Donaghey College of Engineering and Information Technology (EIT)

EIT Building, Room 621, (501) 569-3333, (501) 569-8002 (fax), ualr.edu/eit/

Professor Eric Sandgren, Dean

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The mission of the Donaghey College of Engineering and Information Technology is to educate the next generation of technical professionals in the skills and knowledge base necessary to create and manage the technology based enterprises that will provide future economic growth and an improved standard of living for the State of Arkansas and its citizens. The College's expectation is for every Arkansas child to have the opportunity to participate in the new knowledge-based digital economy of the 21st Century. This mission includes technological education at all levels, from high school through advanced graduate degrees, as well as contributions through scholarly research and community involvement.

In meeting this mission, the College offers a wide range of graduate degrees. Graduate students have the option to pursue a Ph.D. in Integrated Computing or Engineering Science and Systems. The College participates in the M.S.-Ph.D. program in Bioinformatics (See program entry in the College of Science) offered jointly with the University of Arkansas for Medical Sciences. Additional graduate programs in the College include an M.S. degree in Computer Science, an M.S. degree in Construction Management, a graduate certificate program and an MS degree in Information Quality as well as a graduate certificate program in Technology Innovation. It also offers a graduate certificate program and an M.S. degree in Systems Engineering. Extensive outreach to the general undergraduate population is through our Computer Literacy classes and the acclaimed Information Technology (IT) Minor, designed to provide the non-technology majors with the IT tools necessary to command leadership positions in today's IT-enabled enterprises.

Outreach to the community includes the IT certificate program for in-service learning and extensive partnering with high schools across the state for in-school activities and summer programs. Specific emphasis is on partnerships with the local and regional industries ranging from direct company input into our programs to in-service courses to directed research projects.

Program	Certificate or Degree Program	Department
Bioinformatics	Master's (M.S.)	Multi-departmental joint degree
Bioinformatics	Doctorate (Ph.D.)	Multi-departmental joint degree
Computer Science	Master's (M.S.)	Computer Science
Construction Management	Master's (M.S.)	Construction Management and Civil and Construction Engineering
Engineering Science & Systems	Doctorate (Ph.D.)	Systems Engineering
Information Quality	Graduate Certificate	Information Science
Information Quality	Master's (M.S.)	Information Science
Integrated Computing	Doctorate (Ph.D.)	Computer Science
Systems Engineering	Graduate Certificate	Systems Engineering
Systems Engineering	Master's (M.S.)	Systems Engineering
Technology Innovation	Graduate Certificate	Information Science

Bioinformatics

EIT, Room 303
(501) 569-8501

The University of Arkansas at Little Rock (UALR) and the University of Arkansas for Medical Sciences (UAMS) jointly offer master's and doctorate degrees in bioinformatics. Combining the academic, clinical, and research resources of UAMS with the computational, scientific, academic, and research capabilities of UALR, this program prepares students to function in an interdisciplinary research environment. For more information, visit the Bioinformatics graduate program's website at bioinformatics.ualr.edu/grad.

Admission Requirements for both MS and Ph.D.

Applicants are expected to have a minimum of a four-year undergraduate degree (BS or BA) in the life sciences, statistics, or information/computer sciences. Students with an undergraduate degree in another field may be considered for admission if they have either relevant work experience in one of these three areas or complete sufficient remedial course work as defined below. Students who have not satisfactorily completed the following courses, or their equivalent, as part of their academic studies will be required to complete them on a remedial basis:

Genetics

A junior-level, life science course equivalent to UALR's BIOL 3300 Genetics

Statistics

A junior-level, calculus-based course equivalent to UALR's STAT 3352 Applied Statistics I

Programming

Some programming experience; a sophomore-level introduction to Java programming equivalent to UALR's *IFSC 2300 Object-Oriented Technology* course is preferred

Databases

A junior-level course equivalent to UALR's *IFSC 3320 Database Concepts* is recommended

Students will have to meet the minimum admission requirement of a GPA of 3.0 or a GPA of 3.3 or greater on their last 60 credit hours as an undergraduate. GRE scores, a letter of intent, a résumé and letters of reference are considered in the admission process; TOEFL scores are required of international students who have not matriculated from a university in a country where the primary language is English. (Please see the UALR Graduate School's requirement for English proficiency exams.)

Master of Science in Bioinformatics

Requirements for the Master of Science Degree

The MS program is built around four cores: bioinformatics, biostatistics / modeling / simulation, information / computer science, and the life sciences. Students must complete thirty eight (38) credit hours consisting of a minimum of two, approved, graduate-level courses in each of the biostatistics/modeling/simulation, information/computer science, and life science cores. Additionally, students are required to participate in four lab rotations for two credits and to complete the following bioinformatics courses:

- BINF 7193 Biosciences and Bioinformatics Seminar (for every semester enrolled and a minimum of four semesters).
- BINF 5445 Bioinformatics Theory and Applications.
- BINF 7295 Practical Topics in Science Management.
- BINF 8445 Bioinformatics Master's Capstone Project.

Master's Advising

Master's students are advised by the Bioinformatics Program Director.

MS Graduation Requirements

Successful completion of an approved program of study with a minimum GPA of 3.0 with no more than one grade below a B and successful completion of the writing requirement.

Doctor of Philosophy in Bioinformatics

Requirements for the Doctor of Philosophy Degree

The Ph.D. requires completion of the MS degree in bioinformatics with a grade of A on the student's Bioinformatics Master's Capstone Project. Enrolling in the BINF 7193 Bioinformatics Seminar every semester (minimum of four credits required) and a minimum of 32 credit hours of research complete the Ph.D. program culminating in the successful defense of the student's dissertation research. Students completing the MS degree in bioinformatics at another institution may be admitted directly in the Ph.D. program, but may need to complete additional coursework to cover all four cores of the UALR/UAMS MS degree program.

Within the first six months of entering the Ph.D. program, students must have an approved advisory committee and defend their dissertation proposals as part of their Candidacy Examination. The dissertation proposal should be written according to standard grant format as would be used for submitting a proposal to NIH or NSF.

Important Program Information

Transfer of Credit and Advanced Placement

Transferability of credit is determined by the Program Director, based upon the applicability of the courses to the student's educational goals and research project. Transfer of credit may not be granted when courses have been used to meet other degree requirements. Additionally, students with relevant graduate degrees in related fields may petition the Program Director for an Advanced Placement which reduces the total credits required for a Master's degree to thirty-two (32).

Graduate Assistantships

Graduate assistantships that support research opportunities are available to qualified full-time students on a highly competitive basis. Tuition is paid, and a stipend is provided for living expenses. Students must pay registration fees, buy textbooks, and purchase any necessary support materials. For more information about graduate assistantships, the application process, and other financial assistance opportunities, visit the website at bioinformatics.ualr.edu/grad.

A student supported by a graduate assistantship may not take less than nine credit hours during the Fall and Spring semesters and is prohibited from any other employment.

Entrance Exams

In the week prior to the start of classes, incoming students may be asked to undergo a series of entrance exams or placement interviews in which the student must demonstrate proficiency in the core areas. The student's first semester of study will be based on the results of these exams/interviews and his/her interests. A student may be required to take additional undergraduate courses, which will not count toward his/her degree program, to remedy any deficiencies. Courses numbered at the 4000-level or below do not count for graduation credit and may not be covered under the assistantship tuition waver.

Writing Requirement

An English Writing Proficiency: Exam (WPE) will be offered early each Spring term. This exam will assess the student's ability to communicate in a written format. Each student must pass this exam to fulfill graduation requirements. A student who does not pass the WPE is required to take the English Writing Proficiency Laboratory (EWPL) which is offered each Spring term. The student must take the EWPL each Spring term until he/she passes.

International Student Requirements

International students whose native language is not English must take the English proficiency exam and have an official score that meets the minimum standards established by the UALR Graduate School. (Please see the UALR Graduate School's website for information on approved exams and minimum required score.) Only students who have studied full-time for two or more years at a college or university where English is the language of instruction located in a country where English is the native language are exempt from this English proficiency exam. Exceptions to this policy must be approved by the UALR Graduate School.

Dissertation Defense

Students will orally defend their research before their Doctoral Advisory Committee. Printed copies of the penultimate draft of the dissertation must be delivered to the Advisory Committee members at least two weeks prior to the defense. The defense will be open to the public and must be announced at least two weeks in advance by the Program Director. Following the open presentation session (including the typical question-and-answer period) will be a closed examination of the candidate by the Doctoral Advisory Committee. The examination can be wide-ranging but will usually utilize the student's research as a starting point. At the completion of the examination, the student will be temporarily excused and the Doctoral Advisor and Advisory Committee will vote to either pass or fail the student.

Doctoral Graduation Requirements

- Successful completion of an approved program of study (including completion of the Master of Science in Bioinformatics degree) with a minimum GPA of 3.0 with no more than one grade below a B;
- Successful completion of the candidacy examination and dissertation proposal defense; proposal should be written using a grant proposal format;
- Successful completion of a grant proposal and its oral presentation;
- Successful completion of the dissertation and oral defense; and
- Successful completion of the writing requirement.

Doctoral Advisory Committee

The student's Doctoral Advisory Committee will be composed of a minimum of five members, including the student's doctoral advisor who will serve as the Committee chair. Four of the Committee members, including the chair, must hold bioinformatics graduate faculty status. The fifth member must be an external member who is not affiliated with the program, UALR, or UAMS. The Bioinformatics Graduate in conjunction with the Bioinformatics Steering Committee must approve the Committee constituency.

The dissertation subject is selected by the student and Doctoral Advisory Committee at least two years prior to the oral defense of the research. It must be a scholarly contribution to a major field of bioinformatics and involve all four cores of the program. The written dissertation format must follow the UALR Graduate School Dissertation and Thesis Guide found on the Graduate School website. Changes may not be made to the student's Doctoral Advisory Committee within six months of the dissertation defense. In event of extenuating circumstances, an appeal may be made to the Bioinformatics Program Director to change this requirement.

Candidacy Examination

At least eighteen (18) months prior to the dissertation defense, the candidate must present a proposal for his/her dissertation work to his/her Doctoral Advisory Committee. At this time, the Committee will evaluate the dissertation proposal, the student's ability to undertake the research program successfully, and whether the applicant possesses the attributes of a doctoral candidate as part of a comprehensive oral candidacy examination. Only after completing this requirement are student eligible to participate in the UAMS Research Induction Ceremony.

Courses in Bioinformatics

BINF 5445 Bioinformatics Theory and Applications

Prerequisites: Course Director's permission plus the following: BIOL 3300: Genetics or equivalent, IFSC 3320: Database Concepts or equivalent, IFSC 2300: Object-oriented Technology (Java Programming) or experience with another programming language such as "C" or "C++", STAT 3352: Applied Statistics I or equivalent, MATH 1304: Calculus I or equivalent recommended, BINF 2345: Introduction to Bioinformatics recommended, some exposure to molecular biology recommended. An overview of concepts central to the study and application of bioinformatics drawing upon the fields of biostatistics, computer and information science, and the life sciences. Three hours of lecture plus two hours of laboratory per week. Four credit hours.

BINF 7145, 7245 Introduction to Bioinformatics Research

Prerequisite: permission of instructor. Rotations through the bioinformatics, biostatistics, information science, and/or life sciences research laboratories of faculty participating in the bioinformatics graduate program.

BINF 7193 Bioinformatics Seminar

Prerequisites: bioinformatics graduate student status or instructor's consent. A survey of scientific and technical topics relevant to bioinformaticists. The seminar has two components: attending seminars hosted primarily by BINF Ph.D. students and participating in a presentation workshop where students present seminars on their research interests. A passing grade is required in both components for a passing grade in the course. One credit hour.

BINF 7199, 7299, 7399, 7499 Special Topics in Bioinformatics

Prerequisites: instructor's consent. Detailed study in bioinformatics and related areas; may be lecture or lecture and laboratory, depending on specific topics. Variable credit of one to four hours. Offered on demand.

BINF 7295 Practical Topics in Science Management

A survey of practical topics relevant to practicing scientists and engineers such as ethics, project management, and grant writing. While an emphasis is placed on bioinformatics, topics will be if interest to all participating in science and engineering projects. Two credit hours. Cross-listed with ASCI 7295.

BINF 8445 Bioinformatics Master's Capstone Project

Prerequisites: Course Director's permission and completion of at least one graduate-level course in each of the four core areas of the UALR/UAMS Joint Graduate Program in Bioinformatics (must include BINF 5445: Bioinformatics Theory and Applications). This course provides a structured context in which the student completes an individual capstone project for the Masters Degree in Bioinformatics. The project draws upon all four core areas of the graduate program and is done under the direction of a project mentor who is a member of the graduate faculty of the UALR/UAMS Joint Graduate Program in Bioinformatics. Four credit hours.

BINF 9100-9900 Doctoral Research/Dissertation

Prerequisite: Consent of advisor. Bioinformatics doctoral research leading to Ph.D. dissertation.

EIT Building, Room 579
(501) 569-8130
ualr.edu/computerscience/

Computer Science

Master of Science in Computer Science

The Master of Science in Computer Science program at UALR reflects current trends in the computer science discipline and provides students with a solid theoretical and practical foundation for careers in computer science and/or advanced graduate studies.

The curriculum consists of core and specialization course work. Core curriculum refers to required courses that provide students with fundamental knowledge and skills. Building on the core foundation, the specialization course work allows students the opportunity to select electives to acquire more in-depth knowledge and skills in the students' specific areas of interest.

To satisfy the requirements for the master's degree, in addition to the course work, students must complete one of the following program options: thesis, project, or comprehensive examination.

The program is accessible to day and evening students and lends itself to full- and part-time study.

Additional information is available at: ualr.edu/computerscience/.

Admission Requirements

- Baccalaureate degree in computer science, engineering, mathematics, or a related discipline from an accredited institution
- Cumulative Grade Point Average (GPA) of at least 3.0 (4.0 scale)
- Graduate Record Examination (GRE) General Test with quantitative reasoning score of 156 or above, a verbal reasoning score of 145 or above, and analytical writing score 3.0 or above, and , where applicable, Test of English as a Foreign Language (TOEFL) score 80 or above. The combined scores for GRE are no longer used; however, contact the Graduate Coordinator of the program if there are any questions or concerns about the minimum GRE score requirement.
- Completion of deficiency course work

For more information visit ualr.edu/computerscience/.

Deficiency Course Work

All students seeking admission to the program must have completed (with a grade of B or greater in each course) undergraduate course work equivalent to the following:

CPSC 2380 Data Structures and Algorithms
CPSC 2382 Introduction to Computer Systems and Assembly Language
CPSC 3370 Net Centric Computing I: Systems Concepts
CPSC 3371 Net Centric Computing II: Language Concepts
CPSC 3375 Database Concepts I
CPSC 3482 Computer Organization I
MATH 1451 Calculus I and 1452 Calculus II
MATH 2310 Discrete Mathematics

Students must complete deficiency course work prior to enrolling in graduate classes. Exception: students with a single deficiency course remaining may register for that class and graduate classes as long as no prerequisites are violated.

Waiver of deficiency courses is at the discretion of the Computer Science Graduate Committee.

Program Requirements

Core Course Work

All students must take the following 5 courses (15 credit hours):

CPSC 7311 Software Engineering
CPSC 7321 Operating Systems
CPSC 7331 Computer Architecture
CPSC 7341 Telecommunications and Networking
CPSC 7385 Analysis of Algorithms

Specialization Course Work

Students must choose five specialization classes (three if the thesis option is selected) from the Department's graduate-level courses. Students are strongly encouraged to select courses with the guidance of their graduate advisors with the goal of in-depth exploration of a particular area of computer science. Students may take a maximum of two 5000-level courses as part of their specialization course work. Additionally, the total number of special topic/independent study classes cannot exceed two. Substitution of up to two graduate electives from other disciplines (in particular Applied Science, Systems Engineering, Information Science, and Mathematical Sciences) for specialization course work is at the discretion of the Computer Science Graduate Coordinator.

Transfer of credit hours earned elsewhere

Maximum of six (6) graduate credit hours can be transferred into the graduate degree plan.

Program Options

All students must complete one of the following options:

- Comprehensive Graduate Exam: 31 credit hours of course work plus a written comprehensive examination covering the core curriculum. The examination is offered once per regular semester and can be taken only twice.
- Graduate Project: 34 credit hours, consisting of 31 hours of course work plus 3 credit hours of CPSC 7398 Graduate Project.
- Graduate Thesis: 31 credit hours, consisting of 25 hours of course work plus 6 credit hours of CPSC 8100-8600 Thesis.

Students choosing the project or thesis options must complete the core curriculum prior to enrolling in CPSC 7398 Graduate Project or CPSC 8100-8600 Thesis. Additionally, these students must form a Thesis/Project Committee must have at least two members, including the advisor, from the Computer Science Department and can have at most one member from other departments. Following the recommendation of the Thesis/Project Committee, the student must schedule an oral proposal presentation and a defense for the graduate project or thesis.

Performance Requirements

- Students receiving a C grade will be warned that their academic performance is unacceptable and their status will be reviewed by the Computer Science Graduate Committee, which will suggest corrective action.
- Upon receiving two Cs or either a D or an F, the student will be dismissed from the program.
- Courses with grades of B or greater may not be repeated.
- Core courses with grade C do not satisfy the degree requirement and must be repeated. A minimum score of B is required for each of the core courses.
- Deviation from the degree plan requires the approval of the Computer Science Graduate Committee.
- Conditionally admitted students must earn the Grade Point A verge (GP A) above 3.5 in the first 9 hours and may not receive a grade of incomplete (1).

Academic Advising

Each semester, academic advising is required for every student prior to course registration. A copy of the approved courses must be filed with the Graduate School.

Graduate Assistantships

A limited number of graduate assistantships are available. Contact the Computer Science Graduate Coordinator for information.

Graduation Requirements

- Cumulative GPA of at least 3.0 in an approved program of study and satisfying all requirements specified in Performance Requirements.
- Successful completion of one of the program options specified in Program Options.

