

University of South Carolina - Columbia

Substantive Change Prospectus

Approval for a New Program: PhD in Informatics

June 22, 2020

A handwritten signature in black ink, reading "Donald Miles", written over a horizontal line.

Donald Miles

Director of Institutional Effectiveness and Accreditation
SACSCOC Liaison

Contact:

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List of Degrees and Majors which the institution is authorized to grant: See Appendix A

List of existing approved Off-campus sites and addresses: See Appendix B

Cover Sheet for Submission of Substantive Changes Requiring Approval

COMPLETE ONE FORM PER PROSPECTUS OR APPLICATION SUBMITTED.

For questions about this form, contact the Substantive Change Office at 404.679.4501, ext. 4526, or email Dr. Kevin Sightler at ksightler@sacscoc.org

Complete, attach to submission, and send to:
 Dr. Belle Wheelan, President
 Southern Association of Colleges and Schools
 Commission on Colleges
 1866 Southern Lane
 Decatur, GA 30033

OFFICIAL NAME OF INSTITUTION

MAIN CAMPUS CITY + STATE (OR NON-U.S. COUNTRY)

SUBMISSION DATE
(MM/DD/YYYY)

INTENDED STARTING
DATE (MM/YYYY)

Type of change (check the appropriate boxes)

New program at the current degree level that is a significant departure from current programs

FULL NAME OF PROPOSED PROGRAM (E.G., CERTIFICATE IN CYBER SECURITY, BACHELOR OF SCIENCE IN CIVIL ENGINEERING)

New off-campus instructional site where 50% or more of a program's credits are offered

SITE NAME

CITY

STATE

STREET ADDRESS

ZIP

COUNTRY

Will the site be a **branch campus?** (see Substantive Change Policy, p. 16, for definition) Yes No

Distance delivery: approval of the institution to offer 50% or more of programs electronically for the first time

Competency-based educational program in which 50% or more of the credit is offered by direct assessment (see "Direct Assessment Competency-based Educational Programs" policy)

Closing a program, instructional site, or institution

Type of closure:

Program closure

Site closure

Institution closure

Degree Level Change (see Substantive Change Policy, p. 15, for definitions; for changes from Level III to IV and from Level V to VI, an Application is not required; contact Commission staff for guidance)

FROM LEVEL

TO LEVEL

TO OFFER (E.G., BACHELOR OF SCIENCE IN COMPUTER SCIENCE)

Merger / consolidation, program acquisition, or site acquisition

NAMES AND ACCREDITORS OF ALL INSTITUTIONS

DESCRIPTION AND LEAD INSTITUTION

Change of governance, ownership, control, or legal status

NAMES AND ACCREDITORS OF ALL INSTITUTIONS

DESCRIPTION

Other (PLEASE DESCRIBE)

OFFICE USE ONLY

On sanction | date imposed: _____
 Sanction recently removed for CR 2.11.1
 or CS 3.10.1 | date removed: _____

Institutional ID

1. ABSTRACT

Creation of new program: Ph.D. in Informatics with an optional concentration in Health Informatics. The proposed Ph.D. in Informatics will include research options in cyberinfrastructure, artificial intelligence, user experience design and interaction, data analytics, and health informatics, covering fundamental aspects of integration and performance of modern technology infrastructures. The IT/Informatics research agenda emerges from the multi-disciplinary intersection of technology, complex systems, and social and behavioral sciences (socio-technical systems).

The desired start date for the program is the Spring 2021 semester (January 2021), and the new program will be offered on the Columbia Campus of UofSC Columbia. The program will be ongoing and will be offered in a wholly traditional (face-to-face) delivery method.

We anticipate five students entering in the first year. We already have expressions of interest from three candidates, and two students currently in other Ph.D. programs who would like to transfer to the proposed program. We therefore expect to meet this target easily. We then project an additional three students in year two and four students in year three. By year four, we expect that three students will graduate, and four new ones will enter, and in year five we expect three students to graduate and five to enter.

Projected Enrollment - GRADUATE NEW PROGRAM									
Year	Fall Headcount			Spring Headcount			Summer Headcount		
	New	Total	Total Credit Hours	New	Total	Total Credit Hours	New	Total	Total Credit Hours
Year 1	5	5	39	0	5	39	0	5	15
Year 2	3	8	63	0	8	63	0	8	24
Year 3	4	12	93	0	12	93	0	12	36
Year 4	4	13	102	0	13	102	0	13	39
Year 5	5	15	117	0	15	117	0	15	45

The Ph.D. in Informatics prepares graduates for research, teaching, and leadership in informatics and information technology fields in universities, public or private research institutes, industry, and government agencies. The target audience is graduate students or professionals with a background in computing technologies, business, health sciences, or clinical practice who desire to advance their careers in teaching, research, or leadership in digital transformation. The Ph.D. in Informatics is a good choice for anyone interested in undertaking independent research to advance the evolving field of informatics and the application of advanced technologies such as artificial intelligence (AI), machine learning, data analytics, blockchain, and biomedical-technologies.

The IIT Department, College of Engineering and Computing, and the University are all well positioned to fully support the planned research focus in cyberinfrastructure, artificial intelligence, user experience design and interaction, data analytics, and health informatics, covering fundamental aspects of integration and performance of modern technology infrastructures. The accreditation of our Master of Health Information Technology (MHIT) program by CAHIIM in Health Informatics demonstrates that our current program meets international standards in this field. Our joint PharmD / MHIT is one of only two or three such programs in the country. The publication record of our faculty members shows that our work is valued by our peers. Several of our faculty members hold leadership positions in national and international Informatics organizations, including the Health Information Management Systems Society (HIMSS), the Association for Information Systems, ACM, and American Medical Informatics Association (AMIA). Our faculty members have established multidisciplinary national and international research collaborations with leading Informatics researchers. Faculty researchers also engage in collaboration with major vendors such as IBM, Siemens, SIOS, Fraunhofer, and others. IIT has also just established the first Healthineers Innovation Think Tank Lab in the U.S. supported by funding from Siemens Healthcare. Siemens is looking to the UofSC Innovation Think Tank Lab to become the hub for U.S. expansion. IIT has recently established a state of the art cyberinfrastructure lab, funded in part by several NSF grants, and used for graduate research and instruction. The lab's virtual cyber infrastructure supports both campus and distributed learning and has developed a growing national reputation as it offers summer instructional camps funded by NSF that attract national participation. IIT has also established a new Computer Interaction/User Experience Laboratory to support the new PhD program, which has already attracted new research funded projects.

The college's new interdisciplinary Artificial Intelligence (AI) Institute provides opportunities for collaborating on research and instruction, for both faculty and PhD students, as well as joint faculty appointments between IIT and the AI Institute. The proposed PhD program will take advantage of UofSC's greatly expanded computing research capacity. A powerful new High-Performance Computing (HPC) cluster, Hyperion, is available to faculty and students. Hyperion is the newest addition to UofSC's HPC cluster environment. This 300 TeraFLOP cluster offers both dedicated resources to research groups and shared resources to the community. This new cluster, managed by Research Computing (RCI) in the Division of Information Technology and funded by the Office of the Provost, enables leading-edge research capabilities in computer modeling and simulation.

The department also plays a leadership role in the University's recently established interdisciplinary Big Data Health Sciences Center, which has expanded our capacity for big data analytics and predictive modeling. The department and college have active collaborative relationships for research and teaching with the College of Business (PMBA Certificate in Cyberinfrastructure), School of Medicine, College of Nursing, School of Public Health, and College of Pharmacy. The university has also been expanding its outreach to national laboratories and military installations with SRL, Fort Jackson and Fort Gordon, and the proposed new program will further strengthen those efforts. The department and college also work closely with the university's Office for Economic Engagement in establishing academic/business collaboration as well as support for commercialization of intellectual property.

2. DETERMINATION OF NEED FOR THE CHANGE/RELATIONSHIP TO MISSION/PLANNING AND APPROVALS FOR THE CHANGE

The Informatics Ph.D. fits the University of South Carolina's mission to lead "the way in providing all students with the highest-quality education, including the knowledge, skills, and values necessary for success and responsible citizenship in a complex and changing world through engagement in nationally and internationally ranked research, scholarship, [and] community outreach." It directly addresses four Focus Carolina 2023 priorities: (1) to "deliver academic programs that are robust, relevant, innovative, and collaborative," directly mapping to areas of distinction in health care and information technology; (2) to improve scholarly productivity and to increase research expenditures; (3) to spur innovation; and (4) to achieve recognized institutional excellence by creating a unique degree that distinguishes the University among its peers and peer aspirants. The proposed PhD in Informatics also directly supports the South Carolina VISION 2025 for Advancing South Carolina's Capacity and Expertise in Science and Technology. Specifically, it contributes to the health, science, and technology workforce goal of "expanding the human resource infrastructure (e.g. PhD, MS, and BA/BS degrees) in STEM by 25% at South Carolina research universities and other educational units."

The field of informatics is at a dramatic inflexion point in its growth internationally as a multidisciplinary field of study. The demand for the application of data and technology to the solution of health, business, and social problems is exploding as the amount of data and the ubiquity of technology escalates. Moreover, the program emphasizes the type of collaborative, convergent research with high societal impact, which is increasingly required by major funding agencies. Foundational informatics research occurs in all sectors--academia, industry, military and government—and applications are used across the board. We believe there is a significant opportunity for both the University and the State of South Carolina to become part of the global leadership shaping the field as it evolves. The science and methodology of informatics is a rapidly developing, dynamic field of study. We need to train professionals who will advance the science and train the next generation of informatics professionals.

