

Proposal for a New Undergraduate Degree Program

Bachelor of Science in Interdisciplinary Computing

Department of Electrical Engineering and Computer Science

School of Engineering

The University of Kansas

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BASIC PROGRAM INFORMATION

Proposing institution: The University of Kansas

Title of proposed program: Interdisciplinary Computing

Degree to be offered: Bachelor of Science in Interdisciplinary Computing

Anticipated date of implementation: Fall 2011

Responsible department: Electrical Engineering and Computer Science

Point of Contact: Professor Arvin Agah (email: agah@ku.edu Phone: 785-864-8821)

CIP code: 11.0101

EXECUTIVE SUMMARY

The Electrical Engineering and Computer Science Department of the University of Kansas is proposing a new Bachelor of Science program in Interdisciplinary Computing (BS IC). The proposed BS IC program transcends traditional academic boundaries, allowing students to study computing within the context of other disciplines. A deep-rooted understanding of biology, geography, arts, or other disciplines, enables future graduates to more efficiently and economically develop new applications and technologies for their field of specialization. By providing a “big picture” view of complex problems, the program will further enhance students’ critical thinking skills and their ability to collaborate with those from different professions. A BS IC degree will better prepare the students to fill an urgent industry need—fluency in Computer Science and another discipline [43]. Since the program incorporates existing classes, no new faculty positions or resources will be needed. The proposed program will be offered in parallel with the existing Computer Science program.

Computer Science programs must prepare students for a competitive and dynamic job market [73]. In order for the students to be prepared to live in the “knowledge society,” the computing disciplines must be integrated with other fields [89]. Interdisciplinary computer scientists can assist other disciplines to solve problems and address challenges, further increasing the importance of applied computer scientists [36].

U.S. Bureau of Labor projects that computer scientists and database administrators will be among the fastest growing occupations in the next decade [108]; and therefore, the need for undergraduate enrollment in computer science is important. The National Science Foundation and other organizations concerned with computer science education have recommended an interdisciplinary approach to energize the talented students’ interest in this important field [66]. Their research indicates that most computer science majors are not only interested in the study of computers, but also hope to use them as effective and productive tools to address societal issues [7]. This has sparked a burgeoning national trend in interdisciplinary computing programs to attract outstanding students interested in cutting-edge disciplines and in exploring various subjects. The proposed BS IC proposal reflects such an approach.

Elite universities, such as Carnegie Mellon and Virginia, have degree programs integrating computing and arts. The Electrical Engineering and Computer Science Department (EECS) at the University of Kansas (KU) aims to become the first Kansas Regents University to offer a degree in interdisciplinary computing. Initially, the program will include five areas of specialization, namely, Astronomy, Chemistry, Biology, Geography, and Physics. Additional focus areas in science, engineering, humanities, arts, etc., can be added, as other disciplines are integrated into the program. The proposed BS IC program follows KU faculty and staff recommendations for increased interdisciplinary education and research within the University’s latest strategic plan, *Initiative 2015* [95]. BS IC will allow KU EECS to attract the best and brightest students who will provide a workforce for the future [35]. Kansas Department of Labor [49] includes Computer Software Engineers–Applications and Computer Software Engineers–Systems Software as two of the 10 fastest growing occupations in the 2006-2016 Kansas Occupational Outlook [52]. These are the types of positions which will be sought by future graduates of the proposed BS IC program.

“As the need for informatics continues to grow throughout the health care, biomedical, and business industries, so does the need to provide educational opportunities that prepare students for a specific area of informatics study” [78]. This is the mission of the proposed BS IC program.

PROGRAM PROPOSAL NARRATIVE

The main objective of the proposed Bachelor of Science in Interdisciplinary Computing (BS IC) program is to provide students with the opportunity to study computing within the context of another discipline. “An interdisciplinary field or multidisciplinary field is a field of study that crosses traditional boundaries between academic disciplines or schools of thought, as new needs and professions have emerged...cutting across disciplines and forming a new method for understanding the subject” [113]. Interdisciplinary studies are becoming increasingly popular in academic institutions, because we live in an information-rich world with complex problems that cross disciplines of science, engineering, business, humanities, arts, and social sciences [74]. Graduates who have pursued interdisciplinary studies can effectively address such complex problems. The BS IC degree will expand the boundaries of computing through interdisciplinary collaboration, as many important scientific challenges can be addressed by interdisciplinary computing [75][76].