Courses in Computer Science

CPSC 5360 Computer Security

Prerequisites: Graduate standing. Increasing reliance on our computer based infrastructure elements along with the information driven nature of today's business require a solid and in-dept understanding of security issues pertinent to these systems. The topics include threats, assumptions, assurance, confidentiality, integrity, availability, access control matrix and policies, security models, requirements imposed by policies, protection models, covert channels, formal methods for security, designing and evaluating systems, intrusion detection, auditing, and other contemporary issues. Three hour lecture; three credit hours. Not open to students with credit for CPSC 4360.

CPSC 5366 Interactive Computer Graphics and Animation

Prerequisites: Graduate Standing. Knowledge of C, C++ or Java Programming. Approval from the instructor. This course introduces computer graphics and all details of the design of modern graphic architecture. The topics covered include two - and three - dimensional modeling and transformation, lighting and shading, animation techniques, and an introduction to OpenGL. Three hours lecture; three credit hours. Not open to students with CPSC 4366.

CPSC 5372 Object-oriented Programming

Prerequisites: working knowledge of a procedural programming language and UNIX operating system, or consent of the instructor. Concepts of object-oriented analysis, design, and implementation. Object-oriented programming in C++, Smalltalk, Java, and/or another current object-oriented programming language.

Graduate Standing. This is a foundational course that covers fundamentals of modern software engineering. Topics included are: requirements definition, analysis, and modeling including use cases and use case paths, domain names, state transition diagrams; techniques to increase robustness and avoid disastrous defects; object oriented architecture and design patterns and specification in UML; performance impact of design choices; analysis of designs regrading maintainability and testability; security engineering; practical system test and glass - box testing fundamentals; verification of test coverage via decision tables and state transition tables. Three hours lecture per week. Three credit hours. Not open to students with credit for CPSC 4373.

CPSC 5376 Applied Cryptography

Prerequisites: CPSC 2380, MATH 2310, and STAT 3352 or equivalents. A survey and study of the major cryptographic techniques, algorithms, and implementations, with emphasis on applications to communications and network security. Intended as a practical introduction to the current state-of-the-art of cryptographic usage. Three hours lecture. Three credit hours.

CPSC 5199-5499 Special Topics

Prerequisites: graduate standing, consent of instructor. Various topics in applied computer science, selected from the areas of intelligent systems and computer systems design. On demand.

CPSC 5373 Fundamentals of Software Engineering

Prerequisites: graduate standing, consent of instructor. Various topics in applied computer science, selected from the areas of intelligent systems and computer systems design. On demand.

CPSC 5381 Computer Architecture and Design

Graduate Standing. This course addresses the architecture and design of modern microprocessor computers. In it adheres to the principle of "no mysteries" and reveals all the details of the design of modern pipeline microprocessor system. The topics covered include formal description of computer architecture and design, instruction set architectures, processor design of modern computers, pipeline and instruction level parallelism, memory system design, and input and output systems. Not open to students with credit for CPSC 4381.

CPSC 5382 Compiler Construction and Theory

Prerequisites: Graduate Standing. The fundamental principles of compilers such as finite state machines, context free grammar, are studied. The compilation techniques covered include compile and run- time symbol tables, lexical analysis syntax analysis, semantic analysis, object code generation, error diagnostic and optimization. Three hours lecture. Three credit hours. Not open to students with credit for CPSC 4382.

CPSC 5384 Computer Networks

Prerequisites: Graduate Standing. This course is an introduction to the design and analysis of computer networks. The course covers a breadth of topics including computer communications architecture and protocols, local and wide area networks, IP networks, bridging and routing, Ethernet, wireless LANs, sockets programming, and distributed applications. Three hours lecture; three credit hours. Not open to students with credit for CPSC 4382.

CPSC 5388 Smart Software Systems

Prerequisites: Graduate Standing. Ability to perform independently and as a team member is absolutely essential. A working knowledge of C, C++, Java and a course in digital logic/ assembly language programming is very much desired. This class will involve extensive independent work with your group and the instructor to plan and implement an embedded software systems project. Three hours lecture; three credit hours. Not open to students with credit for CPSC 4388.

CPSC 7101 Research Methodology

Prerequisites: Graduate Standing. A one-credit course in a set of three, introducing students to the research methodology of doctoral level research in the Integrated Computing field. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the Integrated Computing discipline.

CPSC 7102 Research Tools

Prerequisites: Graduate Standing. A one-credit course in a set of three, introducing students to the research methodology of doctoral level research in the Integrated Computing field. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the Integrated Computing discipline.

CPSC 7103 Research Application

Prerequisites: SYEN / IFSC / CPSC 7101 and 7102. A one-credit course in a set of three, introducing students to the research methodology of doctoral level research in the Integrated Computing field. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the Integrated Computing discipline. Students may with permission of the other Graduate Coordinator concurrently enroll in this course with either SYEN / IFSC /CPSC 7101 or 7102.

CPSC 7190 Graduate Seminar

Prerequisite: Graduate Standing. A weekly expository lecture series by the faculty and invited speakers on current research areas.

CPSC 7301 Essentials of Computer Software

Prerequisites: Graduate Standing with an engineering or science degree and at least one programming language of C, C++ or Java. This course introduces students to important concepts and techniques in developing software and internet based applications. Topics include: programming language paradigms, data structures, algorithms and programming environments: compiled versus interpreted environments, web based languages and scripting techniques, data access techniques and support for secure protocols, methods for querying and updating structured web documents and semi structured data. Language issues in the development and management of commercial projects, etc. This course and CPSC 7302 will prepare the science or engineering graduates for the computer science master program and the credit of this course is not counted towards the requirement of the master program. Three hours lecture and three credit hours.

CPSC 7302 Essentials of Computer Systems

Prerequisites: Graduate Standing with an engineering or science degree and at least one programming language of C, C++ or Java. This course takes an integrated approach to cover the major components of the complete computer system: digital logic, computer organization and architecture, programming languages and compilers, and operating systems and computer networks. This course and CPSC 7301 will prepare the science or engineering graduates for the computer science master program and the credit of this course is not counted towards the requirement of the master program. Three hours lecture and three credit hours.

CPSC 7311 Software Engineering

Prerequisites: Graduate Standing and a working knowledge of C or C++. An overview of the software development paradigm to include the software life cycle, prototyping and object-orientation; reliability, quality assurance, formal methods, and CASE tools.

CPSC 7312 Parallel Processing

Prerequisites: Graduate Standing; CPSC 2380 and CPSC 3482. Concepts of parallel computing, parallel architectures and interconnection networks; parallel programming and applications; basic paradigms and primitives, programming using PVM and MPI; efficient mapping of programs, automatic parallelization of serial code.

CPSC 7313 Concurrent Software System Architecture

Prerequisite: CPSC 5373 or permission of the instructor based on an existing background in object orientation methodology. This course covers the internal issues of modern software engineering. Topics include requirements of interface definition, notation, and analysis of systems of programs; software systems architecture issues, synchronization while managing shared data stores, and ensuring the architecture supports performance goals; concurrent task structuring criteria; software architecture patterns for common categories of software systems; concurrency support including enforcing mutual exclusion, engineering for deadlock avoidance, and ensuring liveness; design for testability; architecture performance analysis, performance design patterns, and anti-patterns. Three hour lectures. Three credit hours.

CPSC 7314 Integrated Software System Engineering

Prerequisites: CPSC 4373/5373. This course covers the integration related issues of modern software engineering. Topics include but not limited to specification of use cases for a distributed application; design and development concerns such as fault tolerance, reliability, security, interoperability; how these concerns influence the placement of functionality in the distributed environment—subsystem structuring criteria; design that allows upgrades and modifications of installed distributed systems; representation of timing sequences; performance analysis of concurrent and distributed systems; design for testability; distributed architecture design patterns; other issues about testing distributed systems. Three hour lectures. Three credit hours.

CPSC 7321 Operating Systems

Prerequisites: CPSC 3380 and 3482; working knowledge of C, C++, or Java Programming Language, and UNIX. Advanced topics in operating systems; process synchronization, deadlock, concurrency; fault tolerance, protection and security; distributed operating systems, multiprocessor operating systems.

CPSC 7322 Distributed Systems

Prerequisites: CPSC 3380 and 3482; working knowledge of C, C++, or Java Programming Language, and UNIX. Foundations of distributed operating systems; design and implementation of distributed systems; communication methods for open systems; kernel facilities; file management, naming and dock synchronization; transactional services for shared data.

CPSC 7325 Software Security Assessment

Prerequisite: CPSC 5360 or Consent of Instructor. Today's networked and complex software not only increases number of potential vulnerabilities but also increases risk associated with vulnerabilities. The industry-specific regulations further necessitate building software with the minimum number of vulnerabilities. This course delivers the know-how of dealing with software vulnerabilities. The topics covered include Software Vulnerability Fundamentals, Auditing and Black Box Testing, Design, Implementation, and Operational Vulnerabilities, Design and Operational Review, Attack Surface; Insecure Defaults; Access Control; Secure Channels, Application Review Process, Code-Auditing Strategies, Software Vulnerabilities, Assessing Memory Corruption, Synchronization and State, Vulnerabilities in Practice, Documentation of Findings.

CPSC 7326 Malware Analysis

Prerequisite: CPSC 4360/5360 or Consent of Instructor. Malware, despite the wide-spread use of anti-malware tools, still persists to exist in large-scale. Malware outbreaks can cost businesses large sums of money through business disruption, harming reputation, and recovery efforts. This class offers a thorough analysis of Malware including cutting edge techniques to detect and deal with it. Topics covered include History and Prevalence of Malicious Code, Types of Malicious Code, Infection Mechanisms and Targets, Virus Propagation Mechanisms, Defending against Viruses, Worms and Worm Components, Impediments to Worm Spread, Super Worms, Malicious Mobile Code, Backdoors, Polymorphic Malware, Rootkits, Process for Malware Analysis.

CPSC 7331 Computer Architecture

Prerequisite: CPSC 3482. A study of computer architecture fundamentals; the impact of technology on architecture cost and performance; Instruction Set Architecture; design and analysis of the building blocks of computer systems, including data path, control, and memory hierarchy; recent architectural developments.

CPSC 7332 Advanced Computer Architecture

Prerequisite: CPSC 7331. An in-depth study of recent advances in computer architecture; speedup architectural techniques for high performance computer systems; caches and memory hierarchy; RISC and Superscalar computer architectures.

CPSC 7333 VLSI Design

Prerequisite: CPSC 3482. This course introduces the principles of CMOS VLSI technology and design; design methodologies from concept to implementation of VLSI chips; Mentor Graphics and Cadence software packages that support design, layout, and verification.

CPSC 7334 Digital Systems and Hardware Design Languages

Prerequisites: Computer Science 3482 and working knowledge of . Architecture of a representative 32-bit processor, system building blocks, design conventions; HDL languages; modeling, simulation and verification of the representative processor.

CPSC 7341 Telecommunications and Networking

Prerequisite: Graduate Standing. Fundamentals of data communications; topologies and transmission media; protocol architecture; LAN, MAN, and WAN systems; network design issues.

CPSC 7342 Advanced Computer Networking

Prerequisite: CPSC 7341. Advanced concepts of computer networks; network hardware and software; preference models; data communications services; network standardization; design issues and their applications.

CPSC 7343 Sensor Networks

Prerequisites: CPSC 4384/5384. This course aims to develop fundamental understanding of sensor network systems. It covers architectures and communications protocols for sensor networks. Node and network architectures, naming and addressing, time synchronization, localization and positioning, topology control, and content-based networking are all covered. At the completion of the course, students will understand how sensor networks work as intelligent and coordinated systems.

CPSC 7351 Database Design

Prerequisite: CPSC 2380 and 3375, Mathematics 2310. Design process, objectives, techniques, syntactic and semantic analysis design; entity relationships model, binary and n-ary relationships, minimality of relations, recursive relationships, role-modeling structures, aggregate objects, conversion methods, implementation models, evaluating design, choosing design methodologies.

CPSC 7352 Advanced Database Issues

Prerequisite: CPSC 7351. Advanced issues in distributed databases, transaction systems, database machines, database mining, expert database systems, object-oriented databases, and extended data models.

CPSC 7361 Computer Graphics

Prerequisites: MATH 1305; working knowledge of C programming. Introduction to computer graphics and graphic systems; output primitives and attributes; two-dimensional graphics: geometric transformations, viewing; three-dimensional graphics: object representation, geometric and modeling transformations and viewing; illumination models and animation; user interface and interactive input.

CPSC 7362 Advanced Computer Graphics

Prerequisite: CPSC 7361. Advanced concepts in two-dimensional graphics and three-dimensional graphics; object representations, geometric and modeling transformations, viewing, NURBS curves and surfaces; texture mapping, visible-surface detection methods, advanced illumination and shading models, color models and color applications; advanced animations.

CPSC 7373 Artificial Intelligence

Prerequisites: CPSC 2380; MATH 1305 or MATH 1312. Undergraduate course work in artificial intelligence would be beneficial but is not required. Study of the major areas of artificial intelligence, including general problem solving, search strategies, heuristics, knowledge representation, machine learning, games, scene analysis, expert systems, robotics, natural language processing, and Al languages.

CPSC 7374 Image Processing

Prerequisites: MATH 1305 or MATH 1312 and a working knowledge of C programming. Study of digital image fundamentals; transformation enhancement, restoration, segmentation, compression, encoding, representation, and description of digital images.

CPSC 7375 Machine Learning

Prerequisites: CPSC 2380; MATH 1305 or MATH 1312. Prior course work in artificial intelligence would be beneficial but is not required. In-depth study of machine learning foundation, neural networks, learning paradigms, inductive learning, deductive learning, learning techniques, rough classifiers, fuzzy systems, genetic algorithms, lattices, pattern recognition, and applications.

CPSC 7382 Systems Analysis and Design

Prerequisite: Graduate Standing. Analysis and design of computer information services to meet the needs of industries and businesses; intended as a real-world practicum via field study, and as a community outreach via the provision of expertise and training.

CPSC 7383 Modeling and Simulation

Prerequisites: CPSC 2380; MATH 1305 or MATH 1312; knowledge of statistics and probability. Performance analysis of models of various systems using analytical approaches, discrete and continuous simulation, and hybrid techniques.

CPSC 7385 Analysis of Algorithms

Prerequisites: CPSC 2380; MATH 2310. A study of categories of computer algorithms: greedy, divide-and-conquer, recursive, and probabilistic; performance analysis techniques: order relations, recurrence relations, generating functions, induction, simulation; storage efficiency issues; complexity theory.

CPSC 7386 Compiler Design

Prerequisite: CPSC 2380 and CPSC 3383; MATH 2310. Grammars, languages, and the anatomy of compilers: scanners, parsers, semantic analyzers, type systems, run-time environments, intermediate code generation, code generation, and code optimization.

CPSC 7398 Graduate Project

Prerequisites: Graduate Standing and consent of the student's graduate advisor. Students, under faculty supervision, will conduct directed research on a particular problem or area of computer science in some depth, and will produce an appropriate project and report based on their investigations.

CPSC 7399 Selected Topics

Prerequisites: Graduate Standing, consent of instructor. Various topics in applied computer science, selected from the areas of intelligent systems and computer systems design. Offered on demand.

CPSC 7100 - 7400 Independent Study

Prerequisite: Graduate Standing, instructor permission. Provides an opportunity for doctoral students to learn material relevant to their research that is not offered in a regular course. Students must take this course with an instructor who will guide the study. A copy of work done in the course will be submitted at the end of the semester.

CPSC 8100-8600 Thesis

Prerequisite: Consent of thesis advisor. Scholarly investigation of a selected problem in computer science culminating in a written, orally defended thesis. Maximum of six hours may be applied to MS. Variable credit of one to six hours.

Construction Management

ETAS 203, (501) 569-8133
(501) 569-8341 (fax)
ualr.edu/constructionmanagement/

Master of Science in Construction Management

The Master of Science (MS) in Construction Management develops upper-level management personnel for the construction industry, while helping students to pass the Certified Professional Constructor (CPC) examination administered by the American Institute of Constructors (AIC).

Admission Requirements

All applicants to the MS program in Construction Management must satisfy the requirements of the UALR Graduate School in addition to any requirements specific to the Donaghey College of Engineering and Information Technology. To be considered, an application must contain the following items:

- A bachelor's degree in construction management or construction engineering, civil engineering, architecture, business, or similar areas is required. Students with educational backgrounds different from construction management may need to take prerequisite courses. Applicants must have an overall undergraduate grade point average (GPA) of 3.0 (4.0 scale).
- The Graduate Record Examination (GRE) General Test should be taken within five years of application. The applicant must have a minimum verbal reasoning GRE score in the range of 146-150 , a minimum quantitative reasoning GRE score in the range of 150-154, and a minimum score of 3.5 on the analytical writing test. The GRE requirement will be waived if the GPA is 3.5 or higher (4.0 scale).
- Demonstrated proficiency in written English (via the TOEFL exam) – for applicants whose native language is not English. Applicants' scores must exceed 525 (paper -based test) or 197 (computer -based test) or 71 (internet-based test). Applicants with scores below but close to 525 (197 if computer-based test or 71 internet-based test) may be admitted provisionally upon the recommendation of the Graduate Coordinator to the Dean of Graduate School, and allowed to fulfill the TOEFL requirement as specified in the Graduate School admissions policies.
- Demonstrated proficiency in spoken English (via the Test of Spoken English (TSE) or the American English Oral Communication Proficiency Test (AEOCPT) exams) - for applicants whose native language is not English and who are seeking financial support via a teaching assistantship. The student must get a score of 80% or higher on the AEOCPT or the TSE.
- Three (3) letters of recommendation.
- Official college transcripts including grades and curriculum for undergraduate and (if applicable) graduate studies.
- Written statement by the applicant regarding the reasons (e.g. interests, relevant experience, and goals) why he or she should be considered for this MS program.
- A resume detailing any professional work experience, published papers, or presentations.
- The department graduate faculty will evaluate the compatibility between the applicant's background, research interests, and communication skills vis-a-vis the MS program when making admission decisions, and may decline to admit an otherwise qualified application based on a lack of fit with the program.