A Ph.D. program in informatics would establish the University of South Carolina as an innovative leader in this rapidly developing field. Although other universities in the Southeast offer specialized health, medical, or biomedical informatics doctoral degrees, no other university currently offers a generalized doctorate in informatics. With federal funders viewing an increasing portion of their research portfolios as strategic investments in transdisciplinary initiatives with societal impact rather than time-limited projects, informatics is a critical discipline to integrate not only with health and medical sciences programs, but with other engineering, business, and science disciplines as well. Although we anticipate that the greatest initial demand may be in a health informatics specialization, we also see a growing demand in cyberinfrastructure, for example. Thus, we strongly recommend implementing the broader doctorate in informatics in anticipation of increasing demand for informaticists as multiple industries seek to tightly integrate technologies into everything they do.

It is important to note also that a doctoral program in informatics is distinctly different than a doctoral program in computer science in significant ways. The informatics doctorate is focused on advancing technical capabilities and innovation in designing and integrating information technologies across a wide range of enterprises and work environments, which requires interdisciplinary skills in research as well as product, service and process management. It is concerned with evidence-based, human-centered,

secure information technology practice and the societal impact of information technology. In contrast, a doctoral program in computer science is concerned with the detailed study of computing itself, including computer architecture, compiler construction, the theory of computation, and the analysis of algorithms. The proposed informatics program intends for graduates to use a broad range of information technology processes, tools and techniques, of which computer programming is but one aspect, to address significant societal challenges. The computing disciplines in the College of Engineering and Computing have been the fastest growing area of study with a combined enrollment of over 1350 students.

Development of the proposed PhD in Informatics has been a two-year effort engaging the entire IIT faculty, college curriculum reviews, advisory boards, external constituencies, professional organizations, and global research. The minutes of department faculty meetings and advisory board meetings document a number of these discussions. It is also informed by the extensive experience and research of some of our faculty members in this evolving field both nationally and internationally. Considering that two primary goals of the program are to train leaders in using technology to advance practice as well as to train professionals to advance the science and train the next generation of informatics professionals, we looked to evolving societal needs. We carefully researched related existing programs, but relied more heavily on the evolving directions and demands of the field as documented by research of the National Academies of Science and Engineering, National Institutes of Health, National Science Foundation, industry research, and professional associations such as the International Medical Informatics Association and American Medical Informatics Association. The program has undergone the college review process, preliminary review by the Provost office, and is now advancing through the university graduate curriculum review process, and then will be reviewed by the Board of Trustees and the Commission on Higher Education. Copy of letters of support from the former President of the International Association of Information Systems and former Director of AMIA are attached in Appendix C. Copies of meeting minutes can be found in Appendix D.

Employment Opportunities

The following chart identifies occupation categories identified by the Bureau of Labor Statistics (BLS) that relate to informatics. BLS currently does not have a separate classification for informatics. The statistics indicate a continued high growth rate overall in information technology related categories.

Occupation	State*		National		Data Type and Source
	Expected Number of Jobs	Employment Projection	Expected Number of Jobs	Employment Projection	
Computer and information research scientists	n/a	n/a	33,200	+19%	BLS Occupational Outlook Handbook
Informatics faculty positions	n/a	n/a			BLS Occupational Outlook Handbook
Health and Professional Scientific and Technical Services	n/a	n/a	n/a	+26% to 35%	BLS Occupational Outlook Handbook
Data scientists	n/a	n/a	n/a	+256% since 2013	https://www.techrepublic.com
Computer systems analysts	n/a	28%	654,900	+9%	SC Dept. of Employment & Workforce, projected growth 2012-22. BLS Occupational Outlook Handbook
Computer user support specialists	n/a	n/a	923,800	+11%	BLS Occupational Outlook Handbook
Database Administrators	n/a	13%	133,200	+11%	SC Dept. of Employment & Workforce, projected growth 2012-22. BLS Occupational Outlook Handbook
Network and Computer System Administrators	n/a	n/a	415,300	+6%	BLS Occupational Outlook Handbook
Information Security Analysts	n/a	40%	128,500	+28%	SC Dept. of Employment & Workforce, projected growth 2012-22. BLS Occupational Outlook Handbook

Supporting Evidence of Anticipated Employment Opportunities

Informatics aligns with the Bureau of Labor Statistics (BLS) category Computer and Information Research Scientists, which requires a master's degree at minimum for entry level positions. However, jobs in this classification are becoming more research oriented and demanding with the complexity of integrating big data analytics, AI, machine learning, blockchain, etc. with work processes. BLS also points out that many of these positions require additional knowledge in the industry in which individuals are working. For example, those working in health informatics need a deep knowledge of the medical field as well. This perspective is reinforced consistently by the two leading medical informatics organizations, the American Medical Informatics Association (AMIA) and the International Medical Informatics Association (IMIA). They point out the growing demand for increased research skills. According to BLS data, the overall job outlook for positions in the category of Computer and Information Research Scientists is predicted to grow by 19% over the next ten years, much faster than average. The average 2017 salary according to the BLS was \$114,520. The BLS forecast in the category of Health and Professional Scientific and Technical Services is 26% to 35% growth. In recognition of the dramatic change in the informatics field over the past 10 years, BLS recently recommended addition (2018) of a new Standard Occupational Classification (SOC) Code category 29-9000 Other Healthcare Practitioners and Technical Occupations which encompasses health informatics specialists and health information analysts. However, no information on education levels, salaries, or other information has yet been published. For just one current example, the AMIA Job Post site lists 16 open faculty positions in informatics as of 2/13/2020.

For South Carolina, projectionscentral.com predicts a growth of 3.4% over the same period, while for the Southeast (AL, FL, GA, NC, SC), the projected growth is 15.4%.

- BLS data also shows that the two highest growth rates in Ph.D. faculty are in the areas of health and computer and information sciences professional and related sciences. One of the three priority educational needs in informatics identified by AMIA is educational professionals to meet the growing demand for health information technology workforce (JAMIA, 2016;23:666):
“While the science and methodology of informatics are beyond its infancy, it is still a developing and dynamic field of study. In order to build the health IT workforce of the future, we need to train professionals who will advance the science and train the next generation of informatics professionals.”
- The American Medical Informatics Association (AMIA) explicitly calls out a growing need for “educational professionals who will advance the science and train the next generation of informatics professionals. . . and build the health IT workforce of the future. (Doug Fridsma, MD, PhD, AMIA President and CEO, in *Journal of American Medical Informatics Association*, 2016;23:666)
- The Institute of Medicine (IOM) in addressing the need for major healthcare transformation, identifies the need for convergence of data from disparate sources, developing what they have termed the “learning health system” (LHS), which “aims to lead to a situation where each patient-care experience naturally reflects the best available evidence, and, in turn, adds seamlessly to learning what works best in different circumstances in order to provide information to improve healthcare decisions, encourage patient empowerment by means of

education on health issues and self-management, help in defining public health strategies, and provide the necessary support research and development of new knowledge that can provide feedback to the LHS as a virtuous cycle.” (IMIA Yearbook of Medical Informatics 2014).

- The Health IT Special Interest Group has by far the fastest growing membership in the Association of Information Systems (AIS), the leading international IT/IS research organization. A letter of support for a Health Informatics PhD from a former president, Dr. Douglas R. Vogel is attached. We also have an email of support from Dr. Robert Hoyt, MD, Captain Retired U.S. Navy, Diplomate, Clinical Informatics, Informatics Education Organization, who led a workshop on graduate programs in health informatics at the last AIS American Conference on Information Systems.
- Data scientist job postings have increased 256% since December 2013, and median base salaries have reached \$130,000, according to Indeed Prime data (<https://techrepublic.com/article/why-data-scientist-is-the-most-promising-job-of-2019>).
- *Employment projections not available at <http://dew.sc.gov>

Supporting Evidence from Industry Collaborators

The IIT Department has agreements with leading cyberinfrastructure technology companies, including Cisco Systems, VMware, Palo Alto Networks, Red Hat, Juniper Networks, and Barefoot Networks. These companies make up a substantial share of the networking, virtualization, cybersecurity, and operating systems markets and have already committed resources that are currently used by the undergraduate and graduate IIT programs:

- Cisco Systems: donated network operating systems and curricular material for applied networks and cybersecurity research.
- Palo Alto Networks: donated licenses for Next-Generation Firewalls, for teaching and research in cybersecurity analytics and firewall migrations and deployments.
- VMware: donated licenses for developing and deploying a distributed cloud system across North and South Carolina.
- Red Hat: donated access to instructor and student training materials for Linux system installation, tuning, and management.
- Juniper Networks: donated virtual routers for applied research on network telemetry.
- Barefoot Networks: donated software development kits for applied research in programmable switches, in-band network telemetry, and custom protocol design.
- XPODA Data Analytics Software donation (\$1.3m) for faculty and student research

Currently, IIT faculty and graduate students are conducting research using several technologies from industry collaborators. Research in cyberinfrastructure has resulted in journal and conference papers and a best-paper award in applied research.

Supporting Evidence from National Laboratories

IIT's faculty members actively collaborate with several national laboratories, including Berkeley National Laboratory, Los Alamos National Laboratory, Savannah River National Laboratory, and the Energy Science Network (ESnet). ESnet is the national backbone network that carries traffic for the U.S.

Department of Energy. It connects all national laboratories, research institutions, and the U.S. and Europe. For high-throughput high-latency networks, ESnet now refers to the research work by IIT's faculty (see <http://fasterdata.es.net/science-dmz/>). Additionally, since the Summer of 2019, Savannah River National Laboratory opened internship positions for IIT students with skills in the operation and configuration of networks and security appliances.