Computing can be considered to be at the center of the action in many sciences, and it can be considered a universal science [3]. It is argued that the computation revolution is here now and that computation is a fundamental process in many areas. This revolution is stimulating curriculum innovation and can attract bright students into the field [24]. Computer Science educators are encouraged to identify emerging areas and adjust their curriculum accordingly, “As a discipline that borders on many other disciplines such as engineering, mathematics, physics, and psychology, and more recently, as a science that can be applied to many fields such as biology, entertainment, commerce, and communication, Computer Science continues to reinvent itself every 5-7 years” [22].

The need for interdisciplinary programs has been echoed in the computer science education community. Computer Science should provide courses that are considered valuable by students in other disciplines [68]. It is stated that the role of computer scientists should be emphasized as partners of other professionals, and that students in computer science should select a field of study and specialize in computing for that discipline [40], i.e., the degree in computer science should provide an interdisciplinary foundation [2]. Many students who take computer science courses are not interested in the study of computers as an end in themselves, instead the students want to use the computers as tools to address other issues [7]. Computer science should be developed as an academic service discipline with established significance for other disciplines, in addition to its traditional role [73], especially now that there is willingness and ability to address interdisciplinary issues [25]. It is argued that many universities are not providing students with the needed computing education for them to be productive in their fields of study [18], and that interdisciplinary computing is an academic need that is recognized by many students [2]. In non-computer science programs where computing courses are included in the curricula, students may not learn enough about computer science to be considered computer scientists [118]. The proposed BS IC degree will directly address these issues.

More and more interdisciplinary approaches are being proposed to capture the interconnectedness of knowledge for undergraduate educations that prepare students to solve important problems with real world relevance [37], ranging from computer science options in bioinformatics [26] to forensic accounting courses [38]. Computer science educators should design interdisciplinary curricula so that students can apply their computing knowledge to an

application area [118]. “Local interdisciplinary cooperation will permit development of technical, methodological departments that provide support to the relevant disciplines while, at the same time, retaining a specialized computational research program” [9].

In order to develop and advance an interdisciplinary computing education, an integration of curricula in computer science with the natural sciences and business is needed [4]. The curricula in computer science should emphasize interactions between computer science and other disciplines [88]. A number of academic institutions are developing interdisciplinary programs across historically successful scientific disciplines [46]. A number of agencies and organizations concerned with the direction of engineering education have recommended a shift from disciplinary to interdisciplinary approaches, a direction embraced by the curriculum at Olin [28]. The Committee on Frontiers at the Interface of Computing and Biology for the National Research Council has reported that biology will use computer science as a language and a medium to study biological systems [72]. Other studies on interdisciplinary and multidisciplinary approaches to undergraduate educational programs in Computer Science include [45][55][57][60][61][70][114][117].

The National Science Foundation has also recognized the need for enhancing Computer Science education nationwide. The Directorate for Computer and Information Science and Engineering at the National Science Foundation has two complementary programs addressing its educational goals: Pathways to Revitalized Undergraduate Computing Education (CPATH) and Broadening Participation in Computing (BPC). Together these programs aim to reconfigure undergraduate computing education and to increase the number of computing degrees for underrepresented groups, with the vision that a diverse workforce can benefit the computing field [115]. Along these lines, the BS IC degree will enable the EECS Department at KU to enhance its Computer Science education.

The proposed degree is in response to a national need for graduates who can effectively integrate computing with other disciplines to address the challenges within those disciplines. The proposed program will utilize the existing faculty, staff, and resources in the EECS Department in order to provide future students with the opportunity to pursue an undergraduate degree in Interdisciplinary Computing. The BS IC program will offer five areas of specialization, namely, Astronomy, Chemistry, Biology, Geography, and Physics. Additional areas can be added, as other disciplines are integrated into the BS IC program.