Students may apply to the MS program at any time. Applicants to the MS program are ordinarily expected to start in the fall semester of each year. Foreign national graduate students who are candidates for admission must process their visa applications so that they can arrive in the United States and attend orientation at the Office of International Students (OIS). Those students who are not able to obtain approval for entry into the United States in order to meet this timeline may request an admission deferral to attend the following semester or academic year.

Program Options

The Master of Science degree in Construction Management offers two options:

1. **Thesis Option:** 30 credit hours beyond the baccalaureate degree, including six credit hours of thesis work.
2. **Non-Thesis Option**: 30 credit hours beyond the baccalaureate degree, including a three credit hour project.

For both thesis and non-thesis options, the work must include at least 18 credit hours of 7000-level or above work. A maximum of 12 credit hours (with grades of B or greater) can be 5000-level courses, and a maximum of nine credit hours (with grades of B or greater) of graduate courses can be taken from programs outside the construction management program or from another university.

Program Requirements

Students with backgrounds outside of construction management or construction engineering are required to take the following background courses:

CNMG 1205 Drawings and Specifications	**CNMG 3339 Estimating I**
CNMG 2313 Construction Materials	**CNMG 4211 Estimating II**
CNMG 2314 Mechanical, Electrical, and Plumbing (MEP) Systems	**CNMG 4329/5329 Construction Planning and Scheduling**
CNMG 2323 Construction Administration	**CNMG 4342/5342 Construction Safety**

Students will develop their own programs of study in cooperation with appropriate faculty and in consideration of the courses and facilities available. The student's plan of study must be developed in conjunction with the student's advisor with approval by the program coordinator.

All master's course work must be completed with a minimum overall graduate GPA of 3.0. If a student receives one "C" or lower grade, the student will be warned that this academic performance is unacceptable and the department graduate faculty will review the student's performance and recommend corrective action.

Transfer of Credit

Course credit may be granted to the student for completing equivalent graduate coursework from other institutions based upon the applicability of the courses to thesis work and the student's educational goals. Such credit must be exclusive of thesis or other exit project credits, be no more than nine credit hours, be no more than five years old at the time of transfer, and must have a letter grade of B or greater. Students interested in requesting credit transfer should discuss the request with their advisor and the program coordinator. The Dean of the Graduate School must also approve the request before the transfer of credit can be granted.

MS Advisor

Each student will choose a faculty member to be his or her mentor through the program. New students will be assigned an advisor by the program coordinator prior to the start of classes. Students may change their advisors until they have completed the first semester. After that, changes in a student's advisor will be granted only in special circumstances.

Thesis Committee

A student choosing the thesis option will be guided by the student's thesis committee, comprising the student's MS Advisor (serving as committee chair) and two members of the department graduate faculty. Successful completion of the thesis will require an oral defense in which the student will defend his or her findings and conclusions. Policies and procedures for passing, failing, and repeating the thesis defense will be in compliance with the UALR Graduate School policies.

Courses in Construction Management and Civil and Construction Engineering (CNMG)

CNMG 5329 Construction Planning and Scheduling

Prerequisite: CNMG 4211 or equivalent. An in-depth study of the process of creating and monitoring a construction project schedule. Creation of project schedules on a variety of scheduling software, with primary focus on Primavera. Three hours lecture. Three credit hours. Dual-listed in the UALR Undergraduate Catalog as CNMG 4329. Students cannot receive graduate credit for CNMG 5329 if they have previously taken CNMG 4329.

CNMG 5334 Construction Contracts and Law

A study of construction contracts in relation to project delivery systems and the basic principles of construction law. Case studies are used to analyze selected areas that affect the construction process. Topics include standard agreements and conditions, negligence, risk, indemnities, modifications, mechanics lien, claims, dispute resolution, conflicts of interest, ethical consideration, and labor law. Three hours lecture. Three credit hours. Dual-listed in the UALR Undergraduate Catalog as CNMG 4334. Students cannot receive graduate credit for CNMG 5334 if they have previously taken CNMG 4334.

CNMG 5342 Construction Safety

A study of the principles of construction safety management and OSHA 29 CFR PART 1926. The OSHA Construction Industry Training Course 500 topics covered in depth. Students develop a company safety plan and hazardous communications program, perform safety analysis, conduct safety meetings, and write accident investigation reports. Students complete the topic requirements for the OSHA 10-hour and 30-hour Construction Safety and Health training card. Two hours lecture and two hours lab. Three credit hours. Dual-listed in the UALR Undergraduate Catalog as CNMG 4342. Students cannot receive graduate credit for CNMG 5342 if they have previously taken CNMG 4342.

CNMG 5361 Green Construction

Overview of design and construction delivery systems for high performance green buildings; relevant criteria and established guidelines; green standards; high performance green buildings and sustainability; vocabulary associated with sustainability and green buildings; physical limitations of materials. Three hours lecture. Three credit hours. Dual-listed in the UALR Undergraduate Catalog as CNMG 4361. Students cannot receive graduate credit for CNMG 5361 if they have previously taken CNMG 4361.

CNMG 5389 Professional Engineering Licensure

Prerequisite concurrent: Registration for the Fundamentals of Engineering exam, or consent of instructor. Legal, regulatory, and ethical issues related to the practice of engineering; preparation for engineering licensure examinations. Two hours lecture. Three hours lab. Three credit hours. Cross listed as SYEN 5389. Dual-listed in the UALR Undergraduate Catalog as CNMG 4389. Students cannot receive graduate credit for CNMG 5389 if they have previously taken CNMG 4389.

CNMG 7100, 7200, 7300 Independent Study

Topic and method of procedure must have approval of the supervising faculty member. Typically four to six hours per week of work on the project for each hour of credit earned. The exact hourly commitment per week and credit hour value depends on the nature of the project and must be agreed on in advance by the student and instructor, and must be submitted in writing to the student's graduate advisor. With approval, may be repeated for up to nine credit hours. One to three credit hours.

CNMG 7318 BIM and 4D Simulation

Prerequisite: CNMG 4218 or equivalent. Advanced techniques of using Building Information Modeling (BIM) together with scheduling control to do 4D simulation. Potential applications of computer and information systems in construction industry. Three hours lecture. Three credit hours.

CNMG 7345 Applied Construction Management

Prerequisites: CNMG 4211 and CNMG 5329 or equivalent, or consent of the instructor. This course discusses design, development, estimating, scheduling, contracting, and administering small construction projects, including extensive site and feasibility analyses. Three hours lecture. Three credit hours.

CNMG 7376 International Construction Business Management

Construction contracting , with emphasis on international economics, marketing , contracts, design, and specifications. Issues of local construction techniques, construction marketing, international construction, sustainability, global economics, and influence on construction of local culture, traditions, architecture, history, and political climate. Three hours lecture. Three credit hours.

CNMG 7385 Construction Management Graduate Project

Prerequisites: graduate standing, completion of at least 18 graduate credit hours in the MS in construction management program, or consent of the advisor. Students, under faculty supervision, will work on practical problems related to construction management, and will submit a project report documenting the results. Three credit hours.

CNMG 7399 Special Topics

Prerequisites: Consent of instructor. Selected advanced topics in construction. Three hours lecture. Three credit hours.

CNMG 8100, 8200, 8300, 8400, 8500, 8600 Construction Management Master's Thesis

Prerequisites: graduate standing, completion of at least 18 graduate credit hours in the MS in construction management program, or consent of the thesis advisor. Scholarly investigation of a selected problem in an area related to construction management culminating in a written thesis and an oral defense. A maximum of six hours may be applied toward the MS degree. Variable credit of one to six hours.

Engineering Science & Systems

EIT Building, Room 518
(501) 569-3100

Doctor of Philosophy

The Engineering Science and Systems Doctoral Program leading to the Ph.D. degree is housed in the Donaghey College of Engineering and Information Technology. Faculty, curriculum, and resources for this program are contributed by five departments: Systems Engineering, Computer Science, Information Science, Engineering Technology, and Construction Management. The program is designed to provide a collaborative, interdisciplinary framework of graduate studies and research in engineering with exposure to the systems approach that is increasingly the hallmark of current research and development in the global engineering community. Students enrolled in the Engineering Science and Systems Ph.D. program can select one of the four following tracks:

Systems Engineering

The Systems Engineering track focuses on design and analysis of systems and their architecture, integration of systems, decision and risk analysis, simulation and optimization of systems that are part of the technical infrastructure that supports an organization's application and information needs.

Electrical and Computer Engineering

The Electrical and Computer Engineering track focuses on embedded systems, robotics, measurement techniques, design of analog and digital electronics and circuits, power systems, digital systems, coding, software systems and operating systems.

Telecommunications and Networking Engineering

The Telecommunications and Networking Engineering track focuses on communications and mobile networking and protocols, advanced digital communications, digital signal processing, and antennas and wireless systems.

Mechanical and Materials Engineering

The Mechanical and Materials Engineering track focuses on advanced solid and fluid mechanics, MEMS and microsystems, vibration analysis, applied numerical and finite element methods, and smart materials.

Admission Requirements

In addition to the UALR Graduate School admission requirements, the applicants for the Ph.D. program in Engineering Science and Systems must also meet the following criteria:

- **Education:** Applicants must have a bachelor's degree in engineering, technology, science, or related discipline. The applicants with only a bachelor's degree must have an overall undergraduate GPA of 3.0 or 3.3 on the last 60 credit hours. Alternatively, applicants with a master's degree in engineering should have a master's GPA of 3.3 or better.
- **Standardized test scores:** Applicants are required to take the GRE test. Applicants must have the following minimum scores on the GRE test: a score of 146 on the Verbal Reasoning section and a score of 155 on the Quantitative Reasoning section. Applicants should also have a score of 4.5 in the Analytical Writing section. English language requirement: International students must satisfy the Graduate School TOEFL or IELTS tests requirements.
- **Statement of purpose:** Applicants are required to submit a personal statement that should include their background and qualifications for doctoral studies, and emphasize their educational and research interests they intend to pursue at UALR.
- **Letters of recommendation**: Applicants should make the arrangements for having three letters of recommendation submitted to UALR, on their behalf, by individuals familiar with their academic background and educational interests.

The Engineering Science and Systems Governance Committee will assign a track at the time of admission to each Ph.D. student after considering the student's past academic credentials, as well as student's request for a track. Applicants who do not meet all the admission requirements may be recommended for conditional admission by the Engineering Science and Systems Governance Committee. The conditionally admitted students must fulfill the requirements specified by the UALR Graduate School and the Engineering Science and Systems Governance Committee.

Graduate Assistantships

A limited number of graduate assistantships that support teaching and research opportunities are available to qualified full time students. Tuition is paid for nine credits per semester, and a stipend is provided for living expenses. Students must pay registration fees, buy textbooks, and purchase any necessary support materials. For more information about graduate assistantships, the online application process, and other financial assistance opportunities, visit the Engineering Science and Systems doctoral program website at ualr.edu/enss. A student supported by a graduate assistantship must be a registered full time student taking at least nine credit hours during the Fall and Spring semesters.

Transfer of Credit

Transferability of credit is determined by the Engineering Science and Systems Governance Committee based upon the applicability of the courses selected for student's dissertation work and educational goals.

Program Requirements

The program consists of a total of 76 credit hours, which include 17 credit hours of program core courses, 9 credit hours of track core courses, 12 credit hours of elective courses, and 38 credit hours of dissertation research. In addition, the student is required to:

- Maintain acceptable academic performance. If a student receives one C grade in his/her course work, he/she will be warned that his/her performance is unacceptable and that his/her status will be reviewed by the Engineering Science and Systems Governance Committee, which will suggest corrective actions. A student receiving two C grades or either a D grade or an F grade in his/her course work will be dismissed from the program, pending review by the Engineering Science and Systems Governance Committee;
- Pass candidacy examinations;
- Pass proposal defense;
- Publish and present at least one paper in a peer-reviewed national/international conference;
- Have at least one paper accepted for publication in an international reputed journal with the student as the first author;
- Pass dissertation defense.

Engineering Science and Systems Curriculum

The student's plan of study must be developed in conjunction with his/her Doctoral Dissertation Committee and filed with the appropriate Track Coordinator, as well as, the Engineering Science and Systems Graduate Coordinator.

Program Core: The program core provides students an introduction to the systems approach to engineering, as well as the mathematical and research methodologies and tools needed to successfully complete the Ph.D. studies. The 17 credit hours of program core courses are listed below:

- Engineering systems component - 3 credit hours: SYEN 7311 Systems Design and Analysis.
- Engineering seminar component - 4 credit hours (1 credit hour per semester for 4 semesters): SYEN 7192 Graduate Seminar.
- Engineering ethics component - 1 credit hour: SYEN 7118 Research Ethics in Science and Engineering.
- Engineering research methodology component – 3 credit hours: CPSC/IFSC/SYEN 7101, 7102, 7103 Research Methods.
- Engineering mathematical foundations component - 6 credit hours, as advised by the Doctoral Dissertation Committee.

Program Track Courses

The track courses consists of both core and elective courses, as follows:

- **Track core courses:** 9 credit hours.
- **Elective courses:** 12 credit hours.

A list of the core courses for each of the four program tracks and examples of elective courses are presented below. Students must choose three of the four listed core courses under their chosen track, and four elective courses, usually from the ones listed under their chosen track. Student may, with their advisors' permission, choose elective courses from other tracks as necessary to further their research.

Systems Engineering Track

Core courses:

SYEN 7312 System Architecture and Design
SYEN 7313 System Management and Evaluation
SYEN 7314 Multicriteria Decision and Risk Analysis
SYEN 7316 Advanced Systems Simulation

Elective courses examples:

SYEN 7342 Networks and Combinatorial Optimization
SYEN 7315 Complex Engineered Systems
CPSC 7373 Artificial Intelligence
CPSC 7383 Modeling and Simulation
IFSC 7310 Information Systems Analysis
INFQ 7318 Total Quality Management and Statistical Quality Control

Electrical and Computer Engineering Track

Core courses:

SYEN 7302 Advanced Electronics for Instrumentation
SYEN 5332 Applied Operating Systems / CPSC 7321 Operating Systems
SYEN 5354 Power Systems Analysis
SYEN 5366 Advanced Digital Systems
Elective courses examples:
SYEN 7306 Real-Time Embedded Systems
SYEN 7331 Transducers and Real-Time Control
SYEN 7332 Advanced Operating System Design
CPSC 7321 Operating Systems
CPSC 7331 Computer Architecture
CPSC 7374 Image Processing

Telecommunications and Networking Engineering Track

Core courses:

SYEN 5310 Introduction to Signal Processing
SYEN 5353 Advanced Digital Communications
SYEN 5356 Radio Frequency Techniques and Systems
SYEN 5355 Mobile Multimedia Internet / CPSC 7341 Telecommunications and Networking

Elective courses examples:

SYEN 7357 Advanced Antennas for Wireless Systems
CPSC 7341 Telecommunications and Networking
CPSC 7343 Sensor Networks
CPSC 7374 Image Processing
IFSC 7321 Information Science: Principles and Theory

Mechanical and Materials Engineering Track

Core courses:

SYEN 5371 Introductory Continuum Mechanics
SYEN 5375 Mechanical Vibrations / SYEN 5384 Computer Methods in Fluids and Heat Transfer
SYEN 5383 Finite Element Analysis
SYEN 7317 Nanostructural Materials: Physical and Chemical Properties / SYEN 7318 Micro- and Nano-Fabrication

Elective courses examples:

SYEN 7307 Smart Materials
SYEN 7374 Elasticity
SYEN 7376 Fracture Mechanics

Dissertation Research Courses:

Students are required to complete at least 38 credit hours of doctoral dissertation research courses during their doctoral studies, using one of the below designations:

CPSC/IFSC/SYEN 9100-9900 Doctoral Research Dissertation

Candidacy Exams

The program is designed so that the student is exposed to a breadth of knowledge through the program core and a depth of knowledge through the track core. The candidacy exam will have a written and an oral component. The written component will test the student on the fundamental knowledge at the advanced undergraduate level, whereas the oral component will test the student's ability to conduct research in his/her area of interest. The following candidacy exam structure is followed:

1. The student can take the candidacy exam no sooner than the second semester he/she is in the program and no later than the third semester he/she is in the program.
2. The student will have to officially declare his/her intention to take the candidacy exam by the end of the semester prior to the semester in which he/she will take the exams for the first time.
3. The student will have to attempt both components in the same semester, and will need to pass each of the component separately. If the student fails to pass one or more components in the first attempt, he/she will have to retake those components in the next semester. Failure to pass the exam in two attempts will result in dismissal from the program, pending review of the Engineering Science and Systems Governance Committee. This review will be completed and a decision conveyed to the student by the end of the academic year when he/she has taken the exam.
4. A sample written exam for each track and a sample research topic for the oral exam will be on file with the Graduate Coordinator. The students will have access to the sample exam for the purposes of familiarizing themselves with the written component of the candidacy exam.
5. Decisions of the Track Candidacy Exam Committee will be supported by a minimum of 2/3 majority of the committee members present and will be any one of the following:

   i. Pass

   ii. Pass with remedial course work

iii.Fail; in this case, the student will retake the oral component in the next semester on the same research topic; a new report will have to be submitted by the student prior to retaking the oral exam.

Written Component:

1. The written exam for each track will be one 4-hour exam, and there will be only one exam for each track.
2. The syllabus of the written exam will be identical for the Fall and Spring semester exams in a given academic year, and will be published at the beginning of the Spring semester of the prior academic year. The study materials for each track will also be recommended.
3. The student will have passed the exam if her/his overall grade in the written exam is 70% or higher.