Supporting Evidence from the National Science Foundation

In the last 15 months, the IIT Department has received approximately \$2M from the National Science Foundation for teaching, training, research, and development of cyberinfrastructure technologies. IIT is currently funding multiple PhD students in computing-related areas. The NSF offices and programs the IIT department received funding from are:

- Advanced Cyberinfrastructure. Project: Building a Science DMZ for Data-intensive Research and Computation at the University of South Carolina (integration and applied network innovation).
- Division of Graduate Studies. Project: Building a Cybersecurity Pipeline through Experiential Virtual Labs and Workforce Alliances (virtual laboratories and implementation of a private cloud).
- Cybertraining. Project: Cyberinfrastructure Expertise on High-throughput Networks for Big Science Data Transfers (training and research in operational aspects of high-throughput high-latency networks).
- Advanced Technological Educational. Project: Multi-state Community College, University and Industry Collaboration to Prepare Learners for 21st Century Information Technology Jobs (curricular implementation of operational and managerial IT concepts in networks, cybersecurity, virtualization, and operating systems).
- Core Advanced Cyberinfrastructure. Project: Devising Data-driven Methodologies by Employing Large-scale Empirical Data to Fingerprint, Attribute, Remediate and Analyze Internet-scale IoT Maliciousness (operational cyber security, development of a large-scale cyberinfrastructure for IoT-relevant threat sharing)
- NSF Engineering Research Planning Grant. To support development of a collaborative proposal for a national Engineering Research Center for Healthcare Transformation (major partners are Clemson University, U. of Kentucky Medical School, Johns Hopkins University, Claflin, Prisma Health System).

Note that the above programs, such as Cyberinfrastructure and Cyber-training, specifically target *applied* research and infrastructure (e.g., “data-driven infrastructure,” “network integration and applied innovation,” etc.). IIT's faculty members have such expertise and partnership with leading technology vendors, which enable the department to secure funds for applied research. NSF has also recognized IIT's capability as a national leader to train the country in cyberinfrastructure technologies. NSF has provided funds to develop advanced curricular material and run nationwide training workshops using this material. Since 2018, IIT has organized workshops in Arizona, New Mexico, and South Carolina. The training material has been used by institutions in more than 25 states (see <http://ce.sc.edu/cyberinfra/workshop.html>). NSF has provided funding for additional training until 2022, for organizing workshops nationwide.

Similar Programs in South Carolina offered by Public and Independent Institutions

There are currently no Ph.D. programs in general Informatics in the state or the Southeast

Program Name and Designation	Total Credit Hours	Institution	Similarities	Differences
Ph.D. Human-Centered Computing		Clemson University	CIP Code 11.0104 Programs are similar in coverage of human computer interaction and user interface design.	Distinctly greater computer science focus.
Ph.D. Health Informatics		U. of North Carolina	The field of health IT is diverse, rapidly changing, and covers numerous areas of scholarship. Programs are similar in their interdisciplinary approach and emphasis on advanced database management, analytics methods and evaluation, and human-computer interaction. Min. 55 hours of coursework plus dissertation research.	Carolina Health’s Informatics Program at UNC appears to provide a greater emphasis on administrative management in comparison to our emphasis on health information technology, IT-based change, and clinical transformation. No focus on cyberinfrastructure and AI, for example. Stated purpose of the UNC program is to prepare graduates to contribute to the field of biomedical and health informatics studies through research, teaching and exposure to practical BMHI challenges.
Ph.D. Biomedical Data Science and Informatics		Clemson/MUSC	Informatics orientation. Both share some areas of focus on data analytics.	Focuses specifically on domain of data science, preparing graduates “to manage and analyze big data sources from mobile sensors to genomic and imaging technologies” for “careers in biology, medicine, or public health focused on the development of prescriptive analytics from large data sources.”

3. REQUIRED INFORMATION FOR THE SPECIFIC SUBSTANTIVE CHANGE (New Program)

Program Admission

Admission Requirements

Admissions requirements follow those of The Graduate School and include:

- Completed application with all requested information and supporting documents supplied.
- Official transcripts from all post-secondary schools and colleges previously attended, including non-degree courses taken.
- Evidence of academic performance at a B or better level on academic transcripts
- Satisfactory GRE scores. For the Ph.D. program, a minimum of 300 (combined verbal and quantitative) is required.
- Three letters of recommendation from academic and/or professional sources.
- Letter of intent which describes research interests and professional goals.
- Satisfactory score on the TOEFL or the IELTS Intl. Academic Course Type 2 exam for applicants whose native language is not English. The minimum acceptable score on the TOEFL is 80 (Internet-based) or 570 (paper-based). The minimum acceptable overall band score on the IELTS Intl. Academic Course Type 2 exam is 6.5.
- Current resume or curriculum vitae.
- Personal interview with one or more graduate faculty.
- Doctoral applicants should be supported by at least two IIT faculty members willing to serve as mentors in order to be admitted into the program.

Once received, the student's application and credentials are sent for review by the IIT graduate faculty. After reviewing the credentials, the department makes a recommendation to The Graduate School which officially grants admission. Candidates are informed of the department's recommendation regarding admission, but official notice of admission comes from the USC Graduate School.

Curriculum

Completion of the doctoral degree requires a minimum of 60 credits beyond the baccalaureate degree, of which 12 must be ITEC 899 Dissertation Preparation in Informatics. Students having an earned master's degree must complete a minimum of 48 credit hours beyond the master's degree. At least half of the course work must be completed at the 700 level or higher. All students must satisfy the prescribed core courses and four required research courses. All programs of study must be approved by the department.

Students enrolled in graduate programs are subject to the academic regulations and degree requirements of the Graduate School and the academic program in which enrolled. The requirements described here pertain specifically to the Ph.D. in Informatics.

Total Credit Requirement

Area	Credits Required
Informatics Core Courses	21 credits
Research Methods	12 credits
Dissertation	12 credits
Electives	15 credits
Total	60 credits

Informatics Core Courses (21 credit hours)

- ITEC 742 Cyberinfrastructure and Information Assurance or ITEC 743 Health Information Privacy and Security
- ITEC 749 Principles of Informatics or ITEC 747 Management of Health Information Systems
- ITEC 754 Systems Analysis and Design or ITEC 752 Systems Analysis and Design for Health Applications
- ITEC 765 IT Usability and Interface Design or ITEC 762 Health IT Usability and Interface Design
- ITEC 766 Project Management or ITEC 764 Project Management for Health IT
- ITEC 772 Database Systems or ITEC 770 Health Database Systems
- ITEC 785 Enterprise Data Analytics or ITEC 784 Data Analytics for Healthcare

Required Research Courses (12 credit hours)

Students must complete four research methods courses at the 700 level or above appropriate for their research focus with approval of the department.

- BIOS 700 Introduction to Biostatistics
- BIOS 757 Intermediate Biostatistics
- BIOS 765 Research Design in Biomedical Sciences (*pre-req EPID 741, BIOS 757*)
- STAT 700 Applied Statistics I
- STAT 701 Applied Statistics II
- HSPM 716 Quantitative Methods for Health Administration (*pre-req. HSPM 775 or BIOS 700*)
- HPEB 715 Qualitative Research Methods in Public Health
- PSYC 702E Experimental Design
- PSYC 709 Basic Quantitative Methods in the Analysis of Behavioral Data 1
- PSYC 710 Basic Quantitative Methods in the Analysis of Behavioral Data II (*pre-req PSYC 709*)
- PSYC 821 Theory of Psychological Measurement
- PSYC 823 Multivariate Analysis of Behavioral Data
- PSYC 824 Special Topics
- PSYC 825 Introduction to Statistical Mediation Analysis
- EDFI 730 Qualitative Epistemologies, Paradigms & Theories
- EDFI 731 Qualitative Inquiry
- EDRM 710 Educational Statistics 1

- EDRM 711 Educational Statistics 2 (*pre-req EDRM 710*)
- EDRM 712 Nonparametric Statistics
- EDRM 718 Research and Statistical Packages (*pre-req. EDRM 710 & 711*)
- EDRM 810 Design and Analysis of Experiments (*pre-req. EDRM 711 or equivalent*)
- EDRM 816 Correlational and Multivariate Methods (*pre-req. EDRM 711*)
- Other approved courses in quantitative research taught outside the department approved by the department

Dissertation (12 credit hours)

- 899 Dissertation Preparation in Informatics

Elective Courses (15 credit hours)

In addition to the above requirements, students must complete 15 hours in ITEC courses numbered 500 or above. Courses listed as Informatics Core, Research Methods, and Dissertation may not be used to satisfy an elective requirement. Courses from other departments may satisfy an elective requirement with approval of the advisor and Graduate Director.

- ITEC 544 Training Systems
- ITEC 545 Telecommunications
- ITEC 552 Linux Programming and Administration
- ITEC 562 Advanced Web Support Systems
- ITEC 590 Special Topics in Integrated Information Technology
- ITEC 790 Special Topics in Informatics
- ITEC 760* Enterprise Network Management
- ITEC 761* Management of Cyberinfrastructure
- ITEC 787* Advanced Analytics Tools and Techniques
- ITEC 786* Advanced Enterprise Data Analytics
- ITEC 781* Artificial Intelligence and Informatics I
- ITEC 782* Artificial Intelligence and Informatics II
- ITEC 775 Large-scale Health Information Systems
- ITEC 776 Health Information Technology and Clinical Transformation
- ITEC 745 Telecommunications for Health Information Technology
- ITEC 795 Independent Study
- Courses from other departments with approval of the advisor and Graduate Director.