(A) Program Need and Student Characteristics

(1) Central to the Mission of the Institution

The proposed BS IC degree is central to the mission of the University of Kansas, which is “committed to offering the highest quality undergraduate, professional and graduate programs, comparable to the best obtainable anywhere in the nation” [96]. The mission of the University of Kansas encompasses teaching, research, and service. KU strives to offer the highest quality programs that prepare our students for a complex global community. BS IC students will explore a broader curriculum that will develop their understanding of the interconnectedness of challenges and enhance their critical thinking skills.

The proposed degree is also central to the mission of the Electrical Engineering and Computer Science (EECS) Department, which is to “educate the next generation of electrical engineers, computer engineers, and computer scientists, to advance the state of knowledge through research, to strive to promote economic development for the state, and to engage in service to the public and the profession” [94].

KU understands the importance of an educated workforce and how it fosters innovation and increases productivity. More than 142,000 KU graduates currently live in Kansas and form the backbone of the Kansas economy. EECS graduates helped Kansas secure the nation’s fastest rate gain of high-tech employment in 2007. The Kansas high-tech industry paid out \$4.2 billion in payroll that year, with average tech industry wages that were 91% higher than the state's average private sector wage [83].

The University places a high value on the recruiting and retention of female students and students from underrepresented groups. These will also be of critical importance to the BS IC. Research has shown minorities and women choose areas such as law and medicine that have strong social relevance [3]. BS IC directly addresses the issue of social relevance by allowing students to specialize within another discipline of their choosing. Students learn the relevant computing techniques in their computer science courses while learning about their discipline in courses that they take in their respective departments. This integration of knowledge prepares the students to effectively tackle problems with real world relevance.

During the spring of 2008, KU faculty and staff created *Initiative 2015*, a strategic plan for the University [95]. The task force recommended developing more multidisciplinary education and research programs. The plan advocated for major efforts to promote collaborative interdisciplinary research and creative activities involving KU faculty and students. Increased collaborations within and between KU’s campuses, with industry partners, and with other institutions around the world were encouraged. The objective of the BS IC degree is to meet some of the goals of that strategic plan.

(2) Student Demand for the Program

Computer science departments are experiencing increased interest in interdisciplinary programs such as computational biology or interactive media [28]. The objective of the proposed BS IC program is to meet such demands for high quality interdisciplinary programs that offer students the opportunity to combine an interest in computer science with a disciplinary context within which they can apply such knowledge. A lack of relevance is reported to be a significant factor for students who had an initial intention and the ability to major in a science field but instead switched to nonscientific fields [118].

The proposed BS IC program will address students' expressed need for computer science programs that are relevant to their lives and personal interests [75]. The BS IC program will provide students with an opportunity to pursue a computing degree with social relevance. Future graduates of the BS IC program will have opportunities to pursue careers that apply computer science expertise in professional fields of interest to them.

A number of studies have shown that students are attracted to information technology courses that are more contextual [82]. It is reported that the number one reason for female students and the number three reason for male students pursuit of computer science is the desire to use computing in another field [17]. Nationwide, women account for 51% of the undergraduate degrees in science, but only 12% in Computer Science and Computer Engineering [115]. Other studies have also shown that the context of computing is often important for many women students. Women more often than men link their interest in Computer Science to other arenas such as medicine, art, or space exploration. Carnegie Mellon University has introduced interdisciplinary courses that bring students of diverse backgrounds together to work on multifaceted problems. They have reported a significant increase in the number of women entering Computer Science, from 7% in 1995 to 42% in 2000 [31]. These educational efforts indicate the importance of the proposed BS IC program at KU, in order to increase the number of women and minorities in the EECS Department, in parallel with increasing the overall number of students in the Department.

