supervising committee of five members appointed. The primary functions of this committee are to suggest coursework, to administer the preliminary and final examinations, and to oversee and evaluate the research of the candidate. The committee will consist of at least three members of the computer science department faculty and at least one non-COSC graduate faculty member. The standards that this committee should consider when recommending programs of study are outlined in the following sections.

A total of at least 72 credit hours must be completed. A minimum of 42 of these credit hours must be taken as coursework. At least 21 hours must be taken at the 5000 level (COSC 5050 may not be applied to this requirement). Each doctoral student must participate in at least four graduate seminars. A minimum of 12 hours of dissertation research must be taken.

A program of original and innovative research will be undertaken by the candidate. At the end of this program, the candidate will document this research in a dissertation. The dissertation will present the details and results of the candidate's research in addition to providing a critical comparison with related published works.

Each successful doctoral student must pass three examinations. These include a qualifying examination, a preliminary examination, and a final (dissertation) defense.

The departmental graduate examination will serve as the Ph.D. qualifying examination. This examination will be given once each year during the spring semester, and should be taken during the fourth semester of graduate study. The graduate examination will test knowledge and reasoning skills based on the upper-division preparatory courses as well as on graduate courses in the core areas. Ph.D. students will be required to answer questions from the undergraduate core courses but will be given greater flexibility to select questions from the graduate courses.

A preliminary examination will consist of a presentation and defense of the proposed dissertation research. This examination is intended to motivate the candidate to review relevant literature extensively prior to pursuing the original and innovative portions of the research. If the nature of the proposed research and methodology are deemed to be both appropriate and significant by the supervisory committee, then the committee will approve the research direction after having administered this examination.

The final examination (dissertation defense) will consist of an oral presentation by the candidate of his/her research and the results that were derived. At this examination, the candidate is expected to defend the research as being original and contributory to the discipline of computer science.

All Ph.D. candidates must satisfactorily complete COSC 5050 (Research Writing for Computer Science).

Information concerning timeline and deadlines for meeting doctoral degree requirements is available from the department office.

### Academic Dishonesty

For cases in which a graduate student has admitted to an act of academic dishonesty or has been found culpable through university procedures according to University Regulation 6-802, the graduate committee will meet with the student and faculty member(s) involved to assess the severity of the act. Both the faculty member(s) and the student will be afforded the opportunity to present views and information relevant to the act. The graduate committee may then take action by recommending that the student be terminated from graduate study in the department (for flagrant violations) or that a letter of reprimand be sent to the student with a copy sent to the Office of the Registrar.

## Computer Science (COSC)

**5000. Seminar in Computer Science. 1-3. (Max. 10).** One or more current research areas in computer science are investigated. *Prerequisite:* consent of instructor.

**5010. Graduate Topics in Computer Science. 1-6 (Max. 12).** Individual or small group pursuit of computer science research areas. (Max. of 12 hours from COSC 4010 and COSC 5010 may be applied to graduate study). *Prerequisites:* graduate standing and consent of instructor.

**5020. Advanced Topics in Computer Science. 1-6 (Max. 12).** Advanced topics in computer science. (A maximum of 12 hours may be applied to graduate study.) *Prerequisites:* graduate standing and consent of instructor.

**5050. Research Writing in Computer Science. 3.** Instruction in methods for performing and reporting research in the field of computer science. The primary task is preparation of a research paper; to that end, the class covers how to collect and analyze previously published work, generate and develop a research topic, and present research results in acceptable written form. *Prerequisite:* graduate standing, consent of instructor.

**5110. Analysis Of Algorithms. 3.** Analysis of algorithms to determine their time and space requirements. Beginning with data structures such as lists, stacks, trees, and sets and their implementations. The class then analyzes specific algorithms for internal sorting, hashing, and string search. Offered fall semester of even numbered years. *Prerequisites:* COSC 3020 or equivalent and consent of the department.

**5120. Theory Of Computation. 3.** Models of computation, the Church-Turing thesis, computable functions, decidable and enumerable sets, unsolvable problems, correctness of programs, and complexity of computation. The theory of computation provides precise answers to the fundamental questions of computer science: Which problems can be solved by machine computation and which can be solved using a reasonable amount of computer resources. *Prerequisite:* COSC 4100.

**5200. Computational Complexity. 3.** Study of efficient computation and computational intracability. Time and space complexity; P, NP, and the polynomial-time hierarchy; reductions and completeness; randomized complexity; non-uniform complexity; approximation algorithms and inapproximability. *Prerequisite:* COSC 4100 or COSC 4200.

**5220. Languages and Automata. 3.** The study of regular, context-free, and context-sensitive languages and their relations to finite-state, pushdown and linear-bounded automata. Context-free language recognition. The halting problem and decidability results. *Prerequisite:* COSC 4100.