*new

Optional Concentration in Health Informatics

Completing the Health Informatics concentration satisfies the Electives requirement. Students taking the Health Informatics Concentration also are advised to take the health informatics options for the core courses.

Required:

- ITEC 776 Health Information Technology and Clinical Transformation

- ITEC 775 Large-Scale Health Information Systems

Any three of the following:

- ITEC 748 Internship in Health Information Technology
- ITEC 745 Telecommunications for Health Information Technology
- HSPM 765 Leadership in Health Care Organizations
- NURS 734 Conceptual Basis of Health Systems
- HSPM 730 or NURS 738 Financing of Health Care
- HSPM 769 Organizational Behavior
- BIOS 710 Effective Data Management for Public Health
- HSPM 711 Health Politics
- HSPM 712 Health Economics
- HSPM 726 Applied Public Health Law for Administrators
- HSPM 777 Healthcare Policy and Principles of Health Insurance
- HSPM 791 Special Topics in Public Health
- HSPM 768 Approaches and Concepts for Health Administration
- Any 700 level ITEC course from the electives listed above

Publication Requirement

To demonstrate their ability to effectively communicate research results, Ph.D. candidates are required to submit, based on research performed while at the University of South Carolina, at least one journal article or national conference paper prior to graduation.

Graduation Requirements

To remain in the PhD program, each student must receive no less than a B in core courses and must maintain a grade point average (GPA) of 3.0 or higher.

Completion of the doctoral degree requires a minimum of 60 credits beyond the baccalaureate degree, of which 12 must be ITEC 899 Dissertation Preparation in Informatics. Students having an earned master's degree must complete a minimum of 48 credit hours beyond the master's degree. At least half of the course work must be completed at the 700 level or higher. All students must satisfy the prescribed core courses and four required research courses. All programs of study must be approved by the student's academic advisor and the Integrated Information Technology Department graduate director.

Additional requirements for graduate students include:

Residency

Minimum 2 consecutive semesters of full-time enrollment and residency on campus as a graduate student.

Teaching assistantships

Prior to receiving a Ph.D. degree, students will be required to teach and participate in research under the direction of an informatics faculty member in the Integrated Information Technology Department. Students will be required to be a teaching assistant for a minimum of two courses approved by the doctoral advisory committee; one should be completed in the first two years of study.

Comprehensive Qualifying Exam for admission to candidacy

The PhD comprehensive qualifying examination will consist of both written and oral components generally administered upon completion of required course work. This exam seeks to discover whether the student has a sufficiently deep understanding of topics in the area of interest to carry out the proposed research.

The plan for the qualifying exam will be developed in conjunction with the doctoral chair. It will consist of demonstration and competency with both domain specific knowledge and breadth of knowledge across the informatics disciplines. Demonstration of knowledge, conceptual understanding, and proficiency in domain specific content and methodology will relate to course work and independent research in relevant literature designed to deepen knowledge of specific interests. The domain specific reading list will be developed in conjunction with the advisor/committee. Students will demonstrate breadth of knowledge across health informatics disciplines through questions that require synthesis of knowledge from core areas. In addition to the written exam, the student will prepare a proposal abstract (1-2 pages) and delivery a public presentation of this abstract.

Following the written exam and abstract presentation, the student and committee will take part in a closed question and answer session (1-2 hours) over the written exam and proposal presentation. The oral examination may also examine the student on any other material it deems relevant.

Dissertation Committee

The student's doctoral dissertation advisory committee must approve the program of study, so students are advised to form their committee as early in their course of study as possible. The committee is comprised of at least three graduate faculty members. Two members, including the Chair, must be from the Integrated Information Technology Department. The Chair is responsible for overseeing and guiding the student's progress, coordinating the responses of the committee members, and informing the student of her/his academic progress.

Doctoral Dissertation

Each student must prepare and defend a dissertation that contributes significantly to knowledge in the field of informatics. The dissertation must give evidence of original and significant research and must be completed no later than five years after successfully completing the oral comprehensive examination. The candidate must defend the dissertation before their doctoral advisory committee and informatics faculty. A minimum of twelve hours of dissertation preparation credit is required. As an alternative with approval of a doctoral advisor, students may elect to publish 3 journal research articles in lieu of the dissertation.

Course Descriptions

As stated in ACAF 2.03 *Creation and Revision of Academic Courses*, "the University adheres to the IPEDS definition of a credit hour as 'a unit of measure representing the equivalent of an hour (50 minutes)

of instruction per week over the entire term.' Therefore, each single course credit requires a minimum of 700 minutes of continuous and ongoing instructional time. A minimum of one calendar week of instruction

with a cumulative total of at least 700 minutes is required for each credit offered. This time excludes breaks and final exams.” All courses offered at the University of South Carolina Columbia are recorded in semester hours. Course descriptions for new courses are included below; a complete list of course descriptions can be found in Appendix E.

New Courses:

The following new courses have been developed for the PhD program. The full list of course descriptions for the program is provided in the supplemental documents.

ITEC 742 Cyber Security and Information Assurance (3)

Information Technology (IT) elements of the cyberinfrastructure; information assurance and security in a modern cyberinfrastructure; securing advanced systems related to the use, processing, transmission, and storage of information.

ITEC 749 Principles of Informatics (3)

Comprehensive overview of the integration of information technology across the business spectrum. Focuses on underlying technological developments and important business drivers of performance and vital importance of digital technology’s role in relation to three major components of business performance improvement: people, processes and technology.

ITEC 754 Systems Analysis and Design (3)

Application of the principles of information systems analysis and design to organizational processes and applications. Analysis and logical design of business processes and management information systems focusing on the systems development life cycle. Techniques for logical system design.

ITEC 760 Enterprise Network Management (3)

Information Technology (IT) elements of the cyberinfrastructure; information assurance and security in the modern cyberinfrastructure; design and secure advanced systems that use, process, transmit, and store of information.

ITEC 761 Management of Cyberinfrastructure (3)

Techniques, technologies, and management tools used in modern cyberinfrastructures, including software-defined data centers, next-generation software-defined networking (NG-SDN), and cloud systems.

ITEC 765 IT Usability and Interface Design (3)

Overview of the analysis, design, and usability of information systems. Includes consideration of computer interfaces, web portals, and human-computer interaction.

ITEC 766 IT Project Management (3)

Application of project management tools to document key components of the implementation of a real-world information technology projects.

ITEC 772 Database Systems (3)

Fundamentals, design, implementation and management of database systems that form the foundation for information systems and data analytics.

ITEC 781 Artificial Intelligence and Informatics I (3)

Fundamental concepts in artificial intelligence, including intelligent agents, problem solving by searching, logic-based knowledge representation and inference, planning, and probabilistic reasoning. Basic techniques for building intelligent computer systems and applications to problems.

ITEC 782 Artificial Intelligence and Informatics II (3)

Artificial Intelligence concepts including algorithmic decision making. Machine learning techniques such as learning from examples, learning probabilistic models, and reinforcement learning. Applications of AI technologies, e.g. natural language processing, robotics, and perception.

ITEC 785 Enterprise Data Analytics (3)

Mathematical and software tools and quantitative reasoning for analysis of enterprise data. Fundamental concepts and essential skills in data analytics. Critical and creative thinking about quantitative and qualitative problems involving enterprise data.

ITEC 786 Advanced Enterprise Data Analytics (3)

Advanced concepts, issues, and trends in data analytics. Critical thinking and quantitative and qualitative analytical skills essential for Healthcare, Engineering, and Business among many others.

ITEC 787 Advanced Data Analytics Tools (3)

Software tools in data analytics. Advanced analytics techniques. Case studies and problem sets from multiple enterprise domains.

ITEC 899 Dissertation Preparation in Informatics (3-12)

Provide specific programmatic goals (objectives) and specific student learning outcomes for the program.

Total Credit Hours Required: 60 credit hours

Curriculum by Year					
Course Name	Credit Hours	Course Name	Credit Hours	Course Name	Credit Hours
Year 1					
Fall		Spring		Summer	
Management of Health Information Systems or Principles of Informatics	3	Systems Analysis and Design or Systems Analysis and Design for Health IT	3	IT Project Management or Project Management for Health IT	3
Cyberinfrastructure & Information Assurance or Health Information Privacy and Security	3	IT Usability & Interface Design or Health IT Usability & Interface Design	3	Elective or Concentration Course	3
Database Systems or Health Database Systems	3	Elective or Concentration Course	3		
Total Semester Hours	9	Total Semester Hours	9	Total Semester Hours	6
Year 2					
Fall		Spring		Summer	
Research Course	3	Statistics	3	Research Course	3
Enterprise Data Analytics or Data Analytics for Healthcare	3	Elective or Concentration Course	3	Elective or Concentration Course	3
Elective or Concentration Course	3	Research Course	3		
Total Semester Hours	9	Total Semester Hours	9	Total Semester Hours	6
				Total Program Hours	48
Years 3-4					
Fall		Spring		Summer	
Thesis Preparation					
Dissertation	6	Dissertation	6		
				Total:	60

Assessment

Upon completion of the program, students will be able to:

- Demonstrate the ability to apply advanced informatics principles to solve complex problems in multiple settings.
- Design, execute, and evaluate a rigorous research project in a specific informatics area of interest.
- Work in trans-disciplinary teams to analyze problems and develop, integrate and evaluate innovative solutions applying informatics and information technology.
- Exhibit professional skills including scientific writing, oral communication, grant writing, teaching, and professional service.
- Actively contribute to the informatics research through publication or other appropriate avenues of dissemination.