Oral Component:

1. The oral exam for each student taking the exam will be of 1-hour duration.
2. Student will be given a research topic on which to submit a written report. This report shall be submitted no later than one month from the date the student was assigned the topic.
3. The student will be provided with a template. The same template will be used for all the tracks. The submitted report will have to adhere to the guidelines of the template.
4. Using the written report as the basis, the student will be orally tested by the Track Candidacy Exam Committee. The oral exam will be scheduled no earlier than two weeks after the student has submitted the report.

Proposal Defense

At least two years prior to the dissertation defense, candidates must present their research proposal to their Doctoral Dissertation Committee. At the completion of the examination, the Doctoral Dissertation Committee will vote to either pass or fail the student. Students who fail the proposal defense will have to repeat the defense within a semester of their first attempt. If the student fails the proposal defense for a second time, he/she will be dismissed from the program, pending review of the Engineering Science and Systems Governance Committee. More information about the proposal defense can be found in the Engineering Science and Systems Doctoral Student Handbook.

Dissertation Defense

In order to complete the requirements for the doctoral degree, students will prepare and successfully define a written dissertation in accordance with the format and procedures dictated by the Graduate School. Students must orally defend their completed doctoral research to their Doctoral Dissertation Committee. At the completion of the examination, the Doctoral Dissertation Committee will vote to either pass or fail the student. If two or more negative votes are cast by the committee members, the student is considered to have failed the exam and will be dismissed from the program, pending review of the Engineering Science and Systems Governance Committee. More information about the dissertation defense can be found in the Engineering Science and Systems Doctoral Student Handbook.

Doctoral Dissertation Advisor

A student admitted to the doctoral program can declare an advisor, with advisor's approval, no earlier than the second semester that he/she is in the program. The student is required to meet with faculty eligible to mentor him/her as dissertation advisor before the student can declare the dissertation advisor. As part of the process, the student will have to interact/work with at least three faculty members.

Doctoral Dissertation Committee

The Doctoral Dissertation Committee can be constituted once the student has declared his/her Doctoral Dissertation Advisor, and no later than the second semester that the student has been in the program. The committee will include a minimum of five members and a maximum of seven members. At least four members have to be Engineering Science and Systems program faculty. The committee can have one or more external members who are not Engineering Science and Systems program faculty. If the dissertation advisor and the doctoral student are affiliated with different tracks, it is required that at least one Engineering Science and Systems program faculty in the committee belong to the student's track.

Courses in the Engineering Science and Systems Doctoral Program

The catalog description of the program core, track core and elective courses, and the dissertation research courses that are part of the Engineering Science and Systems Doctoral Program, is provided in the "Systems Engineering," "Computer Science," "Information Science," and "Information Quality" sections of this catalog. Other courses may be approved in consultation between the student and his/her Doctoral Dissertation Committee.

Up to twelve credit hours may be granted to the student for completing equivalent graduate coursework at other institutions. Such credit must be exclusive of thesis or other exit project credits, be no more than five years old at the time of transfer, and must have a letter grade of B or better. In some cases students may be required to balance their transfer credit with a corresponding increase in research hours. Students interested in requesting a credit transfer should discuss the request with their Doctoral Dissertation Advisor and appropriate Track Coordinator. The request must also be approved by the Engineering Science and Systems Graduate Coordinator and the Dean of the Graduate School before the transfer of credit can be granted.

EIT Building, Room 550
(501) 569-8951
ualr.edu/informationquality

INFORMATION QUALITY

Master of Science in Information Quality

The Master of Science in Information Quality degree is offered through the Department of Information Science and is designed to prepare students for careers in industry and government as well as advanced graduate studies. The curriculum is designed to balance information quality theory with industry best practices using state-of-the-art tools and technology. The curriculum is based on the Model Curriculum and Guidelines for Graduate Degree Programs in Information Systems endorsed by the Association for Computing Machinery (ACM) and Association for Information Systems (AIS). The course content has been developed with the support of the Massachusetts Institute of Technology Information Quality Program, based at the MIT Center for Technology, Policy, and Industrial Development, and with additional help from leading practitioners and researchers within the information quality community. The program is accessible to both day and evening students and both full-time and part-time students. In addition, a distance education option allows students to participate in the program via live webcasting. For more information, please visit the program's website at ualr.edu/informationquality and the LinkedIn Group "UALR Information Quality Graduate Program."

Admission Requirements

- Baccalaureate degree in information science, computer science, computer information systems, management, or a related discipline from an accredited institution.
- Cumulative grade point average of at least 3.0 on a 4.0 scale.
- Graduate Record Examination (GRE) general test section or Graduate Management Admission Test (GMAT) scores. For regular admission, applicants should have a minimum GRE Verbal Reasoning score of 142, a minimum GRE Quantitative Reasoning Score of 142, (minimum Total Score of 297),and the GRE Analytical Writing Score of at least 3.0 or a GMAT Score of at least 420. The GRE/GMAT requirement is waived for applicants who have completed the UALR Graduate Certificate Program with a GPA of 3.5 or higher.
- Statement of Interest
- Resume
- Completion of any remedial course work that may be specified by the department; in particular, all students seeking regular admission to the program are expected to have completed (with a grade of B or better in each course) undergraduate course work equivalent to the following UALR undergraduate courses:
- IFSC 2300 Object-oriented Software
- IFSC 3320 Database Concepts
- STAT 2350 Introduction to Statistical Methods

Waiver of any or all of these prerequisite courses is at the discretion of the Information Quality Graduate Committee.

Program Requirements

There are two curriculum options within the Master of Science in Information quality degree program, a Thesis Option and a Project Option.

1. **Thesis Option:** Thirty-three (33) credit hours, consisting of 27 hours of course work plus a minimum of 6 credit hours of INFQ 7198, 7298, 7398, 7498, 7598, or 7698, Thesis. Total thesis credits exceeding the minimum will not be count towards minimum course requirements.
2. **Project Option:** Thirty-three (33) credit hours, consisting 27 hours of course work plus of one of the following sub-options:

   INFQ 7686 Graduate Project

   INFQ 7386 Graduate Project (repeated over two semesters)

Minimum of three credits of INFQ 7191, 7291, or 7391 Cooperative Education in Information Quality followed by INFQ 7386 Graduate Project.

To be eligible to enroll in thesis, project, or cooperative education courses, a student must first meet the following requirements:

- Have completed at least 9 hours of required or elective program course work.
- Be in good standing in the program.
- In the case of the Thesis Option, successfully defend a thesis proposal to his or her thesis committee.
- In the case of the Project option, has secured a faculty advisor, an external project sponsor, and has a project plan approved by the MSIQ program committee.

In addition to the above requirements, a student approved to enroll in thesis hours must continue to enroll in at least 3 hours of thesis hours each semester (fall, spring, and summer I) until he or she has successfully defended his or her thesis. Similarly, a student approved to enroll in project hours must continue to enroll in at least 3 hours of project hours each semester (fall, spring, and summer I) until he or she has successfully defended his or her project. Exceptions to this policy will be granted only in cases of significant hardship. Exceptions must be requested in writing and approved by the student's thesis or project advisor and the graduate coordinator.

Core Requirements

All students must take the following seven courses (21 credit hours):

Information Quality Courses

INFQ 7303 Principles of Information Quality
INFQ 7322 Information Quality Theory
INFQ 7342 Information Quality Tools and Industry Landscape
INFQ 7367 Information Quality Policy and Strategy

Information Science Courses

IFSC 5345 Information Visualization
IFSC 7310 Information Systems Analysis
IFSC 7320 Database Systems

Electives

One graduate course with an INFQ prefix such as:

INFQ 7318 TQM and Statistical Quality Control
INFQ 7337 Project and Change Management
INFQ 7348 Entity Resolution and Information Quality
INFQ 7353 Case Studies for Information Quality Professionals

INFQ

One Course from the following list without the INFQ prefix such as:

IFSC 5325 Data Mining Concepts and Techniques
IFSC 5330 Database Security
IFSC 5339 Network Security
IFSC 5399 Special Topics (Title will vary)
IFSC 7321 Information Science and Theory
IFSC 7325 Advanced Data Mining
IFSC 7330 Information Systems Security
IFSC 7331 Network Science
IFSC 7350 Electronic Commerce
IFSC 7360 Data Protection and Privacy
IFSC 7399 Special Topics (Title will vary)
MGMT 7308 Advanced Business Communication
MGMT 7312 Team Development
Other with approval of Graduate Coordinator

Graduate Certificate in Information Quality

The Graduate Certificate in Information Quality program consists of 12 graduate credits, which may be completed in the evenings or online. This certificate will provide individuals with a focused collection of coursework in the information quality area. The program is designed for post-baccalaureate students and working professionals who are interested in moving into information quality leadership roles within their organizations or in preparation for entering master's programs. The program is accessible to both day and evening students and both full-time and part-time students. In addition, a distance education option allows students to participate in the program via live webcasting.

Admission Requirements

A bachelor's degree from an accredited institution with an overall GPA of at least 3.0 (4.0 scale). Candidates who have a background in computer programming, database concepts, and applied statistics or who have professional experience in any information quality role will be the most prepared to enter and successfully complete the certificate program.

Completion of any remedial course work that may be specified by the department for the certificate program. Students seeking regular admission to the certificate program are expected to have completed (with a grade of B or better in each course) course work or to have professional experience equivalent to the following UALR courses:

IFSC 2300 Object-oriented Technology

IFSC 3320 Database Concepts

STAT 2350 Introduction to Statistical Methods

The GMAT or GRE exams are not required.

Program Requirements

The Graduate Certificate in Information Quality consists of 12 hours of coursework as follows:

Required Core Courses (9 hours)

INFQ 7303 Principles of Information Quality

INFQ 7342 Information Quality Tools & Industry Landscape

INFQ 7367 Information Quality Policy and Strategy

Elective Courses (3-hours-Select one course)

INFQ 7318 Total Quality Management & Statistical Quality Control

INFQ 7322 Information Quality Theory

INFQ 7337 Project and Change Management

INFQ 7353 Case Studies for Information Quality Professionals

Additional Requirements

- Graduates of the certificate program with a 3.5 GPA can apply to the MSIQ program without a GMAT or GRE requirement, but students are advised that all other admission criteria to the MSIQ program apply, including deficiency work.
- Concurrent enrollment in the IQ Graduate Certificate and the MSIQ program is permitted (i.e., MSIQ students are eligible to receive certificates upon completion of the appropriate subsection of the MSIQ curriculum).
- Students in the IQ Graduate Certificate program must apply to the UALR Graduate School at ualr.edu/gradschool/prospectivestudents.asp. The Certificate program code is INFQ-GC.

For more information about the Graduate Certificate in Information Quality, contact the program coordinator.

Substitution of Core Requirements

The Information Quality Graduate Committee may substitute other graduate-level courses in Information Quality or Information Science for up to six hours of the core requirements if in the Committee's opinion, an entering student has already completed the same level of work prescribed for that core course or courses through previous academic work or professional experience. Overall course substitution for previous work is limited to a total of 12 hours.

Graduate Assistantships

A limited number of graduate assistantships are available. Contact the program coordinator for more information.

Graduation Requirements

- Cumulative GPA of at least 3.0 in the approved program of study as outlined above
- Successful completion of one of the program options

Distance Education Option

The program offers a distance education option that permits students to participate in classes via a broad-band Internet connection. Students attending class online will be able to see the course materials presented in the on-campus classroom and participate in discussions with the other students on-campus and online. Classes are recorded so that students can replay previous class meetings. The transcript of students completing the program through the distance education option will appear the same as those completing the program on-campus.

All students in the program can take advantage of the webcasting of classes; the distance education option is primarily for remote students, i.e. students who because of distance or other circumstances cannot attend on-campus classes on a regular basis.

Notwithstanding, all major examinations must be taken in person. Examinations for local students are administered in the campus classroom by the instructor. Examinations for remote students must be administered by an approved proctor. Because all students must present their final theses or project reports in person to the Information Quality Graduate Committee as a requirement for graduation from the program, remote students must be prepared to make at least one visit to the UALR campus in order to complete their degree requirements.

Courses in Information Quality

INFQ 7191, 7291, 7391 Cooperative Education in Information Quality

Prerequisite: Graduate standing and approval of assignment by the faculty sponsor and the graduate coordinator. Complements and extends the classroom experience by allowing the student to apply the concepts of information quality improvement in the work place. The exact number of hours per week, activities, and responsibilities of the work are dependent on the nature of the work experience and must be specified in written agreements coordinated with the UALR Office of Cooperative Education between the student, the sponsoring faculty member, and the employer. At a minimum, a written report and 12 hours per week for a 3 credit hour semester course, 8 hours per week for a 2 credit hour semester course, and 4 hours per week for a 1 credit hour semester course with the participating employer are required. The course may be repeated for credit. The course cannot be used for credit toward the requirements for the Masters in Information Quality degree without the special approval from the MSIQ Graduate Coordinator.

INFQ 7300 Independent Study

Prerequisite: graduate standing and consent of the instructor. Independent study in Information Quality is given under the direction of a faculty member. The different topics for independent study can be, but not limited to: Research and Reading, Information Quality Software Development, Research Project on Information Quality, etc. as long as the topic is not offered in regularly scheduled course offerings. Upon the completion of the course, the student is typically required to submit a written report with content and quality comparable that required for a conference or journal such as the International Conference in Information Quality or the ACM Journal of Data and Information Quality. Written proposal and final product required. No more than three hours may count toward concentration requirements. Additional hours may fulfill cognate requirements. May be repeated once for degree credit.

INFQ 7303 Principles of Information Quality

Prerequisites: IFSC 2300 or equivalent. This course provides a rigorous exploration of information quality concepts, assessment, and problems in organizational information systems, databases and data warehouses. A combination of state of the art literature review and hands-on projects is used to develop knowledge and ability to meet objectives. Three hours lecture. Three credit hours.

INFQ 7318 Total Quality Management and Statistical Quality Control

Prerequisites: STAT 2350 or equivalent. This course provides an understanding of how the concepts and techniques of Total Quality Management may be applied to information products. Topics include continuous improvement strategies, statistical process control, experimental design, capability analysis, quality cost assessments, benchmarking, acceptance testing, and auditing. Three hours lecture. Three credit hours.

INFQ 7322 Information Quality Theory

Prerequisite: INFQ 7303. This course is designed to provide students with the theoretical foundations critical for developing a deep understanding of the state-of-the-art information quality research from the technical, organizational and strategic perspectives. This course will prepare students to work on their thesis, project and conduct research in the field of information quality. More specifically, students will be exposed to concepts, principles, tools and models and techniques that are essential for information quality definitions, measurement, analysis and improvements. Additionally, students will be exposed to most current, cutting-edge research that goes beyond current industry practice in information quality. Three hours lecture. Three credit hours.

INFQ 7337 Project and Change Management

Prerequisites: INFQ 7303. A course on how to manage information quality improvement projects within an organizational context, including the processes related to initiating, planning, executing, controlling, reporting, and closing a project. Additional topics include identifying project champions, working with user teams, training, documentation, project integration, scope, time, cost-benefit studies, risk analysis, and change management. Three hours lecture. Three credit hours

INFQ 7342 Information Quality Tools and Industry Landscape

This course is designed to develop and increase capability and skills that students need to critically understand what IQ software tools, techniques and prototypes are currently used in industry, government and research laboratories. The course will prepare students to make software tool recommendations on corporate data quality programs. Students will conduct a survey of academic literature and industry practices in terms of IQ tools such as data cleansing, profiling, and auditing and will participate in a hands-on workshop on commercial IQ tools from participating vendors in the field. Two hours lecture and three hours lab per week. Three credit hours.

INFQ 7348 Entity Resolution and IQ

Prerequisite: INFQ 7342 or consent of instructor. An examination of the theory and practice of entity resolution (ER), and the relationship between ER and information quality. Topics include the primary activities of ER, the major ER system architectures, methods and techniques for determining reference equivalence, major theoretical models for ER, entity-based data integration, ER case studies, and hand-on ER exercises with commercial and open-source ER tools.

INFQ 7353 Case Studies for Information Quality Professionals

Prerequisites: INFQ 7322 and INFQ 7342. This intensive and interactive course is designed to develop and increase the student's capability and skills to critically understand what constitutes data quality, how to analyze and solve data quality problems, and how to institutionalize data quality projects in an organization where data quality is not the most critical priority. Three hours lecture. Three credit hours

INFQ 7367 Information Quality Policy and Strategy

Prerequisite: INFQ 7322. This course explores the top management, strategic perspective for aligning competitive strategy, core competencies, and information quality. Topics include the development and implementation of IQ policies and plans to achieve organizational goals; how to define systems that support the operational, administrative, and strategic IQ needs of the organization, its business units, and individual employees; approaches to managing technology and the information systems function in organizations, role of the CIO. Three hours lecture. Three credit hours.

INFQ 7386, 7686 Graduate Project

Prerequisites: Graduate standing and consent of the student's graduate advisor. Students, under faculty supervision, will conduct directed research on a particular problem or area of information quality and will produce reports and other deliverables appropriate to the project. 7386 may be repeated over two semesters.

INFQ 7399 Special Topics

Prerequisite: graduate standing and consent of instructor. The course explores on an experimental or temporary basis advanced topics in information quality not included in the established curriculum. Content, subtitle, organization change each time offered, based on interest.

INFQ 7198-7698 Thesis

Prerequisite: Consent of thesis advisor. Student's should have completed at least 15 hours of the program core, or have had substantial professional experience in information quality management.

Courses in Information Science

IFSC 5199,5299,5399 Special Topics

Advanced, specialized topics of current interest in information science. May be repeated for no more than 12 hours of credit. One, two, three or four credit hours.

IFSC 5325 Data Mining Concepts and Techniques
Prerequisites: IFSC 4325: IFSC 3330 or equivalent or consent of instructor and Graduate status for IFSC 5325. This course provides in-depth, practical coverage of essential data mining topics, including OLAP and data warehousing, data preprocessing, concept descriptions, association rules, classification and predication, and cluster analysis. It addresses advanced topics such as mining object-relational databases, spatial databases, multimedia databases, time-series databases, text databases, the World Wide Web, and applications in several fields. Three hours lecture. Three credit hours.