**5310. Computational Methods in Applied Sciences I. 3.** First semester of a three-semester computational methods series. Review of iterative solutions of linear and nonlinear systems of equations, polynomial interpolation/approximation, numerical integration and differentiation, and basic ideas of Monte Carlo methods. Comparison of numerical techniques for programming time and space requirements, as well as convergence and stability. Cross listed with MATH 5310. *Prerequisites:* MATH 3310, COSC 1010.

**5340. Computational Methods in Applied Sciences II. 3.** Second semester of a three-semester computational methods series with emphasis on numerical solution of differential equations. Topics include explicit and implicit methods, methods for stiff ODE problems, finite difference, finite volume and finite element methods for time-independence PDEs, semi/fully discrete methods for time-dependent PDEs. Cross listed with MATH 5340. *Prerequisite:* MATH/COSC 5310.

**5345. Computational Methods in Applied Sciences III. 3.** Third semester of a three-semester computational methods series with emphasis on numerical solution of problems displaying sharp fronts and interfaces (nonlinear conservation laws, Hamilton-Jacobi equations. Cross listed with MATH 5345. *Prerequisite:* MATH/COSC 5340.

**5350. System Simulation. 3.** Introduces simulation and comparison with other techniques. Studies discrete simulation models, and introduction to, or review of, queuing theory and stochastic processes. Compares discrete change simulation languages. Examines simulation methodology including generation of random numbers and variates, design of simulation experiments for optimization, analysis of data generated by simulation models and results. Selected applications of simulation. Dual listed with COSC 4350. *Prerequisite:* COSC 3020, MATH 4250 or STAT 2010. Additional work is assigned for those enrolled for graduate credit.

**5450. Computer Graphics. 3.** Introduction to computer graphics, an increasingly important area of computer science. Computer graphics, together with multimedia and the world-wide web, offers exciting new possibilities for the design of human-computer interfaces. Presents the principles, techniques, and tools that enable these advances. Dual listed with COSC 4450. *Prerequisites:* COSC 3020, MATH 2250.

**5540. Computer Vision. 3.** Provides students with an understanding of applying computer methodologies to process two-dimensional and three-dimensional images. Primary areas of investigation are image preprocessing, knowledge representation, pattern recognition and motion understanding. *Prerequisites:* COSC 3020, MATH 2205, MATH 2250.

**5550. Introduction to Artificial Intelligence. 3.** A computational study of intelligent behavior. The focus is on intelligent agents, which could be software agents or robots. Covers how agents sense, reason, and act within their environment. Includes problem-solving, search, knowledge representation, planning, game playing, learning, and neural and belief networks. Dual listed with COSC 4550. *Prerequisite:* COSC 3020.

**5555. Machine Learning. 3.** To program machines to learn and improve their performance on their own, based on experience and/or data. The first part covers machine learning techniques. The second part covers applications. Dual listed with COSC 4555. *Prerequisite:* COSC 3020.

**5560. Modern Robots and Softbots. 3.** Begins with a presentation of popular agent designs: logic-based, biomimetic, and physicomimetic. Presents foundational issues on internal robot and softbot knowledge representations. Planning and control are then covered, followed by issues of how agents can reason and plan under real-world conditions of environmental uncertainty. Concludes with discussions about papers on modern robot and softbot applications, as well as invited lectures by graduate students and faculty in the UW COSC and ECE departments. Dual listed with COSC 4560. *Prerequisites:* none.

**5640. Automated Reasoning. 3.** Study of programs, such as automated theorem provers, which require the use of "intelligence" to solve problems. Topics include resolution, unification, proof strategies, induction based theorem provers, expert systems, and Prolog. *Prerequisite:* COSC 4100.

**5700. Computer Architecture. 3.** A study of the interaction between computing and computer architecture. Memory hierarchies: segmentation, paging, and caches. CPU organizations: pipelining, array processors, parallelism. IO: channels, DMA, auxiliary CPU's. Interprocessor communication in multi-CPU systems. *Prerequisites:* COSC 4740 and 4700.

**5740. Advanced Operating Systems. 3.** Advanced course in operating systems design and implementation. Emphasis on multiprocessing and distributed systems and study of mechanisms for their control. Topics include concurrency control, deadlock memory management, security, and reliability. *Prerequisite:* COSC 4740.

**5750. Distributed Computing Systems. 3.** Provides an in-depth study of distributed computing systems, including both architecture and software issues. Topics include concepts of distributed computing, communication primitives, distributed operating systems, distributed file management, and distributed programming languages. Particular attention is paid to modeling and analysis of distributed systems and algorithms. Programming projects and research papers are assigned. *Prerequisite:* COSC 5740.