The BS IC will utilize the existing programs in the School of Engineering to recruit and retain female students and students from underrepresented groups. Although participation by all students is encouraged in these programs, additional focus is given to junior high and high schools which have large populations of underrepresented groups. Recruitment programs organized by the Diversity and Women's Programs at the School of Engineering include:

- Project Discovery: An engineering summer camp for female high school students (9th to 12th grade), enabling the students to choose an engineering or computer science discipline, and to use the labs and work with faculty.
- Eureka Weekend: A day of discovery for students (6th to 8th grade), providing a hands-on opportunity to discover engineering and computer science.
- Engineer Your Career: A half-day program for female junior high and high school students to learn about engineering and computer science, and to meet KU women engineering students.

- Engineering Expo: A free two-day event that lets student visitors (5th to 12th) explore the fields of engineering and computer science, using numerous engineering demonstrations. Students from throughout the state and the Kansas City metropolitan area attend this event.
- Engineering Senior Day: A one-day event focusing on admissions, scholarships, and degree programs for the School of Engineering.
- Exponent: A two-day interactive camp for high school juniors and seniors to be exposed to the career potential of engineering and computer science.
- Society of Women Engineers Weekend of Engineering: An opportunity for female high school students to experience the KU campus, with a focus on engineering and computer science activities and information.

In terms of efforts to retain female students and students from underrepresented groups, the student chapters of professional organizations are excellent resources for engaging the students, retaining them, and providing them with support. These organizations at KU include:

- Society of Women Engineers (SWE)
- Engineering Student Council (ESC)
- Tau Beta Pi national engineering honor society
- National Society of Black Engineers (NSBE)
- Society of Hispanic Professional Engineers (SHPE)

The proposed BS IC program will enable the EECS Department to offer bright students an interdisciplinary program. Researchers in education have identified four reasons as to why interdisciplinary programs attract strong students: (1) leading edge of science crosses boundaries; (2) students in interdisciplinary programs are well prepared and strong; (3) such programs offer interesting selections of courses; and (4) strong students' interest in exploring several areas [11]. Computer Science may attract highly qualified students by providing interdisciplinary programs with other departments, such as mathematics, sciences, economics, or art [69].

The Integrative Computing Education and Research (ICER) Initiative within the Computing and Information Science and Engineering (CISE) Directorate at the National Science Foundation (NSF) has organized regional workshops to develop strategies to maintain the computing workforce for the nation's economic, cultural, and democratic vitality. Strategic initiatives include "Strengthen[ing] interdisciplinary connections by offering courses for students in other disciplines, encouraging collaborative activities across disciplines for faculty, and developing and distributing interdisciplinary curricula" [21]. The proposed BS IC program is in direct response to the findings of the National Science Foundation.

In addition to the trends, nationally and statewide, the faculty in the department have received multiple inquiries from prospective students about the program; and many who have expressed interest in the proposed degree. This demand before the program begins has greatly encouraged the department to propose the BS IC degree. Based on the current enrollments and the size of incoming freshmen in our department, we anticipate about 10 new students joining the program each year, totaling about 30 students by the third year of the program.

In terms of employment prospects, the job prospects and the occupational outlook for graduates of the proposed program is good in the state of Kansas. Kansas Department of Labor [49] includes Computer Software Engineers–Applications and Computer Software Engineers–Systems Software as two of the 10 fastest growing occupations in the 2006-2016 Kansas Occupational Outlook [52]. These types of outlooks will have a significant impact on the demand for graduates of the proposed program, which in turn will positively influence the student demand for the program.

(3) Demand for Graduates of the Program

The graduates of the proposed BS IC program will be able to pursue careers in a wide range of fields in the industry, government, and academics. Science industries, business, government, and military sectors are making it a priority to hire people with expertise in computing [77]. Industry has identified interdisciplinary computing as an important need [2], and that “hybrid careers that combine computing with other fields will increasingly be the new American jobs of the future” [59]. Universities are now holding meetings where computer science professionals in interdisciplinary roles discuss their careers and views on the potential of interdisciplinary computer science in industry and government, such as the Annual Computer Science Day at the University of Pittsburgh [102]. Companies such as Google, YouTube, and Facebook seek individuals with interdisciplinary expertise in visual arts, communication, and computing [81].