IFSC 5330 Database Security
Prerequisite: IFSC 3330 or equivalent or consent of the instructor. Focus on security issues in databases systems and introduction of how current and future commercial systems may be designed to ensure secrecy and confidentiality. Topics include security models, basic security mechanisms and software, statistical database security, intrusion detection, security models for next generation databases, tested techniques and proven strategies for securing an Oracle environment — from the operating system to the database to the network, and how to implement security using Oracle's built-in tools. Three hours lecture. Three credit hours.

IFSC 5339 Network Security
Prerequisite: MATH 1304 or equivalent and IFSC 3315 or CPSC 4384 or SYEN 3332 or MGMT 4310 or consent of the instructor. This course provides students with a concise and in-depth overview of security issues in current computer networks. It first gives a brief introduction of cryptographic algorithms and protocols underlying network security applications, including encryption, hash function, public key algorithm, digital signatures, and key exchanges. Then, it focuses on the security issues in current computer networks as well as network security tools and applications, including Kerberos, X.509v3 certificates, PGP, S/MIME, IP security, SSL/TLS, SET, and SNMPv3. The course will cover network intrusion-detection techniques and systems. Three hours lecture. Three credit hours.

IFSC 5345 Information Visualization
Prerequisites: MATH 1451 and IFSC 2300. The design and presentation of information. Use of graphics, animation, sound, visualization software, and hypermedia in helping users understand information. Methods of presenting complex information to enhance comprehension and analysis. Incorporation of visualization techniques into human-computer interfaces. Three hours lecture. Three credit hours.

IFSC 5360 Social Computing
Prerequisite: IFSC 1310 and IFSC 2300, or equivalent, or consent of Instructor. A hands-on course focusing on concepts of the social and information networks, Web as graph, models (such as Power law distribution, scale-free models, preferential attachment models, etc.) that simulate behavioral characteristics of these graphs, basic graph theoretical concepts, characteristics of social media and Web 2.0 or the Social Web (such as blogs, microblogging, social friendship networks, social bookmarking, social news, social media sharing, wikis, etc.), understanding and developing API and mashups, issues and challenges in data crawling and web analytics, network data visualization, exposure to information extraction and retrieval concepts aiming at the highly dynamic and noisy nature of social media, harnessing the collective and web intelligence, and basic concepts of cloud computing. Three lecture hours. Three credit hours.

IFSC 7101 Research Methodology
Prerequisite: Graduate standing. A one-credit course in a set of three, introducing students to the research methodology of doctoral level research in the Integrated Computing field. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the Integrated Computing discipline.

IFSC 7102 Research Tools
Prerequisite: Graduate standing. A one-credit course in a set of three, introducing students to the research tools of doctoral level research in the Integrated Computing field. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the Integrated Computing discipline.

IFSC 7192 Graduate Seminar
Prerequisites: Graduate standing, consent of graduate coordinator. Students, faculty, and invited speakers will present discuss and exchange ideas on research topics of general interest to the graduate programs in the EIT college. One-hour session per week. Course may be repeated for credit. Graded: credit/no credit.

IFSC 7310 Information Systems Analysis
Methods of problem identification and definition, data collection and measurement, feasibility study methods, work measurement techniques, task analysis, simulation studies, impact analysis, evaluation methods, forms and display design, proposal writing, documentation and programming standards, design strategies, documentation, and evaluation. (3 credits)

IFSC 7320 Database Systems
The course covers two major areas. It first introduces principles and methodologies of database design, and basic techniques for database development. Then it introduces the fundamentals of information architecture and helps students understand how information architecture acts as the supporting structure aligning application design, technology, and business goals.

IFSC 7321 Information Science: Principles and Theory
Prerequisite: Graduate Standing. This course surveys the major topics in information science including a discussion of entropy, value strategies, security, extraction, and emission of information. Three credit hours.

IFSC 7325 Advanced Data Mining Applications
Prerequisites: IFSC 4325 or equivalent. This is an advanced course on data mining. The focus will be on new data mining techniques and their applications in health information systems, text mining and biological data mining. The course will include presentations and discussions of research papers and projects closely related to topics in data mining. The research papers will be selected from the course supplementary materials and consists of recently published topics on data mining and their applications. Three credit hours.

IFSC 7330 Information Systems Security
Prerequisite: MATH 2310 or equivalent, and IFSC 3320 or equivalent. This course aims at providing a solid theoretical foundation in Information Systems Security, including both Computer Security and Communications Security. The security issues in information systems as well as techniques for ensuring information systems security will be studied. The course will focus on the study of security policies, models, and mechanisms for secrecy, integrity, and availability. The basic principles of information systems security will be discussed, including basic crypotography and its applications, security in computer networks and distributed systems, access control models and mechanisms for database security, multilevel database security, stenography, Internet security, and control and prevention of viruses and other rogue programs.

IFSC 7331 Network Science
Study of network representations of physical, biological, and social phenomena leading to predictive models. This course will focus on the graph-theoretical, statistical and algorithmic foundations of network science. The course is designed for an interdisciplinary graduate audience with an information or computational science or engineering background, or by consent of the instructor. Three hours lecture. Three credit hours

IFSC 7350 Electronic Commerce
Prerequisite: Doctoral-level standing by student or consent of instructor. Seminar style course designed for doctoral level student to be able to explore jointly the field of electronic commerce theoretically, conceptually and through applications including electronic markets, strategy, business models, impacts of information and communication technologies, organization and social behavior, as well as selected economic perspectives.

IFSC 7360 Data Protection and Privacy
This course considers the current status of data, information and privacy protection policies, laws and technologies. At the core is the variety of issues concerning informational privacy, i.e. the gathering, creating, storing, use and protection of information and data about individuals. Topics include the economics of data and privacy protection *vis-a-vis* the right of access to information, control, ownership, free flow, accuracy and use of information; commercial uses of personal information such as data mining and other marketing techniques, as well as the roles of government and the private sector in this setting. Newer information technologies, data mining, security measures, genetic tests and biobanks worldwide have raised important issues and questions.

EIT Building, Room 579
Computer Science, EIT, Room 579, (501) 569-8130
Information Science, EIT 550, (501) 569-8951
Systems Engineering, EIT 518, (501) 569-3100

Integrated Computing

Doctor of Philosophy in Integrated Computing

The Integrated Computing Doctoral Program is housed in the Donaghey College of Engineering and Information Technology. Faculty, curriculum, and resources for this program come from three departments:

1. Computer Science,
2. Information Science, and
3. Systems Engineering.

This degree is designed to promote strong multidisciplinary collaborations across several computing disciplines whose bodies of knowledge influence and intertwine with each other. The following emphasis areas are offered:

Track Department	Description	Sponsoring
Net Integrated Computing	The Net Integrated Computing track focuses on the hardware components and software that allow diverse computer systems to interconnect to form the complex and dynamic computing networks necessary to support an organization's applications and information environment.	Systems Engineering and Computer Science
Computer Science	The Computer Science track focuses on the application architecture whose integrated software systems support the data and functional needs of the enterprise across diverse computing networks.	Computer Science
Information Science	The Information Science track focuses on the theory, applications, technologies, and systems that classify, manipulate, store, retrieve, and disseminate information.	Information Science
Information Quality	The Information Quality track focuses on the theory, principles, models, and techniques for delivering information that is "fit for use", an increasingly challenging task as organizations struggle with such issues as data architecture, identity resolution, data protection, and privacy.	Information Science

Graduate Assistantships

A limited number of graduate assistantships that support teaching and research opportunities are available to qualified full time students. Tuition is paid for 9 credits, and a stipend is provided for living expenses. Students must pay registration fees, buy textbooks, and purchase any necessary support materials. For more information about graduate assistantships, the online application process, and other financial assistance opportunities, visit the Integrated Computing website at ualr.edu/integratedcomputing. A student supported by a graduate assistantship must be a registered full time student taking at least nine credit hours during the Fall and Spring semesters and is prohibited from any other employment.

International Students

International students whose native language is not English and who do not have a degree from a regionally accredited U.S. institution of higher learning must demonstrate proficiency in written English via the Test of English as a Foreign Language (TOEFL). Applicants' scores must exceed 550 (paper-based test) or 213 (computer-based test) or 79 (internet-based test). Applicants with scores below but close to 550 (213 if computer-based test or 79 internet-based test) may be admitted provisionally upon the recommendation of the Integrated Computing Steering Committee to the Dean of Graduate School, and allowed to fulfill the TOEFL requirement as specified in the Graduate School admissions policies.

For applicants whose native language is not English and who are seeking financial support via a teaching assistantship, the student must demonstrate proficiency in spoken English via a score of 80% or higher on the American English Oral Communication Proficiency Test (AEOCPT) or a score of 5.0 or higher on the Test of Spoken English (TSE).

Admission Requirements

Applicants for the Integrated Computing program must meet the requirements of the UALR Graduate School in addition to the following criteria:

- Applicants must possess a bachelor's degree or higher from a regionally accredited institution. Students whose degree(s) are in an appropriate scientific discipline, such as engineering, mathematics, computer science, or technology area will be the most prepared to enter and successfully complete this program. Students should have an overall undergraduate GPA of at least 3.0 (4.0 scale) for their last 60 credit hours.
- Standard test scores (the Graduate Record Examinations (GRE)) taken within five years of application. The desired combined quantitative and verbal scores on the GRE is 301 or above (336 scale), with minimum score requirement of 142 and 144 for verbal and quantitative sections, respectively. Computer Science, Net Integrated Computing, and Information Science tracks have an additional minimum score requirement of 155 for quantitative section. In addition, applicants should demonstrate their ability to communicate complex ideas clearly and effectively either through a strong score on the GRE Analytical Writing Component (e.g., 3.5 or above on a 6.0 scale) or through samples of their written work.
- Three (3) letters of recommendation.
- Official college transcripts including grades and curriculum for undergraduate and (if applicable) graduate studies.
- Written statement by the applicant regarding the reasons (e.g. interests, relevant experience, and goals) why he or she should be considered for this Ph.D. program.
- Résumé detailing any professional work experience, published papers, or presentations

Note: All application materials must be submitted directly to the UALR Graduate School.

Integrated Computing track areas may vary in their allowances to the admission criteria stated above. The Integrated Computing Steering Committee will evaluate the compatibility between the applicant's background, research interests, and communication to skills vis-à-vis the doctoral program when making admission decisions, and may decline to admit an otherwise qualified application based on a lack of fit with the program.

Conversely, the Integrated Computing Steering Committee may recommend conditionally admitting for one semester, a promising student who has less than the specified requirements for admission. These students may be required to take prerequisite coursework at the undergraduate level as part of the terms of their conditional admission. The conditional student must fulfill the admission requirements specified by the Integrated Computing Steering Committee by the specified time frame to be admitted fully (e.g., student may be required to maintain a B or higher in their first 12 hours of the program). Such students will be evaluated by the Integrated Computing Steering Committee after one semester and a decision made to: (1) continue conditional status, (2) grant full admission to the doctoral program, or (3) dismiss the student from the doctoral program.

Writing Requirement

An English Writing Proficiency Exam (WPE) will be offered each Spring semester by the Integrated Computing Program. This exam assesses the student's ability to communicate in a written format. Each student must pass this exam to fulfill graduation requirements. A student who does not pass the WPE is required to take the English Writing Proficiency Laboratory (EWPL). The EWPL is offered each spring term. The student must take the EWPL each spring term until they pass.

Seminar Requirement

All PhD students are required to register for the one (1) credit hour Integrated Computing Seminar for three semesters. This credit hour will count toward the overall program's minimum requirements of 75 credits. The seminar is designed to promote beneficial synergistic, and collaborative relationships between students and faculty across the emphasis areas through the dissemination and discussion of research that cuts across computing and information boundaries. In addition, students are required to complete Responsible Conduct of Research, an online research ethics course (Citiprogram.Org), to gain awareness and understanding of ethical principles and situations in their disciplines.

Doctor of Philosophy of Integrated Computing Program Requirements

The program requires a minimum of 75 hours beyond the Baccalaureate degree. Specific requirements depend on the track area chosen and are detailed in this section. A minimum of thirty -three (33) credit hours of course-work is required from 5000 and 7000 level courses with a maximum of 6 credit hours of 5000 level courses that can be used toward this requirement. This thirty-three (33) credit hours of course-work must include nine (9) credit hours of General Core classes, twelve (12) credit hours of Primary Track courses, a minimum of nine (9) credit of electives, and three (3) credit hours of seminar courses. The student's plan of study must be developed in conjunction with his/her doctoral advisor and filed with the appropriate track coordinator as well as the Integrated Computing graduate coordinator.

The general core addresses the theoretical and methodological underpinnings common to all tracks. It is designed to provide the necessary breadth for all students in the program and consists of the following:

1. either a systems analysis/design course (for students in the Information Quality area) or a software engineering course (for students in all other emphasis areas);
2. an information science theory course;
3. a trio of 1 credit courses covering research methods, tools, and applications.

Each track core consists of four courses designed to give students the necessary depth in their specific area of concentration. In addition, student select at least 3 elective courses based on input from their advisor to further enhance their course portfolio. Electives can be selected from core courses of other tracks, non-track CPSC/IFSC/INFQ/SYEN graduate courses, or other graduate courses appropriate to the student's research interests from the fields of Science, Technology, Engineering, or Mathematics.

A minimum of 42 credit hours in the 9000-level doctoral research/dissertation is required. The research must be substantial and must extend the state of the art in the student's chosen emphasis area through theoretical development, design or process improvement, or experimental technique. Because the program is interdisciplinary in nature, students are expected to demonstrate scholarship exhibiting depth of competency in at least one of the track areas of the program and an understanding of the critical issues that extend across multiple track areas. If a student receives one C in his/her courses, he/she will be warned in writing that his/her academic performance is unacceptable and that his/her status will be reviewed by the Integrated Computing Steering Committee which will suggest corrective action. A student receiving two Cs or either a D or an F in his/her courses will be dismissed from the program, pending review by the Integrated Computing Steering Committee.

Transfer of Credit

Transferability of credit is determined by the student's advisory committee based upon the applicability of the courses selected for dissertation work and the student's educational goals. For students who have completed some graduate work or who have an MS in a non-related field, up to twelve (12) graduate hours may be granted to the student for completing equivalent graduate coursework from other institutions based upon the applicability of the courses to dissertation work and the student's educational goals in the Integrated Computing program. Such credit must be exclusive of thesis or other exit project credits, be no more than five years old at the time of transfer, and must have a letter grade of B or greater. Students interested in requesting a credit transfer should discuss the request with their doctoral advisor and appropriate track coordinator. The request must also be approved by the Integrated Computing graduate coordinator and the Dean of the Graduate School before the transfer of credit can be granted. In some cases students may be required to balance their transfer credit with a corresponding increase in research hours.

Candidacy Exam

The purpose of the candidacy examination is to determine whether the applicant possesses the attributes of a doctoral candidate. Candidacy exams will be held twice a year after the start of Fall and Spring classes. The candidacy exam is a comprehensive test composed of four topic areas, each of which must be passed.

Four topic areas for each program track are as follows:

Computer Science Track:

- Algorithm and Theory
- Operating Systems
- Computer Architecture
- Programming Languages

Net Integrated Computer Track:

- Performance Analysis
- Operating Systems
- Network Protocols
- Network Architecture

Information Science Track:

- Database Systems
- Data Mining
- Programming Languages
- Network Science

Information Quality Track:

- Information Quality Value and Business Impact
- Information Quality Strategy, Policy, and Governance
- Information Quality Assessment, Improvement, and Sustainability
- Information and Information Systems Architecture Quality

The student may attempt the candidacy exam a maximum of two times and must attempt it in consecutive semesters. A student who has not passed all topic areas after the second offering will be dismissed from the program pending review by the faculty who created and graded the failed exam(s) along with input from members of the Integrated Computing Steering Committee.

Students may attempt their exams no sooner than the beginning of the second semester in the program. All students in the program will be required to take their candidacy exams in the four topic areas within one (1) semester after completing all their general core and primary track courses. Students wit sufficient background obtained through undergraduate/graduate course work and who demonstrate fundamental knowledge in their track can apply with their advisor's permission to take the exam earlier.

Extensions may be granted in the event of special circumstances such as a serious medical episode, pregnancy, or military deployment. Upon successful completion of the candidacy exams, the student will be granted candidacy status.

Doctoral Advisory Committee

Each student will choose a faculty member to be his or her mentor through the doctoral program. New students will be advised initially (i.e., their first semester) by the Track Coordinator of the student's chosen emphasis area. Through lab rotations and interactions with faculty, most students should have selected a Doctoral Advisor to guide them through their coursework, preparation for the candidacy exams, and dissertation process by the end of their first two semesters.

The role of the Doctoral Advisory Committee is to advise and help direct a student's academic and research program. Students should select and meet with their Doctoral Advisory Committee prior to the completion of the third semester. The Doctoral Advisory Committee will be composed of a minimum of five members, including the committee chair, who will be the student's doctoral advisor. Four of the five members including the chair must be Integrated Computing doctoral faculty members. The at-large member(s) may be any other UALR graduate faculty or non-UALR faculty with appropriate graduate status. The Integrated Computing Steering Committee must approve the committee constituency after the initial review by the Integrated Computing graduate coordinator.

Dissertation Proposal

Following the completion of the candidacy exams, candidates will write a dissertation proposal for their doctoral advisory committee detailing the intended research and its rationale in National Science Foundation (NSF) format. Students should allow for ample time between the dissertation proposal and the dissertation defense (typically between one to two years depending on the student's background). The dissertation subject must be a scholarly contribution to a major field of Integrated Computing in the student's emphasis area, consisting of new important knowledge or a major modification, amplification, or interpretation of existing significant knowledge.

