Integrated Computing

Doctor of Philosophy

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: Computer Science, Information Science, and 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:

<table>
<thead>
<tr>
<th>Track</th>
<th>Description</th>
<th>Sponsoring Department</th>
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</thead>
<tbody>
<tr>
<td>Computer Engineering</td>
<td>The Computer Engineering track focuses on the integration of hardware components and system software to optimize the computer systems that are part of the technical infrastructure that supports an organization’s application and information needs.</td>
<td>Systems Engineering</td>
</tr>
<tr>
<td>Net Integrated Computing</td>
<td>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.</td>
<td>Systems Engineering and Computer Science</td>
</tr>
<tr>
<td>Computer Science</td>
<td>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.</td>
<td>Computer Science</td>
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<tr>
<td>Information Science</td>
<td>The Information Science track focuses on the theory, applications, technologies, and systems that classify, manipulate, store, retrieve, and disseminate information.</td>
<td>Information Science</td>
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<tr>
<td>Information Quality</td>
<td>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.</td>
<td>Information Science</td>
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</tbody>
</table>

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 web site 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:

(a) 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.

(b) 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 1100 or above (1600 scale). 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., 4.5 or above on a 6.0 scale) or through samples of their written work.

(c) Three (3) letters of recommendation.

(d) Official college transcripts including grades and curriculum for undergraduate and (if applicable) graduate studies.

(e) Written statement by the applicant regarding the reasons (e.g., interests, relevant experience, and goals) why he or she should be considered for this PhD program.

(f) 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 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 Fall 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 fall term. The student must take the EWPL each fall term until they pass.

Seminar Requirement

All PhD students should register for either the Integrated Computing Research Seminar or the Ethics Seminar each semester while they are in the program. These weekly seminars are designed to encourage multidisciplinary collaborations, highlight research advances in a variety of computing and information technologies, and to educate the doctoral student on ethical issues in the discipline. Although required, these seminar hours do not count towards the overall credits requirements needed for graduation.

Doctor of Philosophy Graded Program Requirements
The program requires a minimum of 72 hours beyond the Baccalaureate degree. Specific requirements depend on the track area chosen and are detailed in this section. A minimum of thirty (30) 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 (30) credit hours of course-work must include nine (9) credit hours of General Core classes, twelve (12) credit hours of Primary Track courses, and a minimum of nine (9) credit of electives. 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 better. 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. Each topic area corresponds to a particular course taken by the student. Two topic areas are chosen from the student’s general core. The remaining two topic areas are selected from the student’s particular track area. 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) year of completing their primary track course requirements and in any event, no later than the beginning of the fifth semester in the program. Extensions may be granted in the event of special circumstances such as a serious medical episode, pregnancy, or military deployment. A minimum GPA of 3.0 in the student’s graduate candidacy coursework area is required to take the examination. Upon successful completion of the candidacy exams, the student will be granted candidacy status.

Candidacy Subjects

Students will be tested in these two areas from their general core.
(1) either a systems analysis/design course or a software engineering course
(2) an information science theory course

Students will choose their remaining two candidacy exam topics from their respective track area.

Computer Engineering Emphasis Area
- Computer Architecture
- Digital Systems
- Operating Systems
- Coding Theory

Net Integrated Computing Emphasis Area
- Telecommunications
- Communications Networks
- Sensor Networks
- Optical Networks

Computer Science Emphasis Area
- Telecommunications / Networks
- Computer Architecture
- Algorithms
- Computer / Software Security

Information Science Emphasis Area
- Information Visualization
- Database Design
- Data Protection & Privacy
- E-commerce

Information Quality Emphasis Area
- Database Design
- Information Quality Principles
- Information Quality Research and Theory
- Information Quality Policy and Strategy

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 rational 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 PhD 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 PhD 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 closed 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 any writing, seminar, or ethics requirements.

Additional Program Requirements:

- A maximum of two (2) 5000-level courses may be applied toward the PhD 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 PhD degree.
- Only two (2) special topic courses can be applied toward the PhD 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.

Courses Used in 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.

Courses in Integrated Computing

General Core Course Descriptions

- 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: 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. (3 credits)

- 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)

- 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 semester’s 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).

Primary Track Course Descriptions – Computer Engineering Emphasis Area

- 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).
- **SYEN 5366: Advanced Digital Systems**: Advanced design principles for digital systems, 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. (3 credits)

- **SYEN 7332: Advanced Operating System Design or CPSC 7321 Operating Systems**: SYEN 7332 has prerequisites of SYEN 5332 or consent of the instructor and covers design principles of modern schedulers, multi-processor systems, protection and security components, OS tools, and IP stacks. The graduate students 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 Linux scheduler, signal handler, shared memory control, virtual memory management, and case studies of device drivers. (3 credits). CPSC 7321 has prerequisites of CPSC 3380 and 3482; working knowledge of C, C++, or Java Programming Language, and UNIX and covers advanced topics in operating systems; process synchronization, deadlock, concurrency; fault tolerance, protection and security; distributed operating systems, multiprocessor operating systems. (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 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 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)

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).

Primary Track Course Descriptions – Information Science Emphasis Area

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)

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 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).