The chart below summarizes program goals, student learning outcomes and methods of assessment.

PROGRAM OBJECTIVES	STUDENT LEARNING OUTCOMES ALIGNED TO PROGRAM OBJECTIVES	METHODS OF ASSESSMENT
<ul style="list-style-type: none"> • Develop expertise in core areas of informatics 	<ul style="list-style-type: none"> • Demonstrate the ability to apply advanced informatics principles to solve complex problems in multiple settings. 	Evaluated by written and oral examination conducted by the student's doctoral advisory committee members and chair.
<ul style="list-style-type: none"> • Prepare graduates to conduct independent research and innovation initiatives 	<ul style="list-style-type: none"> • Design, execute, and evaluate a rigorous research project in a specific informatics area of interest. 	Evaluated by student's dissertation advisory committee.
<ul style="list-style-type: none"> • To develop transformational leaders 	<ul style="list-style-type: none"> • Work in trans-disciplinary teams to analyze problems and develop, integrate, and evaluate innovative solutions applying informatics and IT. 	Student work on teams, working on collaborative research projects, internships, or other collaborative endeavors will be evaluated by the student's dissertation committee.
	<ul style="list-style-type: none"> • Actively contribute to the informatics research through publication and other appropriate avenues of dissemination. 	Students will present research results in a public dissertation defense, which will be evaluated by their doctoral dissertation committee and other external reviewers. Minimum 2 conference presentations expected.

PROGRAM OBJECTIVES	STUDENT LEARNING OUTCOMES ALIGNED TO PROGRAM OBJECTIVES	METHODS OF ASSESSMENT
<ul style="list-style-type: none"> To develop effective professional skills 	<ul style="list-style-type: none"> Exhibit professional skills including scientific writing, oral communication, grant writing, teaching, professional service. 	<p>Student’s dissertation advisory committee will select and evaluate several artifacts during the dissertation research phase to assess student’s professional skills.</p> <p>All passing students will achieve a grade of “good” or better on the rubric-based evaluation of their teaching and communication abilities during teaching and lab supervision assignments.</p>

Students in the Health Informatics Concentration will be assessed in the same manner. However, evaluations will be tailored directly to the healthcare environment.

The program will be assessed through the standard University of South Carolina assessment software system, which reports results on all the program objectives. Student learning outcomes are assessed each year. The results of the assessment are discussed in a meeting of program faculty, with any necessary modifications proposed for the next assessment cycle. An alumni placement database tracks the employment of graduates. Finally, an industry advisory board provides assessment input to the faculty. Assessment data is used to make academic changes to the program.

We will establish a database to track employment after graduation. If data is not available immediately upon program completion, we will follow-up with graduates within first 3-6 months. All students will be required to establish an account on the Department Linked-In Group and encouraged to keep this information updated to facilitate networking among graduates.

Program Administrative Oversight

Oversight of graduate programs is provided at the department, college, and the Graduate School levels. The Integrated Information Technology Department will designate a graduate program director from among existing graduate faculty. Research faculty in the Department of Integrated Information Technology will serve as advisors for doctoral students and oversee their research projects.

At the department level, the department chair provides general oversight for all programs to ensure quality and compliance with all departmental, college, and graduate school policies and regulations. The IIT Director of Graduate Programs manages the admissions process and the operational oversight. Administrative support for graduate programs will be provided by a full-time advisor/administrative coordinator position.

At the college level, the Assoc. Dean for Research and Graduate Education provides support and oversight for graduate student research and research laboratories. The office also provides support for PhD recruitment of candidates, especially for under-represented populations. Currently, the college has an NSF Bridge to Doctorate grant to support recruitment of students to STEM disciplines. The college research

office also provides support for graduate student mentoring, including guidelines and education.

Mentoring of graduate students occurs on three levels:

- Department: Ownership of the graduate program. Clarity and consistency of program requirements, progression requirements, policies, and procedures (Graduate Handbook, web, other). Conflict resolution.
- College: College-wide support programs. Bulletin and curriculum support. Liaison with graduate school. Clarity and consistency of policies, and procedures. Conflict resolution.
- University and Graduate School: Professional development; teaching excellence; clarity and consistency of degree and graduation requirements; support networks.

At the University level, the Graduate School provides oversight for all graduate programs, including admissions, academic progress, compliance with all university policies and regulations, and eligibility for graduation. Support services available to doctoral students through the Office of Graduate Programs and the Success Center include: professional development, scholarly initiatives, travel grants, on-campus help and activities, ombudsman, and international student support.

4. FACULTY QUALIFICATIONS

The University of South Carolina Columbia Faculty Manual outlines the minimum qualifications required of teaching faculty, by rank, on the Columbia campus. Minimum requirements for all teaching positions, regardless of rank, are outlined in ACAF 1.20 *Credentials Verification for Instructors of Record* and are as follows:

Post-graduate Level: Terminal Degree in the Teaching Discipline OR Terminal Degree in a Related Discipline

If a department wishes to hire an individual that does not meet these qualifications but possesses outstanding professional experience or demonstrated contributions to the teaching discipline, special exceptions may be made via the use of alternative credentials. Alternative credentials include, but are not limited to, work or research experience, professional licensure or certification, non-credit professional development courses, or other specialized training.

Please see Appendix F for a faculty roster containing information for those faculty teaching core courses in the PhD in Informatics. Non-core faculty will meet the minimum requirements as required by university policy ACAF 1.20.

Faculty, Staff, and Administrative Personnel:

The Integrated Information Technology Department currently offers the Master of Health Information Technology (MHIT) degree and a dual PharmD/MHIT degree with the College of Pharmacy. Graduate faculty currently teaching in the MHIT program, as well as other qualified faculty, will teach in the proposed PhD program. In addition, students in the proposed program may take elective courses from the College of Nursing, Arnold School of Public Health, College of Pharmacy, College of Arts and Sciences, or other departments as approved by their advisory committees. Students meet their 12 credit hour research methodology requirements by choosing from a large selection of established research methodology and statistics courses offered by the biostatistics department, statistics department, psychology department, research and measurement in education, educational foundations and Inquiry, or health services policy and management.

Total FTE needed to support proposed PhD program:

Faculty: 4 FTE

Administration: 1

Staff: .5

The hire of one additional faculty member for the PhD Program is anticipated in a joint appointment with the AI Institute. In addition, two well qualified instructors have been hired to support the undergraduate program as current faculty increase their teaching load on the graduate level or supervising PhD students.

The qualifications of IIT faculty identified to teach in the PhD program have been approved by the Graduate Program Office. Seven of those faculty members have prior graduate teaching experience as well as experience supervising graduate student research at the doctoral level.

Graduate faculty are research active with strong publication records, as well as current or prior research funding. Specific details of faculty research, grant funding, publications, and supervision of graduate students is documented in the Program Faculty Roster.

5. LIBRARY AND LEARNING RESOURCES

Current resources include PASCAL for general research resources and database subscriptions such as the ACM Digital Library, IEEE Explore, and Gartner for Information Technology; and PubMed-Medline, Web of Science Core Collection, and Science Direct for health care administration. Library liaison services for the Arnold School of Public Health and the College of Engineering and computing provide both department-level and individual level research assistance. The library liaison meets with faculty throughout the year to provide updates on library resources and answer questions; she is also invited to regularly scheduled department meetings. The library liaison also provides orientation to new faculty hires.

The library liaison will be included in the orientation sessions for all new PhD students and will conduct a required research seminar session for all PhD students (currently under development). Faculty and instructors can request library sessions or specific workshops for their classes from the liaison librarians.

The Thomas Cooper Library offers a self-guided tour in which students (and others) are provided instruction regarding services available, introduced to the processes for lending, are made aware of all of the libraries (Ernest F. Hollings Special Collections, Music Library, Moving Image Research Collection, South Carolina Library, and the Thomas Cooper Library) and see demonstrations of the online services. The self-guided tour is available at https://guides.library.sc.edu/ld.php?content_id=49144316

No additional resources are anticipated, as current library resources are adequate to support the program. Please see Appendix G for a complete list of research resources and database subscriptions.

Access to resources

All online library resources and services are made available to authorized users with valid university credentials by way of the University Libraries' proxy server. Journal articles and book chapters that are not directly available via the online resources may be obtained through Interlibrary Loan services or the university's Scan and Deliver service. Students and faculty also have access to the extensive physical collections housed in the Library.

The main library is open to id-holding students and faculty members from 8am on Sunday and until midnight on Friday. On Saturday, the library is open from 8am-midnight.

Additional Resources

Research support is provided by a variety of methods including live chat, email, online research guides, online video tutorials, research guides, and a searchable database of frequently asked questions (FAQs) about library services and resources.

6. STUDENT SUPPORT SERVICES

Support services available to doctoral students through the Office of Graduate Programs and the Success Center include: professional development, scholarly initiatives, travel grants, on-campus help and activities, ombudsman, and international student support.

Support services are designed to help graduate students make the most of their time at UofSC. These organizations, programs and tools provide assistance with graduate student life as well as opportunities for personal growth. All graduate students are encouraged to take advantage of the resources available to them as applicable.

Ombuds

The Graduate School Ombuds serves as a confidential, neutral, informal, and independent resource for graduate students. Read more about the types of services provided by the Graduate School Ombuds.

Opportunities Bulletin Board

The place for events, fellowships, job postings, announcements and learning opportunities for graduate students. We update this page regularly, so check back often!