The proposal will be given to the doctoral advisory committee two weeks in advance of meeting with the committee. The student must orally defend the rationale and experimental procedures for the proposal doctoral dissertation. Students are encouraged to present an open seminar on the proposal prior to meeting with the doctoral advisory committee. Students who fail the proposal may be dismissed from the program. Supervisory or examining committee report forms must be filed at the conclusion of the defense with the Track coordinator as well as the Integrated Computing graduate coordinator.

Dissertation Defense

In order to complete the requirements for the Ph.D. degree, students must prepare and successfully define a written dissertation in accordance with the format and procedure dictated by the UALR Graduate School. Students will orally defend their completed Ph.D. research to their doctoral advisory committee. The date and location of the defense must be publicized at least two weeks in advance. The first part of this final examination will be open to the public and will consist of an open seminar on the student's research. This will be followed by a dosed examination during which the candidate's work will be examined by the doctoral advisory committee. This examination will follow the guidelines established by the UALR Graduate School. The examination can be wide-ranging, but it will usually utilize the student's research as a starting point. At the completion of the examination, the doctoral advisory committee will vote to either pass or fail the student. If two negative votes are received from committee members, it is considered a failure of the exam. Supervisory or examining committee report forms must be filed at the conclusion of the defense with the Track coordinator as well as the Integrated Computing graduate coordinator.

Graduation Requirements

Summary of Graduation Requirements:

- Successful completion of an approved program of study with a minimum GPA of 3.0
- Successful completion of candidacy examination.
- Successful completion of proposal and oral defense
- Successful completion of dissertation and oral defense
- Successful completion of writing, seminar, and ethics requirements.

Additional Program Requirements:

- A maximum of two (2) 5000-level courses may be applied toward the Ph.D. degree. Note: Some tracks incorporate 5000-level required courses so students electing these emphasis areas may be restricted in the number of additional 5000-level electives that they can take.
- Only one (1) independent study course (3 credits) can be applied toward the Ph.D. degree.
- Only two (2) special topic courses can be applied toward the Ph.D. degree.
- Students must possess the prerequisites for all core and track courses in their intended area of study.
- Students may be required to take additional courses to gain the necessary prerequisite knowledge.

Required Courses for Integrated Computing Emphases

A list of courses used in the various tracks of the Integrated Computing Doctoral Program along with descriptions is provided on the following pages. Additional elective courses can be found in the "Master of Science in Systems Engineering," "Master of Science in Computer Science," and "Master of Science in Information Quality" sections in this catalog. Other courses may be approved in consultation between the student and his or her doctoral advisor.

General Core Course Descriptions

CPSC/IFSC/SYEN 7101, 7102, 7103 Research Methods

These courses introduce the research methodology component to facilitate development of expertise in research design and assessment. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the five track areas. This requirement is to be completed as 3, 1-credit courses in the first three semesters of a student's study, by the end of which a student will be expected to have completed not just his/her candidacy exams, but also to have drafted a near-final copy of their Ph.D. research proposal (3 courses, 1 credit each).

CPSC 7311 Software Engineering

Prerequisite: Working knowledge of C and C++ programming languages. An overview of the software development paradigm including the software life cycle, prototyping, and object-orientation; reliability, quality assurance, formal methods, and CASE tools. (3 credits)

Note: Students enrolled in the Information Quality Track may substitute CPSC 7382 Systems Analysis and Design or IFSC 7310 Information Systems Analysis in place of the CPSC 7311 Software Engineering Course.

CPSC 7382 Systems Analysis and Design

Prerequisite: graduate standing. Analysis and design of computer information services to meet the needs of industries and businesses; intended as a real-world practicum via field study, and as a community outreach via the provision of expertise and training.

IFSC 7310 Information Systems Analysis

Methods of problem identification and definition, data collection and measurement, feasibility study methods, work measurement techniques, task analysis, simulation studies, impact analysis, evaluation methods, forms and display design, proposal writing, documentation and programming standards, design strategies, documentation, and evaluation. (3 credits)

IFSC 7321 Information Science and Theory

This course provides a rigorous exploration of information theory including entropy, value strategies, security, extraction, and emission of information. (3 credits)

Primary Track Course Description – Net Integrated Computing Emphasis Area

CPSC 7341 Telecommunication and Networking

Fundamentals of data communications; topologies and transmission media; protocol architecture; LAN, MAN, and WAN systems; network design issues. (3 credits)

CPSC 7343 Sensor Networks

This course aims to develop fundamental understanding of sensor network systems. It covers architectures and communications protocols for sensor networks. Node and network architectures, naming and addressing, time synchronization, localization and positioning, topology control, and content-based networking are all covered. At the completion of the course, students will understand how sensor networks work as intelligent and coordinated systems. (3 credits)

SYEN 5336 Advances in Communication Network: Essentials of B-ISDN, InteServ, MPLS, DiffServ

Advances in optical networks, wireless networks, satellite networks, sensor networks, ad hoc networks, access networks, and autonomous networks. FSO technology. VoIP and video-over-IP. Modeling and optimization of networks. Communication switch OS. Elementary queuing theory. Security issues. OPNET training. Socket programming. (3 credits)

SYEN 5359 Optical Networking

Prerequisites SYEN 5355 or consent of instructor. Optical networking fundamentals, basic building blocks, local access and metro networks, SONET, WDM, DWDM, topology optimization, traffic grooming, optical control including GMPLS, wavelength conversion, survivability, restoration. (3 credits)

Primary Track Course Descriptions – Computer Science Emphasis Area

CPSC 7325 Software Security Assessment

This course covers the spectrum of software vulnerabilities in both UNIX/Linux and Windows environments. It demonstrates how to audit security in applications of all sizes and functions, including network and Web software using examples of real code drawn from past flaws discovered in high-profile applications. (3 credits)

CPSC 7331 Computer Architecture or SYEN 5331 Advanced Computer Architecture

CPSC 7331 is a study of computer architecture fundamentals; the impact of technology on architecture cost and performance; Instruction Set Architecture; design and analysis of the building blocks of computer systems, including data path, control and memory hierarchy; recent architectural developments (3 credits). SYEN 5331 covers introduction to Computer Systems, Instruction-Set architecture, Arithmetic/Logic Unit, Data Path and Control, Memory System Design, I/O Interface, and Advanced Architectures (3 credits).

CPSC 7341 Telecommunication and Networking

Fundamentals of data communications; topologies and transmission media, protocol architecture; LAN, MAN, and WAN systems; network design issues. (3 credits)

CPSC 7385 Analysis of Algorithms

A study of categories of computer algorithms greedy, divide-and-conquer, recursive, and probabilistic; performance analysis techniques order relations, recurrence relations, generating functions, induction, simulation; storage efficiency issues; complexity theory. (3 credits)

Primary Track Course Descriptions – Information Science Emphasis Area

CPSC 7351 Database Design or IFSC 7320 Database Systems and Information Architecture

This course covers design process, objectives, techniques, syntactic and semantic analysis design; entity relationships model, binary and n-ary relationships, minimality of relations, recursive relationships, role-modeling structures, aggregate objects, conversion methods, implementation models, evaluating design, choosing design methodologies (3 credits). IFSC 7320 covers two major areas. It first introduces principles and methodologies of database design, and basic techniques for database development. Then it introduces the fundamentals of information architecture and helps students understand how information architecture acts as the supporting structure aligning application design, technology, and business goals. (3 credits)

IFSC 5345 Information Visualization

The design and presentation of information. Use of graphics, animation, sound, visualization software, and hypermedia in helping users understand information. Methods of presenting complex information to enhance comprehension and analysis. Incorporation of visualization techniques into human-computer interfaces. (3 credit hours)

IFSC 7350 E-Commerce

Seminar style course designed for doctoral level student to be able to explore jointly the field of electronic commerce theoretically, conceptually and through applications including electronic markets, strategy, business models, impacts of information and communication technologies, organization and social behavior, as well as selected economic perspectives. (3 credits)

IFSC 7360 Data and Information Privacy

Concepts and methods for creating technologies and related policies with provable guarantees of privacy protection while allowing society to collect and share person-specific information for necessary and worthy purposes. Methods include those related to the identifiability of data, record linkage, data profiling, data fusion, data anonymity, de-identification, policy specification and enforcement and privacy-preserving data mining.

Primary Track Course Descriptions – Information Quality Emphasis Area

CPSC 7351 Database Design or IFSC 7320

Database Systems and Information Architecture CPSC 7351 covers design process, objectives, techniques, syntactic and semantic analysis design; entity relationships model, binary and n-ary relationships, minimality of relations, recursive relationships, role-modeling structures, aggregate objects, conversion methods, implementation models, evaluating design, choosing design methodologies (3 credits). IFSC 7320 covers two major areas. It first introduces principles and methodologies of database design, and basic techniques for database development. Then it introduces the fundamentals of information architecture and helps students understand how information architecture acts as the supporting structure aligning application design, technology, and business goals. (3 credits)

INFQ 7303 Principles of Information Quality

This course provides a rigorous exploration of information quality concepts, assessment, and problems in organizational information systems, databases and data warehouses. A combination of state of the art literature review and hands-on projects is used to develop knowledge and ability to meet objectives (3 credits).

INFQ 7322 Information Quality Theory

This course is designed to provide students with the theoretical foundations critical for developing a deep understanding of the state-of-the-art information quality research from the technical, organizational and strategic perspectives. This course will prepare students to work on their thesis, project, and conduct research in the field of information quality. More specifically, students will be exposed to concepts, principles, tools, and models, and techniques that are essential for information quality definitions, measurement, analysis, and improvement. Additionally, students will be exposed to the most current, cutting-edge research that goes beyond current industry practice in information quality (3 credits).

INFQ 7367 Information Quality Policy and Strategy

This course explores the top management, strategic perspective for aligning competitive strategy, core competencies, and information quality. Topics include the development and implementation of IQ policies and plans to achieve organizational goals; how to define systems that support the operational, administrative, and strategic IQ needs of the organization, its business units, and individual employees; approaches to managing technology and the information systems function in organizations, role of the CIO (3 credits)

Systems Engineering

EIT Building, Room 518
(501) 569-3100

Certificate and Master of Science

The Systems Engineering Department of the Donaghey College of Engineering and Information Technology offers a Graduate Certificate in Systems Engineering and a Master of Science degree in Systems Engineering. Both offerings allow students to specialize in systems engineering topics such as: Systems Engineering Design, Requirements and Functional Analysis, Systems Architecture Development, Design for Operational Feasibility, System Integration, Decision and Risk Analysis, Engineering Project Management, System Lifecycle Cost Analysis, and Organization for Systems Engineering.

The Graduate Certificate in Systems Engineering program can help students bring together knowledge from traditional engineering fields, creating the 'big picture'' for accomplishing goals and managing complex structures such as: Computer Networks, Wireless Networks, Power Plants, Airplanes and Spacecraft Systems, Manufacturing Systems, Transportation Systems, and Healthcare Delivery Systems.

Building upon the theme of the Graduate Certificate, the Master of Science in Systems Engineering program provides unique opportunities for the traditional student as well as for the professional engineering community to broaden their knowledge base and acquire state-of-the-art technical skills. The program helps students to integrate multifaceted engineering projects, model complex engineering systems and optimize their performance, and conduct real-life case studies by carrying out electrical, computers, telecommunications, or mechanical engineering projects. The Master of Science in Systems Engineering program prepares engineers for professional practice in today's complex technical environment, and also, offers cutting-edge knowledge base for innovation and advanced research. To support these goals, both thesis and non-thesis options are available in the program.

Graduate Certificate in Systems Engineering

The Graduate Certificate in Systems Engineering imparts fundamental knowledge, tools, and techniques that prepare industry professionals and students to work in systems engineering related jobs.

Admission Requirements

The minimum entrance requirement is a bachelor's degree in engineering, science, technology, or a related discipline. Because of the professional nature of the Certificate, the precise entrance requirements are determined on a case-by-case basis by the Systems Engineering Admissions Committee.

Program Requirements

The Graduate Certificate consists of 18 credit hours of course work (which amounts to about half of a typical master's degree requirement). It is ideal for working professionals who wish to upgrade their knowledge and skills in the intricacies of systems engineering. Certificate holders who have finished the program may further pursue a master's degree in Systems Engineering, building upon the 18 hours already taken in the Certificate Program. For the Certificate, students must take six, three-credit-hour courses, consisting of four Systems Engineering core courses and two electives.

Core Courses (12 hours)

The Systems Engineering (SYEN) core courses are intended to provide the fundamental methods relevant to the design, implementation, and management of engineering systems. They include:

SYEN 7311 Systems Design and Analysis

SYEN 7312 Systems Architecture and Design

SYEN 7313 Systems Management and Evaluation

SYEN 7314 Multicriteria Decision and Risk Analysis

These four courses address methods and practices involved in the translation of need, deficiency, or market opportunity into a feasible system or product architecture.

Electives (6 hours)

Due to the diversity of students' educational and professional backgrounds, students are encouraged to choose two upper-level elective courses (5000-level or above) that are compatible with their specific interests. These two technical courses need to be approved in advance by the Graduate Coordinator, and can be chosen from university departments such as: Systems Engineering, Computer Science, Information Science, or other graduate science- or engineering-related programs. Sample Upper- and Graduate-Level Electives are listed below after the master's program description.

Master of Science in Systems Engineering

The master's program in Systems Engineering requires 31 credit hours of work that includes graduate course work with an option to carry out either a thesis or a graduate project.

Admission Requirements

In addition to the UALR Graduate School admission requirements, the applicants for the M.S. program in Systems Engineering must also meet the following criteria:

- **Education:** Applicants must have a bachelor's degree in engineering, technology, science or related discipline. The applicants must have an overall undergraduate GPA of 3.0 or 3.3 on the last 60 credit hours.
- **Standardized test scores:** Applicants must have a minimum score on the GRE test: a score of 140 on the Verbal Reasoning section, a score of 155 on the Quantitative Reasoning section, and a score of 3.5 in the Analytical Writing section. GRE will be waived if the student's GPA is 3.5 or higher.
- **English language requirement:** International students must satisfy the Graduate School TOEFL or IELTS tests requirements.

Applicants who do not meet all the admission requirements may be recommended for conditional admission. The conditionally admitted students must fulfill the requirements of the UALR Graduate School and those specified in their letter of admission.

Degree Requirements

The Master of Science program in Systems Engineering consists of a minimum of 31 credit hours beyond the baccalaureate degree, of which a maximum of six hours can be transferred from a graduate program from another university with the Graduate Coordinator's approval. All credit hours earned in the Systems Engineering Graduate Certificate Program are transferable into the master's program upon admission into the master's program, provided the GPA from the Certificate program is 3.25 or better. In addition, the students are required to:

Maintain acceptable academic performance: All master's course work must be completed with a minimum GPA of 3.0. If a student receives one "C" in the course work, the student will be warned that his/her academic performance is unacceptable and that the student will be reviewed by the Systems Engineering faculty, which will suggest corrective action. A student receiving two "C's" will be dismissed from the program, pending review by the Systems Engineering faculty.

- Pass thesis proposal defense / project proposal defense.
- Pass thesis final defense / project final defense.

Master of Science in Systems Engineering Curriculum

The student's plan of study must be developed in conjunction with his/her thesis/project major advisor or Graduate Coordinator and filed with the Systems Engineering Graduate Coordinator.

Program Core: The program core provides students the strong systems engineering preparation needed for either a successful professional career in one of the emerging engineering fields, or for further enhancing their education in high-quality engineering doctoral programs.

Systems Engineering Required Core - 12 credit hours:

SYEN 7311 Systems Design and Analysis
SYEN 7312 Systems Architecture and Design
SYEN 7313 Systems Management and Evaluation
SYEN 7314 Multicriteria Decision and Risk Analysis

Systems Engineering Seminar- 1 credit hour:

SYEN 7190 Systems Engineering Seminar (offered on a credit/ no-credit basis).

Thesis Option- 6 credit hours:

SYEN 8100-8600 Systems Engineering Master's Thesis

Non-Thesis Option- 3 credit hours:

SYEN 7385 Systems Engineering Graduate Project

Program Electives:

Thesis Option - 12 credit hours
Non-Thesis Option- 15 credit hours

In consultation with the Graduate Coordinator or thesis/ project major advisor, students may take their elective course credits from any of the following sample courses. The courses are listed by categories only for easy reference. Students should take at least two 7000-level elective courses.