**5755. Network Applications. 3.** Introduces the structure, implementation, and theoretical underpinnings of computer networking and the applications that have been enabled by that technology. Dual listed with COSC 4755. *Prerequisite:* COSC 3020.

**5785. Compiler Construction I. 3.** Theory and implementation of interpreters and compilers. Compiler topics include lexical analysis, top-down and bottom-up parsing methods, symbol tables, and code generation for a block-structured language with recursion and parameters. Project uses compiler writing tools. Dual listed with COSC 4785. *Prerequisite:* COSC 3020.

**5790. Compiler Construction II. 3.** Advanced topics concerning the front end of a programming language compiler, the description and implementation of features found in the back end of a compiler, and the run time environment. Topics include data type checking, global data flow analysis, flow graph reduction, local and global code optimization, and code generation. Reports on recent research papers. *Prerequisite:* COSC 4785 or 5785.

**5820. Database Systems. 3.** Provides comprehensive coverage of the problems involved in database design, in-depth coverage of data models and database languages. Students acquire practical skills of conceptual/logical database design and general familiarity with the problems and issues of database management. *Prerequisite:* COSC 3020.

**5825. Advance Data Systems. 3.** Provides comprehensive coverage of the problems involved in database system design and an in-depth examination of contemporary structures and techniques used in modern database management systems and database applications. *Prerequisite:* COSC 4820.

**5840. Software Engineering Management. 3.** Management issues in the development of software systems. Topics include planning documentation for requirements, design, implementation and testing, cost projection and modeling, documentation standards, code control, tracking of defects, management psychology, group interaction and communication, and the management of reviews and walk through. *Prerequisites:* COSC 4740, 4780 or equivalent and consent of the department.

**5850. Software Management Laboratory. 3.** Laboratory course designed to illustrate the principles discussed in COSC 5840. Students are team leaders on a project which involves the integration, testing, and maintenance of a large software system. The project is the same as that used for COSC 4850. *Prerequisite:* COSC 5840.

**5880. Software Verification and Validation. 3.** Concepts and practices for assuring the quality of software systems. Covers test planning, operational testing, formal verification, proofs of correctness, and validation testing. *Prerequisite:* COSC 3020 or COSC 4050.

**5900. Practicum in College Teaching. 1-3 (Max. 3).** Work in classroom with a major professor. Expected to give some lectures and gain classroom experience. *Prerequisite:* graduate standing.

**5920. Continuing Registration: On Campus. 1-2. (Max 16).** Prerequisite: advanced degree candidacy.

**5940. Continuing Registration: Off Campus. 1-16 (Max. 16).** Prerequisite: advanced degree candidacy.

**5959. Enrichment Studies. 1-3 (Max. 3).** Designed to provide an enrichment experience in a variety of topics. Note: credit in this course may not be included in a graduate program of study for degree purposes.

**5960. Thesis Research. 1-12 (Max. 24).** Designed for students who are involved in research for their thesis project. Also used for students whose coursework is complete and are writing their thesis. Prerequisites: enrollment in a graduate degree program.

**5980. Dissertation Research. 1-12 (Max. 48).** Designed for students who are involved in research for their dissertation project. Also used for students whose coursework is complete and are writing their dissertation. Prerequisites: enrollment in a graduate level degree program.

**5990. Internship. 1-12 (Max. 24).** Prerequisite: graduate standing.

## Department of Electrical and Computer Engineering

5068 Engineering Building, 766-2279

FAX: (307) 766-2248

Web site: [www.eng.uwyo.edu/electrical](http://www.eng.uwyo.edu/electrical)

Department Head: Mark J. Balas

### Professors:

**MARK J. BALAS**, B.S. University of Akron 1965; M.A. University of Maryland 1970; M.S. University of Denver 1974; Ph.D. 1974; Professor of Electrical Engineering 2004.

**STANISLAW F. LEGOWSKI**, M.Sc. Technical University of Gdansk, Poland 1962; Ph.D. 1971; Professor of Electrical Engineering 1993, 1983.

**JOHN E. McINROY**, B.S. University of Wyoming 1986; M.S. Rensselaer Polytechnic Institute 1988; Ph.D. 1991; Professor of Electrical Engineering 2002, 1991.

**JOHN W. PIERRE**, B.S. Montana State University 1986; M.S. University of Minnesota 1989; Ph.D. 1991; Professor of Electrical Engineering 2002, 1991.

**A. H. M. SADRUL ULA**, B.Sc.E.E. Engineering College in Bangladesh 1968; M.Sc.E.E. University of Engineering and Technology in Bangladesh 1973; Ph.D. University of Leeds 1977; Professor of Electrical Engineering 1992, 1982.