Professional Development

Landing a professional position in today's market requires more than just completing a degree. We've outlined a list of tools, resources, and professional development programs to help you discover and develop your career potential.

Scholarly Initiatives

Enhance your in-classroom experiences through professional development, pedagogical training and exposure to non-academic settings.

Travel Grants

We offer funding to help our graduate scholars travel to conferences where they will present work on behalf of the university.

Career Center

Explore career options, write your resume, connect with employers for internships and interviews, see a career coach or browse a premiere collection of online career tools.

The Career Center provides comprehensive career related services and programs that are available to all students. Services include individual and small group career counseling, resume critiques, mock interviews, online job and internship postings with on-campus interview

scheduling, and resources to research employers and identify contacts for networking. The Career Center coordinates experiential education opportunities such as job shadowing, internships, and cooperative education. Potential employers are brought to the community via multiple job fairs each year, and workshops on topics ranging from career fair preparation to graduate school are provided. Career planning and related services are critical to student identity and purpose as well as life goal development.

Center for Teaching Excellence

Programming, resources and opportunities that foster innovative and effective pedagogical practices among all who teach at USC.

Fellowships and Scholar Programs

Get advice about application and interview processes for national competitions, coordinate faculty nominations for awards, attend national fellowship workshops, see an advisor one-on-one and ask for feedback about your personal statement.

Search the INFO database (Investigate National Fellowship Opportunities) on the Competitions and Deadlines page to locate national fellowships based on your interests or academic and career goals. The INFO database features graduate and dissertation fellowships, funding for study abroad and postdocs.

Graduate Student Association

Attend workshops designed specifically for graduate and professional students' success in the workplace. Workshop topics include diversity in the workplace and developing soft skills.

International Student Services

Support, advising and programming for international students studying at UofSC.

Off-Campus Housing Services

Students looking for housing options in Columbia can take advantage of an up-to-date database of rental properties near the university.

Postdoctoral Association

A networking and professional group supporting and improving the postdoctoral training experience at UofSC by providing opportunities and resources for networking, professional development, social interaction, research, and teaching.

Produce Delivery On Campus

Healthy Carolina offers healthy eating options including on-campus produce delivery from two locally owned produce companies, Pinckney's Produce and AFRESH!

The mission and purpose of the Healthy Carolina program is to create a campus environment that encourages and promotes the development and maintenance of a healthy body, mind, and spirit through the collaborative development, promotion and assessment of a wide-ranging array of wellness programs and services for all students, faculty and staff at the University. Healthy Carolina will guide the planning and implementation of programs, interventions and policies that support a healthy campus environment to live, learn, work, and play. Healthy behaviors and habits directly support and promote optimal learning and development.

SPARC Graduate Research Grant Program

A merit-based award of up to \$5,000 designed to ignite research and creative excellence across all disciplines at UofSC.

Student Affairs and Academic Support

Student Affairs and Academic Support works with university and higher education partners to create an optimal learning environment that supports students, faculty and staff. Professional development opportunities range from leadership and community service to multicultural programming.

Student Disability Resource Center

Coordinates efforts to ensure that students with disabilities receive reasonable accommodations, and serve as consultants to faculty, staff and campus partners.

Counseling and Psychiatric Services provides psychological counseling, psychiatry, education, and consultation, to the University community, as well as clinical supervision for selected mental health graduates. Our multi-disciplinary team offers services that promote social, emotional, physical, and cognitive well-being for people facing developmental or unplanned challenges.

Student Success Center

The Student Success Center is a comprehensive one-stop-shop for academic support services on campus.

Academic Success programs include course-specific support, assistance with study skills, and early intervention referrals. Course specific support includes supplemental instruction and tutoring, which provide high quality, peer guided, assistance to enhance learning and academic success. Supplemental instruction focuses on introductory courses that are critical to students' academic progression and is delivered by trained peer leaders in a group setting. Tutoring provides support for a wide range of courses and is delivered by trained peer leaders in 1:1, group, and online settings. Assistance with study skills is provided by success consultants who engage with individual students in one-on-one appointments to set goals, explore study and time management strategies, develop action plans, and make referrals to appropriate university resources. The early intervention referral program, Success Connect, facilitates outreach to at-risk students based on faculty referrals or student self-identification. Success consultants meet individually with referred students and assist them in accessing appropriate resources and support.

Sustainable Carolina Workshop

Each year, up to twenty sustainability fellows are selected to participate in Sustainable Carolina's annual "Sustainability Across the Curriculum" workshop. All faculty, staff, and graduate students are eligible to apply for the May workshop.

Writing Center

Develop writing abilities, engage in collaborative learning, and get academic writing resources.

7. PHYSICAL RESOURCES

The College of Engineering and Computing maintains state-of-the-art computer labs and students have 24/7 access to these facilities. The college offers graduate student research support and lab spaces and career services located in the Swearingen Engineering Center. We do not anticipate that significant additional facilities will be needed for this program. The program will share resources with the existing undergraduate IIT program and the MHIT program.

Current classroom, office and graduate student space are adequate to meet the needs for the proposed Ph.D. in Informatics. We have recently added new state-of-the-art computer labs for networking and cyber security and IT usability and interface design. The new program will also capitalize on the college's new Artificial Intelligence Institute as well as the department home in the Bert Storey Innovation Center. Doctoral students also have access to the new Big Data Health Sciences Center and the Science DMZ for Data-Intensive Research.

Offices and Administrative Space

The Integrated Information Technology (IIT) Department offices and administrative space are currently located in the College of Engineering and Computing Innovation Center in downtown Columbia. The building is a public private partnership, and in addition to the IIT Department houses the Computer Science and Engineering Department and several private corporations.

All full-time IIT faculty members, student advisor, and internship director have private offices, each approximately 130-140 square feet. The IIT Department's Administrative Coordinator is located in a large reception area. The office space also includes a large state-of-the-art media conference room, a departmental copier/printer and mail room, and storage facilities. The IIT space includes two networking research laboratories, and a large media equipped shared classroom with a capacity of 55 students. An adjacent building houses graduate students and adjuncts with 22 large modular workstations plus storage space.

Classrooms and Associated Equipment

The majority of CEC courses are taught within the College's two primary academic buildings, the Swearingen Center (SWGNC) and 300 Main Street (300M). The college also exclusively schedules courses in the 1200 Catawba building (CATW) and a classroom in the Horizon Parking Garage (HZPG).



Classrooms in other academic buildings on campus are utilized on an as-needed basis. General purpose classrooms contain computer projectors, document cameras, and either white boards or chalk boards. Instructional computer labs contain Windows workstations for students and a workstation and computer projector for instructors. Distance education classrooms are used for graduate educational programs, are managed by University Technology Services, and include live streaming and lecture capture technologies along with a human producer to assist the instructor. Other rooms approved for instruction include program-specific laboratories and conference rooms that may be used for seminar courses. The capacities of these instructional spaces are shown in Table 7.1.

Table 7-1: CEC Classroom Facilities

General Purpose Classrooms		Instructional Computer Laboratory Classrooms		Other Rooms Approved for Instruction	
Room	Capacity	Room	Capacity	Room	Capacity
SWGN 1C01	330	SWGN 1D11	36	SWGN 1A03	49
SWGN 2A14	66	SWGN 1D15	36	SWGN 1D39	24
SWGN 2A15	30	SWGN 1D29	40	SWGN 2B25	28
SWGN 2A18	28	300M B202	42	SWGN 2D32	20
SWGN 2A19	36	300M B205	36	SWGN 2D36	30
SWGN 2A21	36			SWGN 2D47	42
SWGN 2A22	28			SWGN 3A75	36
SWGN 2A24	25			SWGN 3C02	20
SWGN 2A27	49			SWGN 3D05	28
SWGN 2A31	49	Distance Ed Classrooms		SWGN 3D22	24
300M B101	40	Room	Capacity	300M A018	20
300M B102	40	SWGN 1A20	23	300M A228	25
300M B103	61	SWGN 2A05	28	300M A235	10
300M B110	61	SWGN 2A07	22	300M B002	44
300M B111	39	SWGN 2A11	28	300M C004	10
300M B112	40			300M C217	20
300M B201	78			CATW 105	56
300M B213	78			CATW 214	30
HZPG 210	60				

College Computer Laboratories

The College of Engineering and Computing's Information Technology Services (ITS) department is responsible for managing and maintaining the college's academic labs, active directory and services for faculty and staff, network security, LAN network and infrastructure, VPN servers and services, and the Computer Science and Engineering literacy labs. User account authentication is required for access to the college's computing resources.

The CEC network is comprised of a 10 Gigabit backbone uplinked to the University's network, with a Gigabit connection available to every wall jack. All students, faculty and staff have a 250 megabyte network storage drive for saving files and data, which enables roaming profiles in the college computer lab and file storage. The College provides VPN support to the CEC network.

The College maintains five academic computer instructional labs and two open-access computer labs. Computer labs are open 24/7 to students in this program via ID card swipe access to the engineering and computing buildings. All college lab computers run Windows and are connected to networked printers. The college provides 250 "free" pages of print quota to each engineering and computing student for each semester for the printers in the academic computer labs. Additional pages may be purchased by a student.

Software available for student use and maintained by the college is listed in Table 7-2.