Numerous reports indicate the excellent career prospects for future BS IC graduates. In the *Occupational Outlook Handbook, 2008-09*, produced by the Office of Occupational Statistics and Employment Projections at the U.S. Bureau of Labor Statistics, computer scientists and database administrators are projected to be among the fastest growing occupations over the next 10 years [108]. The handbook states that changing technology necessitates an increased level of skill and education, and employers seek professionals with a broader background and range of skills. For instance, computing professionals working for a bank should have expertise in finance, and computing professionals in a hospital should be knowledgeable of health management. These are exactly the types of individuals envisioned to be graduates of the proposed BS IC program.

According to the *Job Outlook 2009* report by the National Association of Colleges and Employers, bachelor degrees most in demand include computer science and information sciences and systems [65]. Despite the reduced overall job market outlook for college graduates, computer science graduates will have better opportunities than most, according to the IEEE Computer Society [41]. In terms of occupations with large projected growth in employment in 2006-2016, number one is network systems and data communications analysis (over 50%) and number four is computer software engineers, applications (over 40%) [10]. Additionally, jobs involving interdisciplinary computing have made a number of Top Lists recently. Careercast.com lists Software Engineer as number five and Computer Systems Analyst as number six on its *10 Best Jobs to Get List* [15].

On the *Top 20 Highest-Paying Careers List*, compiled by Careerbuilder.com, systems and programming managers and lead computer programmers made the cut [14]. Computerworld’s list of the *Nine Hottest Skills* ranks business intelligence, which includes expertise in data mining, data warehousing, and data management, at number five [20]. While certain skills, such as programming, can be targeted for outsourcing, companies want software developers in-house. This requires software developers who are experts in the domain of interest to the company [20]. Software Engineering grabbed the top spot in the Money Magazine and Salary.com survey of jobs in 2006, which considered the growth, pay, stress-levels and other factors of careers [63]. CareerBuilder.com determined the 10 most promising jobs for the class of 2009. Database administrators, network systems and data communications analysts all made the list [13]. All these are qualifying careers for graduates of the proposed BS IC program.

It is reported that relatively few computer scientists practice the traditional roles (programming-coding) with most applying their computing skills to advance business, scientific, or policy goals [74]. There has been a shift in jobs, with an increase in interdisciplinary work (25.4% fewer programmers, 25% more software engineers, and 70% more network systems and data communications analysts) [75]. The National Academy of Engineering reports that the service sector, which is the primary user of information technology, accounts for more than 80% of the U.S. gross domestic product [80]. Career opportunities in interdisciplinary computing are also evident by the number of computer science graduates who are working in other sectors. In a study of computer science majors a decade after graduation, researchers found that 1992-93 graduates were employed in education, health care, manufacturing, finance, insurance, real estate, retail and wholesale trade, utilities, communications, transportation, personal/hospitality services, entertainment/recreation, business services, public safety and administration, agriculture, mining, oil, and construction [110]. This wide range of industry sectors is indicative of the broad and diverse set of disciplines within which the BS IC students can seek employment.

BS IC graduates could pursue careers in pharmaceutical, biotechnology, bioinformatics, chem-informatics, geo-informatics, and other data intensive industries [25]. As other examples of career possibilities, the employment prospects in biomedical informatics are inviting, with unprecedented growth for this interdisciplinary domain [46]. There is growing dependence of health care delivery and life-sciences research on computer and information technology. The proposed massive effort to modernize health care by making records standardized and electronic within five years would present unprecedented growth within health informatics, which requires interdisciplinary computer scientists [46]. Computer science can transform a wide range of scientific, business, and artistic professions, making sciences fundamental and practical [64]. The BS IC graduates will be able to be part of that transformation, and they can have opportunities in areas such as medicine, health, law enforcement, and entertainment [9]. Similar to biology and other physical sciences, computer science can provide the opportunity for a rewarding career that helps humanity [64].