**DAVID L. WHITMAN**, B.S. University of Wyoming 1975; Ph.D. 1978; Professor 1991, 1986, 1981.

### Associate Professors:

**STEVEN F. BARRETT**, B.S. University of Nebraska 1979; M.E. University of Idaho 1986; Ph.D. University of Texas 1993; Associate Professor of Electrical Engineering 2005, 1999.

**EVA S. FERRE-PIKAL**, B.S. University of Puerto Rico 1988; M.S. University of Michigan 1989; Ph.D. University of Colorado 1996; Associate Professor of Electrical Engineering 2004, 1998.

**JERRY C. HAMANN**, B.S. University of Wyoming 1984; M.S. 1988; Ph.D. University of Wisconsin-Madison 1993; Associate Professor of Electrical Engineering 1999, 1993.

**ROBERT F. KUBICHEK**, B.S.C.S., B.S.E.E. University of Wyoming 1976; M.S. 1977; Ph.D. 1985; Associate Professor of Electrical Engineering 1997, 1991.

**SURESH S. MUKNAHALLIPATNA**, B.E. University of Bangalore, India 1988; M.E. 1991; Ph.D. University of Wyoming 1995; Associate Professor of Electrical Engineering 2003, 1997.

**JON M. PIKAL**, B.S. Purdue University 1988; M.S. University of Colorado 1993; Ph.D. Colorado State University 1999; Associate Professor of Electrical Engineering 2005, 1999.

**CAMERON H.G. WRIGHT**, B.S. Louisiana Tech University 1983; M.S. Purdue University 1988; Ph.D. University of Texas 1996; Associate Professor of Electrical Engineering 2008, 2003.

### Assistant Professors:

**JOHN F. O'BRIEN**, B.S. California State Polytechnic University, Pomona 1991; M.S. University of Wyoming 1997; Ph.D. Rensselaer Polytechnic Institute 2001; Assistant Professor of Electrical Engineering 2003.

**MARGARETA STEFANOVIC**, Dipl. Ing., University of Nis, Yugoslavia 1996; M.S. University of Southern California 2002; Ph.D. 2005; Assistant Professor of Electrical Engineering 2005.

### Academic Professional:

**JEFFREY R. ANDERSON**, B.S.E.E. University of Utah 1989; M.S.E.E. 1992; Ph.D. University of Wyoming 2004; Assistant Academic Professional Lecturer in Electrical and Computer Engineering 2006.

### Professors Emeriti:

Christos T. Constantinides, Jerry J. Cupal, Clifford D. Ferris, Raymond G. Jacquot, John W. Steadman

The department offers programs of study leading to the degrees of master of science and doctor of philosophy in electrical engineering. The areas of major concentration at the graduate level are: control systems (including robotics and electrical energy), electronic systems and devices (including material devices and RF circuits), and signal processing (including image processing, computer vision, and biomedical instrumentation) and computer networks. The department also offers a combined B.S./M.S. program for exceptional students wishing to obtain both degrees in a shorter period of time (see below).

## Program Specific Admission Requirements

Statement of purpose

Official transcripts from all post-secondary institutions attended

GRE verbal percentile minimum of 40 percent

GRE quantitative percentile minimum of 65 percent. ETS only reports GRE scores taken within five years of the date of request

TOEFL total of 550 or 79 iBT

## Program Specific Graduate Assistantships

The English Proficiency Assessment (EPA) is mandatory for incoming non-native English speaking international GAs with responsibilities in instruction. The English Proficiency Assessment is recommended for all international graduate students regardless of teaching responsibilities. Students also will need to follow recommendations for English language advancement.

## Program Specific Degree Requirements

### Master's Programs

#### Plan A (thesis)

This is a 30 hour program, 26 hours coursework and 4 hours of thesis

16 (minimum) in ECE formal coursework

3 (minimum) in formal coursework outside the department and approved by the student's committee

7 additional credits in or out of the department with committee approval

4 or more credits of M.S. thesis research

Of the above credit hours in formal coursework, no more than 12 can be 4000 level

#### Plan B (non-thesis)

This is a 30 hour program:

16 (minimum) in ECE formal coursework

3 (minimum) in formal coursework outside the department and approved by the student's committee

11 additional credits in or out of the department with committee approval

Of the above credit hours in formal coursework, no more than 12 can be 4000 level.

The candidate must meet the minimum

requirements for the master of science degree and complete a plan B project

Satisfying the "Plan B project" can be completed in one of the following ways:

Complete a project for a 5000-level EE course, including a class presentation

Complete an independent project under EE 5880 (up to three credit hours), including a presentation