Table 7-2: Student CEC Software

5Spice Analysis	ChemSep	Polymath
7-Zip	Comsol	Pro E Wildfire
Abaqus	Condor v 7.6	Project Pro 2010
ActiveTCL	Cyberlink Power DVD	Robot C for Vex
Adina	Doctor Java	Roxio Creator DE 10.3
Advanced Design System	EasyC2V	Scilab
Agilent ADS	Eclipse	SQL Developer
Ansoft Designer	Foxit Reader X	SSH Secure Shell
Ansoft HFSS	Granola	Symantec Endpoint
Ansoft HFSS RMS	Haskel Platform	Synchro +

Ansoft Q3DExtractor	Java JDK/JRE	Thermodynamics
Ansoft SIWave	Labview	Vex
Ansys	LTSpice	Vex Corver Video Trainer
ArcView GIS	Maple	Vic 2D
AspenTech	MathCAD	Vic 3D
AutoCAD	Mathmatica	Visio Premium
Bentley GeoPAK - Civil	Matlab	Visual Studio Blend
Bentley Microstation	Microsoft Expression Studio	West Point Bridge Designer
Bentley SewerCAD	Mindstorms NXT	WinGamess
Bentley StormCAD	Octave	WinHugs
Bentley WaterCAD	Office Professional 2010	Working Model
Bentley WaterGEMS	OLI (Aspen)	XWIN32
Blender	OpenSees	

University Computing Resources for Students

University Technology Services (UTS) provides centralized and distributed computing services for the campus. UTS academic resources for students include the Blackboard course management system, Self Service Carolina student information and registration system, Microsoft Office 365 email system, and free and reduced priced software including Microsoft, security, and statistics products. All residence halls, buildings and most outdoor common areas of the campus have secure wireless access managed by UTS. UTS also provides a number of non-academic technology services for students, including a dedicated wireless network for gaming and video streaming in all residence halls.

UTS computing resources for students include the Carolina Tech Zone computer support center, and computer labs in Thomas Cooper Library and three residence halls on north, central, and south campus. Collaborative study rooms in the library include technology for up to four laptops to be connected to a large display for group work. UTS labs are open 24/7 to students via ID card access. Printing is available from UTS for a nominal fee at various locations on campus.

Assessment of Computing Resources

As described above, students in this program have access to a variety of computing resources to support their scholarly and professional activities. An indicator of student satisfaction with these resources is included in the course evaluation survey that is administered to students in each CEC course at the end of each semester. This survey includes the question “How satisfied were you with the technology support required in this course?” and a 5-point response scale that ranges from 1 = Very Dissatisfied to 5 = Very Satisfied. Table 7-3 reports the average response from all courses with the program course

designator, and the average responses from all courses with any of the college’s course designators (BMEN, CSCE, ECHE, ECIV, ELCT, EMCH, ENCP, and ITEC). The overall ratings of technology support (shown in Table 7-3) are consistently at or above the rating of 4, indicating that overall students are satisfied with technology support.

Table 7-3: Student Satisfaction with Technology Support per Course

Average student responses to “How satisfied were you with the technology support required in this course?”				
Scale 1=Very Dissatisfied to 5 = Very Satisfied.				
	Spring 2015	Fall 2015	Spring 2016	Fall 2016
All CEC	4.2	4.2	4.2	4.2
BMEN	4.1	4.0	4.2	4.1
CSCE	4.3	4.1	4.3	4.2
ECHE	4.3	4.3	4.3	4.4
ECIV	4.0	4.0	4.1	4.1
ELCT	4.3	4.2	4.2	4.0
ITEC	4.3	4.1	4.3	4.2

The Human-Computer Interaction & UX Research Lab – PI Dr. Dezhi Wu

The Human-Computer Interaction & UX Research Lab at USC has 60 square feet lab space for conducting HCI/UX design and evaluation research projects in interdisciplinary health IT and security fields, along with quantitative and qualitative analyses. This lab is currently hosting several of her graduate students working on multiple AI-based healthcare and security UI/UX design projects. One Precision 3630 Tower Dell computer, three Dell Inc. OptiPlex desktop computers, Android smartphone together with several newly equipped usability equipment, software, and biosensors including a Tobii Nano Eye Tracker, GSR and Facial Expression Reader are available in this lab to support her research projects.

This lab is co-located with another newly established Cyber Infrastructure Lab sponsored by NSF for high-speed networks, big data analytics and network security research projects at UofSC, This lab is hosting multiple doctoral students for Dr. Jorge Crichigno’s multiple cybersecurity and cyber infrastructure projects sponsored by NSF.

Plans are to expand the lab space for future PhD program growth especially to have space for our doctoral students to work on their research. The expansion is planned as part of the Phase II construction of the new AI Institute.

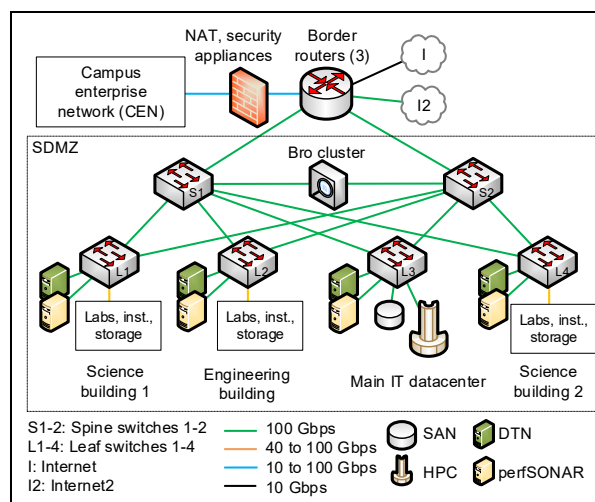
Science Demilitarized Zone (Science DMZ): A Production High-speed Research Network

The Department of Integrated Information Technology (IIT) is leading this effort on behalf of the University of South Carolina. It is establishing a new network, namely a Science DMZ, operating at 100 Gbps, which is connected to national backbone networks such as Internet2. The Science DMZ supports current Master and PhD research in cyberinfrastructure. At the same time, it is used to move terabyte-scale data between UofSC and national laboratories (e.g., Argonne, Fermi, Oak Ridge, Savannah River, Los Alamos), university collaborators, and the national network of supercomputer centers (XSEDE). The project serves the national interest, as it addresses the need to connect UofSC to the national "cyber-highway" system to share big science data, hence promoting collaboration and national competitiveness, aligned with NSF's mission. The new cyberinfrastructure also permits researchers to exchange large datasets with collaborators geographically distributed across the world. Examples include nuclear physics results from the Paul Scherrer Institute in Switzerland and observation files from the Cryogenic Underground Observatory for Rare Events (CUORE) in Italy. The network consists of state-of-the-art 100 Gbps switches (5), purpose-built high-speed servers (10), and intrusion detection systems (1). The network spans across UofSC campus in Columbia.

The project team has also made agreements with Barefoot Networks, an Intel Company, to use its technology for PhD research projects (programmable switches). The Science DMZ is part of the following NSF Project:

- NSF Program: Campus Cyberinfrastructure
- Project Title: Building a Science DMZ for Data-intensive Research and Computation at the University of South Carolina
- Start – End dates: July 1 2019 – June 30 2021
- Amount: \$ 498,525.00
- URL: <https://tinyurl.com/yxuxejbf>

The figure below provides an overview of the current Science DMZ. Equipment is controlled from the Innovation Center Building room 1500B (dedicated to Master and PhD students).



Overview of Current Science DMZ.

Testbed for Networks and Cybersecurity

The Department of Integrated Information Technology has recently inaugurated the Networks and Cybersecurity Lab, located in Innovation Center room 1500A. The lab consists of 22 workstations connected to four racks of equipment (the testbed) containing 30 routers Cisco 4221 and 30 switches Cisco 2960. The testbed is completely isolated from the campus networks and permits the experimentation and development of new routing protocols and cybersecurity techniques. The lab was partially supported by the following NSF project:

- NSF Program: Division of Graduate Education (DGE)
- Project Title: Capacity Building: Building a Cybersecurity Pipeline through Experiential Virtual Labs and Workforce Alliances
- January 15, 2018 - August 31, 2021
- Amount: \$ 420,377.00
- URL: <https://tinyurl.com/y6hukfbz>

The figure below shows the Testbed for Networks and Cybersecurity (see back of the room, four racks with routers and switches). The 22 workstations are connected to the equipment.

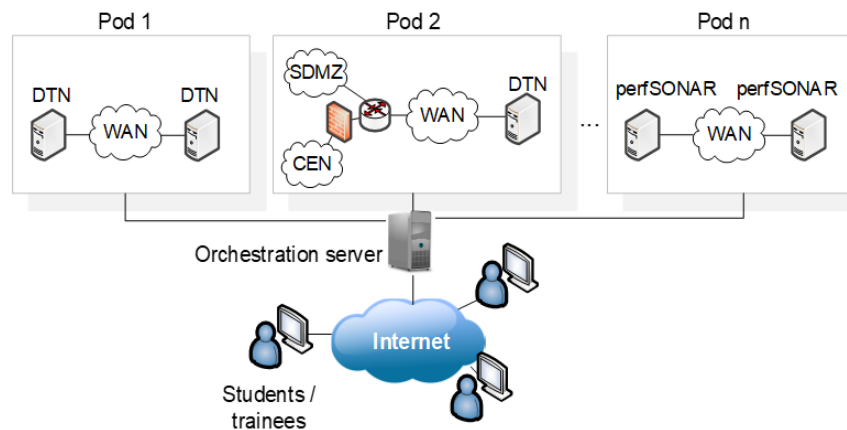


Private Cloud and Virtual Laboratory

The Department of Integrated Information Technology has recently deployed a private cloud that is serving several purposes: graduate research, undergraduate research, and teaching. The private cloud serves as a framework where virtual laboratories for different areas of IT are deployed, such as cloud computing, computer networks, databases, cybersecurity, web systems, and others. The platform supports remote-access capability (REC) to virtual lab equipment from the Internet and can serve more than 100 students / researchers conducting research simultaneously.