Systems Analysis and Applications

SYEN 5314 Queuing Theory and Systems
SYEN 5322 Modeling Transportation Systems
SYEN 5342 Linear Program and Network Flows
SYEN 7315 Complex Engineered Systems
SYEN 7316 Advanced Systems Simulation
SYEN 7342 Networks and Combinatorial Optimization

Electrical and Computer Engineering

SYEN 5308 Linux Systems Programming
SYEN 5320 Linear State-Space Control Systems
SYEN 5325 Fuzzy Logic in Control and Systems Engineering
SYEN 5329 Robust and Optimal Control Systems
SYEN 5331 Advanced Computer Architecture
SYEN 5332 Applied Operating Systems
SYEN 5334 Software Systems Engineering
SYEN 5335 Mechatronics I
SYEN 5362 Neural Networks and Adaptive Systems
SYEN 5354 Power Systems Analysis
SYEN 5366 Advanced Digital Systems
SYEN 7302 Advanced Electronics for Instrumentation
SYEN 7306 Real-Time Embedded Systems
SYEN 7320 Linear Systems Theory
SYEN 7331 Transducers in Real-Time Control
SYEN 7332 Advanced Operating System Design

Telecommunications, Networking, and Signal Processing

SYEN 5310 Introduction to Signal Processing
SYEN 5336 Advances in Communication Networks
SYEN 5350 Digital Signal Processing
SYEN 5352 Spatial Time Series
SYEN 5353 Advanced Digital Communications
SYEN 5355 Mobile Multimedia Internet
SYEN 5356 RF Techniques and Systems
SYEN 5358 Cellular and Wireless Communications
SYEN 5359 Optical Networking
SYEN 7355 Statistical Signal Processing
SYEN 7357 Advanced Antennas for Wireless Systems

Mechanical Engineering

SYEN 5182 MEMS and Microsystems Laboratory
SYEN 5315 Advanced Dynamics I
SYEN 5326 Measurement Techniques
SYEN 5327 Acoustics I
SYEN 5335 Mechatronics I
SYEN 5340 Applied Numerical Methods
SYEN 5371 Advanced Continuum Mechanics
SYEN 5372 Mechatronics II
SYEN 5375 Mechanical Vibrations
SYEN 5381 Thermal and Fluid Systems
SYEN 5282 Microelectromechanical Systems (MEMS) and Microsystems
SYEN 5383 Finite Element Analysis
SYEN 5384 Computer Methods in Fluid and Heat Transfer
SYEN 7307 Smart Materials
SYEN 7317 Nanostructural Materials: Physical and Chemical Properties
SYEN 7318 Micro- and Nano-Fabrication
SYEN 7374 Elasticity
SYEN 7376 Fracture Mechanics
Miscellaneous
SYEN 5300, 7300 Independent Study
SYEN 5389 Professional Engineering Licensure
SYEN 5399 Special Topics* in Systems Engineering
SYEN 7101 Research Methodology
SYEN 7102 Research Tools

SYEN 7103 Research Applications
SYEN 7118 Research Ethics in Science and Engineering
SYEN 7385 Systems Engineering Graduate Project
SYEN 7399 Special Topics* in Systems Engineering
SYEN 8100-8600 Systems Engineering Master's Thesis

*** Based on demand, special topics under SYEN 5399 and SYEN 7399 may include:**

Optimization of Communication Networks
Design and Analysis of Advanced Manufacturing Systems
Economic Evaluation of Engineering Projects
Renewable Energy Smart Grid
Essentials of Coding Theory
Human Movement Biomechanics and Motor Control

Master's Thesis/Project Advisor

A student admitted to the master's program should declare an advisor before he/she enrolls in master's thesis or graduate project courses.

Master's Thesis/Project Committee

The Master's Thesis Committee or Master's Project Committee can be constituted once the student has declared his/her Master's Thesis/Project Advisor. The committee will include a minimum of three members and a maximum of four members. At least two members have to be Systems Engineering faculty.

Thesis/Project Proposal Defense

Students choosing the thesis option must present their research proposal to their Master's Thesis Committee one semester prior to their final thesis defense. Students choosing the non-thesis option must present their project proposal to their Master's Project Committee before their final project defense. At the completion of tile examination, the Master's Thesis or Project Committee will vote to either pass or fail the student. Students who fail the proposal defense will have to repeat the defense. If the student fails the proposal defense for a second time, he/she will be dismissed from the program, pending review by the Systems Engineering Faculty. More information about the proposal defense can be found in the Systems Engineering Graduate Student Manual.

Thesis/Project Defense

Students choosing the thesis option will prepare and successfully define a written thesis in accordance with the format and procedures dictated by the Graduate School. Students choosing the non-thesis option will prepare a final project report according to the requirements defined by their Master's Project Committee. Students must orally defend their completed thesis research or project work to their Master's Thesis or Project Committee. At the completion of the examination, the Master's Thesis or Project Committee will vote to either pass or fail the student. If two or more negative votes are cast by the committee members, the student is considered to have failed the exam and will be dismissed from the program, pending review by the Systems Engineering Faculty. More information about the thesis and-project defense can be found in the Systems Engineering Graduate Student Manual.

Courses in Systems Engineering

SYEN 5199, 5299, 5399, 5499 Special Topics

Prerequisite: Consent of the instructor. Advanced specialized topics of current interest in systems engineering. Topics vary with faculty interest and availability. One, two, three, or four hours lecture. One, two, three, or four hours.

SYEN 5300 Independent Study

Prerequisite: Graduate standing, and consent of the instructor. Individual investigation on entry level topics by a graduate student. Topics determined in consultation with supervising faculty. Agreement must be in writing and filed with the department chairperson. The student work will be evaluated through reports or other means and documented by the faculty. A maximum of six credit hours of independent study courses, SYEN 5300 and/or SYEN 7300, can be applied toward the degree requirements. Three credit hours.

SYEN 5308 Linux Systems Programming

Prerequisite: CPSC 2376 or equivalent. This course introduces the fundamental structure and services of the Unix/Linux operating systems. Upon completion of this course, the students should master application software and middle-ware design in Unix/Linux operating system through programming at the system call level. It covers files and directories, device control, terminal handling, process and threads, inter-process communication, event-driven and signal handling, pipes, sockets, client/server. It also covers graphics and user interface design. Students who have taken SYEN 4308 for credit cannot take SYEN 5308 for credit. Three credit hours.

SYEN 5310 Introduction to Signal Processing

Prerequisite: MATH 3322 or equivalent. Introduction to the fundamental concepts in signal processing. Use of the fundamental transform techniques (Laplace transform, discrete Fourier transform, z-transform). Discrete time representation of signal, linear time invariant subsystems. Correlation, coherence and time delays, Standard system models (ARMA, ARMAC). FIR and IIR filters. Three hours lecture. Three credit hours.

SYEN 5314 Queuing Theory and Systems

Prerequisite(s): SYEN 3314 or equivalent. The theoretical foundations, models and techniques of queuing theory are presented. Topics include classic models of queues including simple and advanced Markovian queuing models, and models of queues with general arrival and service patterns. Applications of queuing theory and queuing systems design considerations. Three hours lecture. Three credit hours.

SYEN 5315 Advanced Dynamics I

Prerequisite: MATH 2453. Kinematics od translating and rotating vectors. Dynamics if systems of particles and rigid bodies. Angular momentum. Newtonian mechanics. Lagrangian mechanics. Examples drawn from the fields of robotics, biological motion, and planetary motion. Three hours lecture. Three credit hours.

SYEN 5320 Linear Systems Theory

Prerequisites: SYEN 3364 or consent of instructor. Introduction to modem control systems, state-space models of linear time-invariant systems, solution to state equations, linear transformations and canonical forms, stability analysis, controller synthesis via state feedback, tracking system design, observer-based compensator design, optimal control problems. Three hours lecture. Three credit hour.

SYEN 5322 Modeling Transportation Systems

Prerequisite(s): SYEN 3312, SYEN 3314, or Consent of Instructor. The objectives of transportation analysis are defined to include mobility provision, consequence identification and selection of courses of action. A set of methodologies have evolved to exclusively address transport modeling, including demand forecasting, technology representation, network-flow, and multi-attribute assessment- of performance. This course reviews very powerful tools to analyze such a class of technological and socioeconomic problems, characterized by the explicit recognition of a spatial dimension.

SYEN 5325 Fuzzy Logic Systems

Prerequisite(s): SYEN 3364. Introduction, basic concepts of fuzzy logic, fuzzy sets, fuzzy relations, Fuzzy If-Then rules, fuzzy implications and approximate reasoning, fuzzy logic in control theory, hierarchical intelligent control, fuzzy logic applications in information systems, fuzzy model identification, neuro-fuzzy systems and genetic algorithms. Three hours lecture. Three credit hours.

SYEN 5326 Measurement Techniques

Prerequisite: SYEN 2315 or equivalent. Principles of operation and implementation of transducers used in electronic measuring systems. Sensors used for the measurement of strength, capacitance, pressure, flow, force velocity, temperature, humidity, vibration, sound, and acceleration are discussed. Interfacing transducers with a digital system will be emphasized. Effects of quantization, scaling, sampling time, and bandwidth will be examined. Two hours lecture and two hours laboratory work. Three credit hours.

SYEN 5327 Acoustics I

Prerequisite: MATH 2353 or equivalent. Development of the equations for acoustics and vibrations. Transducers for measurement of sound and acceleration. Design of sonic actuators using network analysis. Analog and digital processing of signals, including spectral analysis, adaptive signal processing, and central analysis. Applications to noise analysis and control and machinery diagnosis through sound.

SYEN 5329 Robust and Optimal Control

Prerequisite(s): SYEN 3364, MATH 3312. Linear discrete- and continuous-time systems, state equations, transition matrix, internal stability, Lyapunov stability, controllability, observability, realization, linear feedback, state observation, polynomial fraction description, geometric theory, discrete-time stability, reachability, observability, realization, state feedback and observation. Three hours lecture. Three credit hours.

SYEN 5331 Advanced Computer Architecture

Prerequisites: SYEN 3336 or consent of instructor. Introduction to Computer Systems, Instruction-Set architecture, Arithmetic/Logic Unit, Data Path and Control, Memory System Design, I/O Interface, and Advanced Architectures. Three hours lecture. Three credit hours.

SYEN 5332 Applied Operating Systems

Prerequisites: SYEN 3362. Introduction to operating systems. Buffering, physical input/output, and file management. Multiprogramming and processing, resource scheduling, memory management, concept of virtual memory, Process management and scheduling. Device management and scheduling. Process communication, network communication, and protection. The graduate students will use the C language to implement several generic OS components, practice the process management, and practice the shared memory utilities. Three hours lecture. Three credit hours.

SYEN 5334 Software Systems Engineering

Prerequisite: SYEN 3362, Engineering approach to the development of software systems, including the life cycle steps of project planning, requirements analysis and specification, design, production, testing, and maintenance of software systems. Students are required to do a project related to course contents, Dual-listed in UALR Undergraduate catalog as SYEN 4334. Not open to students with credit for SYEN 4334. Three hours lecture. Three credit hours.

SYEN 5335 Mechatronics I

Prerequisite: MATH 2453 or equivalent, PHYS 2321 or equivalent. This course covers basic mechanical design elements, including gears, fasteners, bearings, sprockets and chains, timing pulleys, brakes and clutches. Methods of attaching power and timing elements to shafts, including standard keys, Woodruff keys, splines, pins, and press-fits, is covered. Integration of sensors, including petentiometers, limit switches, and yaw rate sensors is covered. Theories of failure will be introduced, and basic stress/strain calculations will be done. Design theories and project management will be introduced. Three hours lecture. Three credit hours.

SYEN 5336 Advances in Communication Networks

Prerequisites: SYEN 3312, 3316, and 3332. Essentials of B-ISDN, InteServ, MPLS, DiffServ. Advances in optical networks, wireless networks, satellite networks, sensor networks, ad hoc networks, access networks, and autonomous networks. FSO technology. VoIP and video-over-IP. Modeling and optimization of networks. Communication switch OS. Elementary queuing theory. Security issues. OPNET training. Socket programming. Three hours lecture. Three credit hours.

SYEN 5340 Applied Numerical Methods

Prerequisite: SYEN 1305; MATH 3312 and 3322. Scientific computing, error analysis, roots of equations, systems of equations, curve fitting, numerical differentiation and integration, ordinary and partial differential equations. Three hours lecture. Three credit hours. Students are required to do a term project related to the contents of the course. Dual-listed in UALR undergraduate catalog as SYEN 4340. Course not open to students with credit for SYEN 4340.

SYEN 5342 Linear Programming and Network Flows

Prerequisites: SYEN 3312, or consent of instructor. This course covers salient linear optimization topics, including computational issues such as decomposition, LU factorization, and network flow. Of equal interest is the equivalence between algebraic and graph-theoretic representation of a model and its solution algorithms. The relationship between the network flow paradigm and discrete optimization is also emphasized. Last but not least are the software libraries to solve linear optimization models. Three hours lecture. Three credit hours.

SYEN 5350 Digital Signal Processing

Prerequisite(s): SYEN 3350 or consent of the instructor. Signals and signal processing; discrete-time signals and systems in the time and frequency domains; digital processing of continuous-time signals; finite-length discrete transforms; discrete-time signals and systems in the z-domain; LTI discrete-time systems in the transform domain; digital filter structures; IIR digital filter design; FIR digital filter design; DSP algorithm implementation; analysis of finite word-length effects; multi-rate DSP fundamentals; multi-rate filter banks and wavelets; applications of DSP. Three hours lecture. Three credit hours.

SYEN 5352 Spatial Time Series

Prerequisite(s): SYEN 3312 or equivalent, STAT 3353 or equivalent, or Consent of Instructor. Instead of a single stream of data, multiple streams gathered over the target can provide better information. Because of the inherent spatial correlation among these data streams, spatial time-series can play an important role in multiple-sensor and other data-intensive applications. Image-processing applications include image rectification and restoration, image enhancement, image classification, and data merging. Signal processing applications include the Spatial-temporal Autoregressive Moving-Average model and Intervention Analysis. Unifying these diverse analyses and applications is Markov Random Field Theory. Three hours lecture. Three credit hours.

SYEN 5353 Advanced Digital Communications

Prerequisites: SYEN 3354 or consent of the instructor. This course provides an in-depth examination of wireless digital communication design strategies. Topics covered include digital modulation, radio wave propagation characteristics, signal detection methods, BER performance improvement and simulation techniques, RF/hardware architectures, migration path for modulation and demodulation techniques, signal processing building blocks for wireless systems, methods for mitigating wireless channel impairments, perform system simulations, BER and channel models, predict system performance and evaluate tradeoffs, list TDMA and CDMA techniques, and 3G evolution, describe design issues for wireless systems, particularly those issues in which transmit and receive implementation affect system performance. Three hours lecture. Three credit hours.

SYEN 5354 Power Systems Analysis

Prerequisites: SYEN 3358, or consent of the instructor. Fundamental concepts of power system analysis, transmission line parameters, system models, steady-state performance, network calculations, power flow solutions, fault studies, symmetrical components, operation and control. Three hours lecture. Three credit hours.

SYEN 5355 Mobile Multimedia Internet

Prerequisites: SYEN 3314, or consent of the instructor. The course will provide state-of-the-art perspective of the emerging landscape of Mobile Multimedia Internet. Key subject areas covered in advanced mobile Internet technologies include WLAN, GPRS, 3G, UTMS, and VoIP. Topics covered will involve architecture of the systems, protocol issues, the design and analysis of solutions for mobility, quality of service, mobile IP, and standardization efforts. Dual-listed in the UALR Graduate Catalog as SYEN 5355. Three hours lecture. Three credit hours. Students with credit for SYEN 4355 may not take SYEN 5355

SYEN 5356 Radio Frequency Techniques and Systems

Prerequisites: SYEN 2315, MATH 3322, and PHYS 2322. Analysis of electrostatic, magnetostatic, and dynamic fields using vector analysis. Coulomb's Law, electric field intensity, electric flux density, Gauss' Law. Energy and potential. Conductors, dielectrics, and capacitance. Poisson's and Laplace's equations. The steady magnetic field magnetic forces, materials, and inductance. Time-varying fields and Maxwell's equations. Boundary conditions. The uniform plane wave. Plane waves at boundaries and in dispersive media. Transmission lines and antenna fundamentals. Examples are taken from the field of wireless communications. Three hours lecture. Three credit hours.

SYEN 5358 Cellular and Wireless Communications

Prerequisite: SYEN 3354. Characteristics of mobile radio environment, multipath and fading, cellular communication concepts, channel allocation and reuse, access and scheduling techniques, system capacity, power control, diversity, coding, modulation in cellular systems, examples of digital wireless systems, wireless local area networks. Three hours lecture. Three credit hours.

SYEN 5359 Optical Networking

Prerequisites: SYEN 4355, or consent of the instructor. Fundamental concepts of networking, optical networks elements and devices, SONET, WDM, DWDM, optical control plane, MPLS and GMPLS, Free Space Optical Mesh Networks. Three hours lecture. Three credit hours.

SYEN 5362 Neural Networks and Adaptive Systems

Prerequisite(s): SYEN 3312, or consent of the instructor. Introduction to neural networks, neuron models and learning strategies, pattern recognition, multi-layer perceptron, back propagation, principle component analysis, self-organizing feature maps, neural networks for time-series forecasting. Three hours lecture. Three hours lecture. Three credit hours.

SYEN 5366 Advanced Digital Systems

Prerequisite(s): SYEN 3330 and SYEN 3310. Advanced design principles for digital systems. In particular, the students will be exposed to hardware modeling in the hardware description language: VHDL (Verilog Hardware Description language), Compilation techniques for hardware models, and logic-level synthesis and optimization techniques for combinational and sequential circuits.

SYEN 5371 Intro Continuum Mechanics

Prerequisite: MATH 2453 and MATH 3322 or their equivalent, PHYS 231 and PHYS 3300 or their equivalent. This introductory course on Continuum Mechanics will take a unified approach to train the student in the modeling of deformation in solids, fluid flow, and electrical fields. Using a first principles approach, the fundamental conservation laws of mass, charge, momentum and energy will be covered. Application to deformation in solids, heat transfer, fluid flow and electrical fields will be addressed.

SYEN 5372 Mechatronics II

Prerequisite: SYEN 4335 or equivalent. The combination of classical mechanical design, electronic analysis and design, control engineering, and computer science in the design of complex electric-mechanical-controlled systems. Commonly used sensors (Encoders, potentiometers, accelerometers) and actuators (stepping motors, DC motors) are studied. Interfacing sensors and actuators to a microcomputer, discrete controller design, and real-time programming for control using the C programming language. There is a significant out-of-class project exercise associated with this course. Three hours lecture. Three credit hours.

SYEN 5375 Mechanical Vibrations

Prerequisites: SYEN 3370, or consent of the instructor. Analysis of linear multi-degree of freedom systems. Lagrangian formulation, model analysis, lumped parameter analysis of discrete systems, and continuous system vibrations. Introduction to non-linear systems. Three hours lecture. Three credit hours.

SYEN 5381 Thermal and Fluid System Design

Prerequisite: SYEN 4379 or consent of the instructor. Overview of fossil fuel, nuclear and renewable-energy power plants, the Rankine cycle, fossil fuel steam generators, fuels and combustion, pumps and turbines, the condensate-feed-water system, the circulating-water system, gas turbine and combined cycles, principles of nuclear energy, nuclear reactors and power plants, geothermal energy, solar energy, wind energy, energy from the oceans, energy storage and fuel cells, environmental aspects of power generation. Three hours lecture. Three credit hours.