The private cloud has several advantages: complex systems and networks of hundreds of nodes can be deployed in a few seconds; virtual testbeds are capable of recreating realistic scenarios in software; real protocol stacks are used; researchers can experiment with a real cloud system and at the same time manipulate resource parameters such as storage, CPU, and memory. Manipulating these resources at a very granular level is typically not possible in a public cloud. The Department of Integrated Information Technology has reached an agreement with the following technology companies, which are providing professionals tools: VMware, Cisco Systems, Palo Alto Networks, and Intel.

The figure below shows the setup. Once students have entered the virtual environment through a portal, the virtual equipment is deployed via an orchestration server and ready to use without the need for any configuration or package installation. Detailed laboratory manuals are also available to guide students and researchers during their experiments. Note that this laboratory environment is transparent, and each experiment uses the reserved equipment pod. A pod is a set of virtual appliances used to complete a laboratory experiment.



The private cloud relies on physical servers. The physical resources can be classified into compute capability (CPU cores), storage (non-volatile memory), and RAM memory. The table below summarizes these resources, which are located in the College of Engineering and Computing Datacenter and are available 24/7.

Device	Cores	Storage (TBs)	RAM (GB)	Notes
Server 1 (management server)	20	4.8	128	Hosts orchestration server
Server 2 (hosting vLabs pods)	32	4.8	512	Hosts pods' virtual machines
Server 3 (hosting vLabs pods)	32	1.92	768	Hosts pods' virtual machines
Server 4 (hosting vLabs pods)	32	1.92	768	Hosts pods' virtual machines
Total	116	8.08	2,176	

The private cloud is being developed and supported by the following NSF awards:

- NSF Program: Cybertraining - Office of Advanced Cyberinfrastructure
- Project Title: Cyberinfrastructure Expertise on High-throughput Networks for Big Science Data Transfers
- Start – End dates: October 1 2018 – September 30 2021
- Amount: \$ 499,959.00
- URL: <https://tinyurl.com/y4f3h2kc>

- NSF Program: Advanced Technological Education
- Project Title: Multi-state Community College, University and Industry Collaboration to Prepare Learners for 21st Century Information Technology Jobs
- Start – End dates: July 1 2019 – June 30 2022
- Amount: \$ 299,975.00
- <https://tinyurl.com/yy2yyok8>

8. FINANCIAL SUPPORT

See Appendix H for detailed a budget table.

Budget

Year 1. In the revenue projections, year 1 starts with tuition revenue based on five students taking the projected number of credit hours at \$568.75 per credit hour. Program specific fees are \$75 per credit hour, which are the same as the fees currently charged for our Master of Health Information Technology program. The reallocation of existing funds based on a new faculty line from among the faculty enhancement positions currently being recruited in the College of Engineering and Computing.

Administration and salaries in year 1 include \$50,000 in salary and fringe benefits for a full-time administrative coordinator for the graduate program and \$150,000 for a new junior faculty member. Facilities and equipment include \$4,000 in startup funds for the program, mainly for program promotional materials, and \$1,000 for each student for computer resources and office supplies.

Year 2. Tuition revenue in year 2 reflects the addition of three new students and the continuation of the students from the previous year at the same rate per credit hour. Program specific fees are based on the \$75 per credit hour fee.

Administration and salaries in year 2 includes the continuation of the faculty member and the administrative coordinator. Facilities and equipment include \$10,000 for program promotion and operation and \$1,000 per student.

Year 3. Tuition revenue in year 3 reflects the entrance of four new students and the continuation of the students from years 1 and 2. Fee revenue is calculated as in the previous years. On the cost side for year 3, new costs are \$10,000 for program promotion and \$1,000 per student.

Year 4. Tuition revenue in year 4 is based on the addition of four new students and the graduation of three students at the same rate per credit hour as in previous years. Reallocation of funds is the same as in year 3. The estimated costs are on the same basis as in year 3.

Year 5. Tuition revenue in year 5 is based on the addition of five new students and the graduation of three students at the same rate per credit hour as in previous years. Costs are the same as in year 4 and reflect the net gain of one new student.

As new faculty members arrive and existing faculty members expand their research programs, their facility requirements will be funded through external grants and start-up funds.

Contingency Planning

Most resources for the PhD program are already in place. Enrollment projections are very conservative based on anticipated demand. Potential areas of risk are the expansion of the The Human-Computer Interaction & UX Research Lab and the anticipated tenure track faculty hire with joint appointment in the AI Institute. In both of these cases, we already have sufficient resources for delivery of planned courses in these content areas. However, without the additional resources, we may need to limit the number of graduate students researching in these areas and the facilities available to them may not be as robust as desired. It may also reduce our capabilities to expand faculty-funded research in these two areas. The other resource at risk would be the requested full-time administrative support. The failure to

fill this position would put an added burden of administrative work on the graduate program director and department chair. Some of that may be mitigated by making some adjustments in the responsibilities in the student advisor position and the internship director position.

9. DESCRIPTION OF INSTITUTIONAL EVALUATION AND ASSESSMENT PROCESSES FOR THE CHANGE

The program will be assessed through the standard University of South Carolina assessment software system, which reports results on all the program objectives. Student learning outcomes are assessed each year. The results of the assessment are discussed in a meeting of program faculty, with any necessary modifications proposed for the next assessment cycle. An alumni placement database tracks the employment of graduates. Finally, an industry advisory board provides assessment input to the faculty. Assessment data is used to make academic changes to the program.

University Required Annual Program Review Process

For the purposes of improving student learning, all colleges and schools at USC are required to provide data demonstrating ongoing and systematic assessment of academic degree programs. Specifically, all degree programs must submit an annual assessment report and plan, while academic deans must submit an executive summary. The process is managed by the Office of the Provost through the University's electronic "Assessment Plan Composer" system.

Each degree program must compile an assessment report (no more than six pages) presenting data pertaining to the program's strengths and weaknesses garnered each year from the academic assessment activities and describing how these assessment results are being used to improve the program and ultimately student learning. Additionally, each program must compile an assessment plan for the upcoming academic year. All assessment reports and plans must be submitted electronically through the Assessment Plan Composer by the first week of June each year.

The assessment process is also supported by an Assessment Toolbox for additional guidance in writing the assessment report and plan. This Assessment Toolbox provides detailed instructions and examples, and a sample assessment document, among many other resources. The University also provides periodic training sessions on assessment.

Academic deans must submit a signed one- to two-page executive summary of the major results of the college's program assessment, use of results, and the budgetary effects of the major assessment results.

The annual assessment plan and report include the following components:

- **Program Mission Statement**
- **Goal** statements that provide more detailed discussion of the general aims of the program that support the mission (These *goals* are equivalent to ABET's *Program Objectives*).
- **Learning Outcomes** that describe the measurable skills, abilities, knowledge, or values that students should be able to do or demonstrate upon completion of the academic program. Learning outcomes should be SMART: Specific, Measurable, Agreed upon, Realistic, and Time-framed.
- Curriculum Mapping is not included in the plan, but it is recommended to demonstrate where the program curriculum learning outcomes are being addressed.
- **Measures and Criteria** – description of the measures that will be used to determine the extent to which a learning outcome is achieved and define the level of performance that must be met in order for the learning outcome to be considered achieved. (Use of rubrics is strongly recommended.)
- **Methods section** describes how and when each learning outcome will be assessed.

- **Results Section** must present the findings from the data that have been collected and analyzed in a simple, easily understood format. The result section should accurately depict the findings relevant to each learning outcome at the program level. It is intended to include the following:
 - Number of students included in the data collection for each measure.
 - Data relating to aggregate performance
 - Faculty interpretation of the data and results
 - Whether criteria were met and whether the learning outcome was achieved
 - Brief description of common strengths and weaknesses among students with regard to each measure and learning outcome.

- **Use of Results** section explains the actions taken based on the assessment results and assists in documenting changes and the reasons for the changes.
 - Link the changes to the assessment result
 - Evaluate and make changes to improve assessment measures and methods, if needed.
 - The changes proposed need not be completed by the time the Assessment Report is submitted, but there should be a concrete plan to address the issues identified with a timetable and persons responsible.

The University of South Carolina requires comprehensive periodic review of all degree-granting academic programs (ACAF 2.00 *Creation and Revision of Academic Programs*) as an essential part of ongoing strategic planning. Any degree program that is not evaluated by a professional accrediting agency must be reviewed by a team that includes a total of at least three (3) members which includes peer faculty members external to the university.

The external program review is a mechanism by which an academic unit may benefit from the assessment and advice of disciplinary peers and reflect on how the program aligns with other programs of its type and/or how well the program prepares students for success after graduation. This evaluation extends beyond the assessment of student learning in the biennial academic program assessment reports. While the primary focus of the self-study is the academic program and its students, information about the program faculty complement and other program resources and initiatives to support the program is a critical component of any evaluation. For those programs not undergoing a professional program accreditation, external reviews, conducted at least every seven (7) years are necessary. This policy sets forth the process to be used to conduct periodic external reviews of academic programs. Because unit policies, resources and characteristics have direct impact on the academic programs, such unit components are also considered in the review. Costs of the review are the responsibility of the unit or college/school housing the academic program.

(See ACAF 2.20 *Academic Program Review* for detailed review procedures.)