SYEN 5182 MEMS and Microsystems Laboratory

Prerequisites: SYEN 4376 and 4176, or consent of instructor. This laboratory course is an introduction to the principles of micro-fabrication for microelectronic devices, sensors, and micromechanical structures, MEMS, and microsystems with applications in engineering. Course comprises of laboratory work and accompanying lectures that cover silicon oxidation, photolithography, thin film deposition, etching, electrochemical deposition (plating) and packaging. Some selected topic in yield and reliability, as well as process simulation may be covered. Two hours lab, One Credit Hour.

SYEN 5282 Microelectromechanical Systems (MEMS) and Microsystems

Prerequisite: SYEN 3372 or equiv and corequisite concurrent 5182 or equivalent. In this introductory MEMS class, we cover the fundamental basis of microsystems technology. Microelectromechanical devices (MEMS), such as actuators, pressure sensors, and opto-mechanical assemblies, require knowledge of a broad range of disciplines, from microfabrication and mechanics to chemistry and solid state device physics. Three hours lecture. Note: Students enrolled in SYEN 5282 do a project related to course contents. SYEN 5282 is not open to students with credit for SYEN 4282. Two credit hours.

SYEN 5383 Finite Element Analysis

Prerequisite: SYEN 3378, 4376, and 4340 (recommended). Basic concepts of the finite element method (FEM); stiffness matrices, spring and bar elements; truss structures, the direct stiffness method; flexure elements; method of weighted residuals; interpolation functions for general element formulation; applications in heat transfer, fluid mechanics, and solid mechanics; structural dynamics. dual-listed in the Undergraduate Catalog with SYEN 5383, Three hours lecture. Three credit hours.

SYEN 5384 Computer Methods in Fluids and Heat Transfer

Prerequisite: SYEN 4374 or equivalent. Modeling and simulation of thermal-fluid problems using commercial software, finite volume method, solution algorithms for pressure-velocity coupling, solution of systems of discretized equations, unsteady flows, uncertainty in CFD modeling, methods for dealing with complex geometries, modeling of combustion, heat transfer, and unsteady flows. Three hours lecture. Three credit hours.

SYEN 5389 Professional Engineering Licensure

Prerequisite concurrent: Registration for the Fundamentals of Engineering exam, or consent of instructor. Legal, regulatory, and ethical issues related to the practice of engineering; preparation for engineering licensure examinations. Two hours lecture. Three hours lab. Three credit hours. Cross listed as CNMG 5389. Dual-listed in the *UALR Undergraduate Catalog* as CNMG 4389. Students cannot receive graduate credit for SYEN 5389 if they have previously taken SYEN 4389.

SYEN 7101 Research Methodology

Prerequisite: Graduate standing. A one-credit course in a set of three, introducing students to the research methodology of doctoral level research. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the computing and engineering disciplines.

SYEN 7102 Research Tools

Prerequisite: Graduate standing. A one-credit course in a set of three, introducing students to the research tools of doctoral level research. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the computing and engineering disciplines.

SYEN 7103 Research Applications

Prerequisite: Graduate standing. A one-credit course in a set of three, introducing students to examples of doctoral level research. Research examples will be drawn from work that exemplifies the interconnecting research opportunities across the computing and engineering disciplines.

SYEN 7118 Research Ethics in Science and Engineering

The course uses a case-based method to cover various topics related to professional research ethics. It is intended for entering science and engineering graduate students in the Donaghey College of Engineering and Information Technology (DCEIT). The purpose of the course is to familiarize students with professional ethics related to research and to prepare them to deal with typical ethical situations that may occur in the course of their graduate studies and professional careers.

SYEN 7145 Integrated Comp. Lab Rotation

First semester orientation course to allow new students in the Integrated Computing doctoral program to gain exposure in several different faculty research areas. This course will aid the student in the selection of his/her doctoral research advisor. 1 credit hour. Offered on demand. Cross listed between Computer Science, Systems Engineering, and Information Science.

SYEN 7190 Systems Engineering Seminar

Prerequisites: Graduate standing and consent of the graduate advisor. Students, faculty, and invited speakers will present, discuss and exchange ideas on research topics related to Systems Engineering. One-hour session per week. Course may be repeated for credit. Graded: credit/ no credit.

SYEN 7192: Graduate Seminar

Prerequisites: Graduate standing, consent of graduate coordinator. Students, faculty, and invited speakers will present discuss and exchange ideas on research topics of general interest to the graduate programs in the EIT college. One-hour session per week. Course may be repeated for credit. Graded: credit/no credit.

SYEN 7300: Independent Study

Prerequisite: Completion of core course requirements in the graduate program, and consent of the instructor. Individual research investigation by a graduate student. Topics determined in consultation with supervising faculty. Agreement must be in writing and filed with the department chairperson. The student work will be evaluated through reports or other means and documented by the faculty. A maximum of six credit hours of independent study courses, SYEN 5300 and/or SYEN 7300, can be applied toward the degree requirements. Three credit hours.

SYEN 7302 Advanced Electronics for Instrumentation

Principles of operation of analog and digital integrated circuitry, including amplifiers, A/D and D/A circuits, active filters and special function circuits as used in computers and instrumentation for measurement and control.

SYEN 7306: Real-time Embedded Systems

This course presents technologies for the design and implementation of embedded systems using Linux Operating System (OS). Such technologies include Linux, real-time Linux OS, and real-time embedded application design. Students will learn how to administer Linux OS and how to create a task-specific kernel for their own embedded application. They will learn techniques necessary for developing real-time Linux device drivers. real-time kernel space programming, and inter-process communication between real-time kernel and user space. Students will obtain hands-on experience with embedded software design through course projects. Upon completing this course, students should be able to develop their own embedded applications based on open source software resources.

SYEN 7307: Smart Materials

Prerequisite: SYEN 4371 or equivalent. This course will deal with the unique nonlinear, hysteretic response of smart materials that arise due to coupling between mechanical and thermal or electric or magnetic fields. Specifically, microstructural characteristics and constitutive modeling of shape memory alloys, ferroelectric materials and ferromagnetic materials will be covered. Use of these smart materials in sensor and actuator design will be addressed.

SYEN 7310: Economic Evaluation of Engineering Projects

Prerequisite(s): Math 1453, SYEN 3312 and 3314 or their equivalents, or consent of the instructor. Application of engineering management decision making to the life-cycle economic evaluation of engineering projects. Topics include decisions regarding investment in new or existing facilities and improvement of processes in both manufacturing and service industries. Deterministic, stochastic and multi-attribute evaluation approaches with the objectives of profit and utility maximization, as well as cost and risk reduction techniques are explored. Three hours lecture. Three credit hours.

SYEN 7311: System Design and Analysis

Prerequisite(s): Graduate standing or consent of the instructor. This course introduces the concept of a system, system requirements, system life cycle, design and integration. The basic principles of system engineering design process, modeling, and process modeling. Basic concepts of system requirements and definition of the design problem will be presented. The details of functional, physical, and operational architectures will be presented. The details of interface design, integration, and qualification of the system will be presented. Three hours lecture. Three credit hours

SYEN 7312: Systems Architecture and Design

Prerequisites: SYEN 7311 or consent of the instructor. This course introduces the process of systems architecting and the design for operational feasibility in the context of systems engineering design process. Systems architecture topics include the functional, physical, operational, and interface architectures and their correlation with the system design process, as well as graphical modeling techniques to develop these types of architectures. Examples of standardized architecture frameworks used in practice are also presented. The design for operational feasibility includes quantitative and qualitative aspects in reliability, maintainability, productibility, supportability, disposability and affordability as they relate to the system engineering life-cycle design process. Three hours lecture. Three credit hours.

SYEN 7313: Systems Management and Evaluation

Prerequisite: Graduate standing and consent of the instructor. Organized in two parts, this course presents the fundamental concepts of systems management and evaluation. Systems management methodologies, such as Systems Engineering Management Plan, Work Breakdown Structure and Risk Management Plan are presented in the first part of the course. As the design and development of any engineering system is basically an engineering project, the second part of the course introduces the steps in the engineering project management process, Quantitative project management techniques, such as Program Evaluation and Review Technique, and Critical Path Method are presented in detail. Three hours lecture. Three credit hours.

SYEN 7314: Multi-criteria Decision and Risk Analysis

Prerequisite: Graduate standing. The purpose of this course is to expose the student to a wide variety of techniques in handling MCDM problems. The emphasis will be placed on breadth rather than depth. The students will analyze an MCDM problem of their choice. S/he will work with the decision-maker(s) to define the problem (particularly the criteria with which s/he uses to measure `success,') generate alternatives, capture the preference structure of the decision maker(s), and evaluate the alternatives, resulting in preferred courses of action. The student will get the opportunity to use Multi-attribute-decision-analysis and Multi-criteria-optimization computer-software.

SYEN 7315: Complex Engineered Systems

Prerequisite(s): SYEN 3312 and 3362 or their equivalents, or consent of the instructor. Introduction to complex engineered systems and the methods and tools currently under consideration in the ongoing research towards better understanding of such systems and the development of a complex engineered systems theory. Topics include concepts such as emergence, self-organization, learning and adaptation, and various quantitative and computational intelligence techniques that are considered for modeling, analysis and evaluation of such systems. System-of-systems concept is also presented. Three hours lecture. Three credit hours.

SYEN 7316: Advanced Systems Simulation

Prerequisite(s): SYEN 3312 and 3316 or equivalent, or consent of the instructor. Simulation of existing or proposed real-world systems (facilities and processes). Topics include simulation input modeling, random variant generation and stochastic models of arrival processes, statistical analysis of simulation output, variance reduction techniques, statistical design of simulation experiments and optimization of the simulation output. Monte Carlo simulation on spreadsheets, including project management, risk analysis, and reliability applications. Three hours lecture. Three credit hours.

SYEN 7317 Nanostructural Materials: Physical and Chemical Properties

Prerequisites: syen 3372 or phys 4340 or chem 4340 or equivalent. This course introduces students to the area of nanotechnology and the novel properties of the materials built at the nanoscale. The course will cover the main properties of nanomaterials, various methods for synthesis and characterization and the most up-to-date applications from nanoelectronics, advanced materials, bio-medicine, etc. The course is designed for graduate students with a background in chemistry, physics, and engineering.

SYEN 7318: Micro- and Nano-Fabrication

Prerequisites: Consent of instructor. This course will introduce some of the important micro- and nano-fabrication techniques that are mostly used in areas of microelectronics and nanotechnology. Some of the topics that will be covered include diffusion of impurities, thermal oxidation, ion implantation, optical lithography, thin film deposition, etching, nanolithography, nano-imprinting, growth of nanorods and nanosprings by glancing angle deposition, and growth of carbon nanotubes. During the course, students will become familiar with some of the basic experiments including thin film and glancing angle depositions, etching, and film characterization techniques. The course is intended for graduate students from science and engineering majors.

SYEN 7320: Linear Systems Theory

Prerequisites: SYEN 5320 or consent of instructor. This course covers the mathematical basis of linear state-space systems theory. Topics include: linear time-varying and time-invariant system representation, solutions to LTV and LTI systems, stability analysis, controllability and state feedback, observability and output feedback, minimal realizations, MIMO systems, and LQR/LQG optimal control. Three hours lecture. Three credit hours.

SYEN 7331, Transducers and Real Time Control

Prerequisites: SYEN 4335 or equivalent, SYEN 7302, SYEN 1302 or equivalent. Applications of computer techniques for data acquisition, analysis, and real-time control; use of analog-to-digital, digital-to-analog, digital I/O for measurement; C computer language for experiment control; use of standard transduction elements for physical measurements such as position, velocity, acceleration, and force.

SYEN 7332: Advanced Operating Systems Design

Prerequisites: SYEN 5332 or consent of instructor. Design principles of modern schedulers, multi-processor systems, protection and security components, OS tools, and IP stacks. The graduate student will do several projects through the software engineering cycles of requirement analysis, high level design (HLD), detailed design (DD), implementation, unit testing, and system testing. The projects include but not limited to the Linus scheduler, signal handler, shared memory control, virtual memory management, and case studies of device drivers. Three hours lecture. Three credit hours.

SYEN 7342: Network and Combinatorial Optimization

Prerequisites: SYEN 5342 or consent of the instructor. An in-depth study of combinatorial programming and network flow optimization. Emphasis on discrete optimization and specialized solution techniques that are efficient way to solve mixed-integer programming problems. Techniques include minimum cost flow, networks with gain, multi-commodity flow networks, networks with side constraints and Lagrangian relaxation. Computational complexity is also discussed. Three hours lecture. Three credit hours

SYEN 7355: Statistical Signal Processing

Prerequisites: Math 3312 and SYEN 3354, or consent of the instructor. The main coding theory problem. Introduction to finite fields. Vector space over finite fields. Structures of linear block codes. Encoding and decoding of linear codes. Dual codes. Non-binary Hamming codes. Perfect codes. Reed-Muller codes. Cyclic codes. Weight enumerators. Low density parity check codes. Convolutional codes. Three hours lecture. Three credit hours.

SYEN 7357: Advanced Antennas for Wireless Systems

Prerequisite: SYEN 3356 or consent of the instructor. The course introduces the fundamental principles of antenna theory and applies them to particular antennas for wireless communications systems and other advanced antenna systems. In addition, the course develops appreciation for research issues of antennas for mobile wireless and advanced communications systems. The course is useful in the areas of mobile communication, signal processing, antenna theory, and smart antennas. It provides the current state of antenna array research and describes how an antenna array may be used to help meet the ever-growing demand of increased channel capacity for wireless mobile communications services. Three hours lecture. Three credit hours.

SYEN 7374: Elasticity

Prerequisites: SYEN 4376 or ASCI 5320 or consent of the instructor. Fundamental concepts of stress and strain. Linear theory: boundary value problems of elasticity including plane stress, plane strain, and torsion, elementary variation theory of elasticity, Three hours lecture. Three credit hours.

SYEN 7376: Fracture Mechanics

Prerequisites: SYEN 7374, or consent of the instructor. Failure of manufactured products in service and implications for design; energy release rates, toughness, and evaluation of experimental tests; fracture mechanisms in different material systems; fracture toughness testing; damage tolerance; design studies. Three hours lecture. Three credit hours.

SYEN 7385: Systems Engineering Graduate Project

Prerequisites: Graduate standing and consent of the student's graduate advisor. Students, under faculty supervision, will conduct directed research on a particular problem or area of Systems Analysis and Applications/Electrical and Computer Engineering/Telecommunication and Signal Processing/ Mechanical Engineering in some depth, and will produce an appropriate project report based on his/her investigations.

SYEN 7399: Special Topics in Systems Engineering

Prerequisites: Graduate standing and consent of the instructor. Advanced topics in the area of Systems Analysis and Applications/ Electrical and Computer Engineering/Telecommunication and Signal Processing/ Mechanical Engineering. Three hours lecture. Three credit hours.

SYEN 8100-8600: Systems Engineering Master's Thesis

Prerequisites: Graduate standing and consent of the thesis advisor. Scholarly investigation of a selected problem in the area of Systems Analysis and Applications/Electrical and Computer Engineering/Telecommunication and Signal Processing/ Mechanical Engineering culminating in a written, orally defended thesis. Maximum of six hours may be applied toward MS degree. Variable credit of one to six hours.

SYEN 9100-9900: Doctoral Research/Dissertation

Prerequisites: Consent of Advisor. One to nine credit hours to be determined at the time of registration. Cross listed between Computer Science, Systems Engineering, and Information Science.

Technology Innovation

Department of Information Science
EIT Building, Room 550
(501) 569-8951

Graduate Certificate in Technology Innovation

The Graduate Certificate in Technology Innovation is a distinctive program intended for working professionals and post-baccalaureate students who are interested in the development, evaluation and implementation of original ideas for existing businesses and new enterprises. The curriculum is designed to teach a specific set of skills necessary to effectively innovate new products and services. Students will learn how to: choose problems that are ripe for technological solutions, create numerous ideas for solving these problems, effectively evaluate these ideas so that only the most promising ones go forward, assemble a business plan, persuade influential people to support their proposals and successfully implement their solutions in new or existing businesses. The certificate is a joint program between the Donaghey College of Engineering and Information Technology (EIT) and the College of Business, allowing students to get a broad perspective on developing ground-breaking solutions to complex problems.

Admission Requirements

A bachelor's degree from an accredited institution of higher education. Candidates who have a background in engineering, science, mathematics, computer science, information science, business or any other areas of technology or who have professional experience in using technology will be the most prepared to enter and successfully complete the certificate program. The GMAT or GRE exam is not required.

Program Requirements

The Graduate Certificate in Technology Innovation requires 18 credit hours for completion.

Required Courses:

TINV 5301 Strategies for Innovation
TINV 5303 Applied Innovation Project
MGMT 5361 New Venture Creation
MGMT 5383 Issues in Entrepreneurship

In addition, students must select two graduate courses in their field of interest, as approved by the coordinator.

Graduation Requirements

Cumulative graduate GPA of at least 3.0 on an approved program of study as outlined above.

Courses in Technology Innovation

TINV 5301 Strategies for Innovation

Prerequisites: Junior or senior standing (TINY 4301) or graduate standing (TINY 5301). This course examines strategies for developing innovative products. Topics include how to choose promising problems that are ripe for innovative solutions, how to generate multiple ideas for solving these problems, how to select the most promising solutions and how to sell your solution to potential partners, managers and investors. This is a hands-on project-based course.

TINV 5303 Applied Innovation Project

Prerequisites: TINY 4301 / 5301, MGMT 4361 / 5361 and MGMT 4383/5383. The purpose of this course is to give students experience in developing a prototype product in their chosen technological inventions and introduces students to commonly used design tools. It is open to students in any field of science and technology. This is primarily a laboratory class that requires a substantial time commitment. In addition to the activities listed above, students enrolled in TINY 5303 will need to prepare a Prototype User Evaluation Report that documents how potential users of the innovation evaluate the prototype.