On a more global perspective, offering programs in emerging interdisciplinary computing areas can make the difference in an increasingly global job market [22], and in order to be globally competitive, students need broad computing education and expertise in context for working in multidisciplinary settings [33], as will be offered by the BS IC program. “Computing has permeated and transformed almost all aspects of modern life. As computing becomes more important in all sectors of society, so does the preparation of a globally competitive U.S. workforce able to apply core computing concepts, methods, technologies, and tools ... to a broad range of societal challenges and opportunities” [66]. The proposed degree’s focus on context is crucial. It is argued that if students are taught decontextualized skills, they cannot compete globally for jobs [33]. As an example, Britain’s Natural Environment Research Council advocates interdisciplinary approaches to environmental sciences including mathematical, computational, and statistical skills [76].

In addition to pursuing careers in industry, BS IC graduates will have the option to continue in suitable graduate programs in interdisciplinary computing, with examples including: Clarkson University [19], Georgia Tech [34], Indiana University [42], Mills College [62], University of North Texas [100], Rhode Island [103], and University of Vermont [106]. Future graduates with interest in academic positions can pursue Ph.D. degrees.

In addition to the national trends and outlooks establishing the demand for the future graduates of the proposed BS IC program, The state of Kansas Department of Labor [49] has also predicted the demand at the state level. In terms of statewide total occupational employment, the Computer and Mathematical Occupations are expected to increase by 26% from 2006 to 2016 [51]. Among the Statewide Top Ten Occupations with the highest percentage change, two are Computer Software Engineers–Applications (44%) and Computer Software Engineers–Systems Software (35%) [51], the types of positions for which are very suitable for the graduates of the BS IC program. In comparison, in terms of industry projections, the total employment in Kansas is projected to increase by 1.1% per year on average from 2006 to 2016, while the Information industry is projected to grow by 2.3% per year on average [50].

The software and information technologies companies in Kansas are supported by the Software and Information Technology Association of Kansas (SITAKS) [79], which is a corporate membership group. The companies and organizations which are members of SITAKS will be potential employers of the future graduates of the program. Among the over 3,000 companies which are supported by SITKAS, are the founding industry council members: Perceptive Software, Garmin International, Rush Tracking, ThinkGEO, Great Plains Regional Command, Freightquote, LSI, U Incorporated, Chemidex, Kansas State, Wichita State, Enterprise Center of Johnson County, University of Kansas, Netchemia, Horizon Analog, Wichita Technology Corporation, Triple I, Alexander Open Systems, Digital Evolution and SKT [79].

(4) Locational and Comparative Advantages of the Program

By leveraging existing resources and talent, we propose offering a BS IC program at KU that would benefit Kansas; currently, none of the Kansas Regents Universities offers a degree in interdisciplinary computing [29][32][53][71][112].

Doing so would support a national trend toward interdisciplinary computing evidenced by the following examples at Kansas State University and other Big 12 Universities [5][44][67][85][86][92][97][99][101][104]:

- The Department of Computing and Information Sciences at Kansas State University offers the opportunity for the students in computing to use their electives to obtain a minor in another department [54]. This option is also available at KU; however, this does not allow students to major in interdisciplinary computing, building expertise in two fields.
- The Department of Computer Science at the University of Missouri offers a Bachelor of Science in Information Technology, launched in 2005 with an industry gift. The bachelor's in IT has two focus areas: (1) Technologies and Information Systems and (2) Media/Entertainment [98]. It is reported that by the second year there were over 110 students in the program, mostly in the media track. This illustrates the potentials of such interdisciplinary degrees. It should be noted that this program is only limited to two tracks, whereas the proposed BS IC allows the students to choose among a variety of options, with the capability to add new options as deemed suitable.
- At Baylor University, Computer Science undergraduate students can choose among the computer science, gaming, or software engineering tracks. In conjunction with the Biology Department, an Informatics degree with a major in bioinformatics is offered [6].
- At Texas Tech University, Computer Science is part of dual-degree programs, allowing students to earn B.S. degrees in Computer Science and another field, including Electrical Engineering, Chemical Engineering, and Mathematics [87].
- At the University of Texas, Computer Science students can choose between a Bachelor of Arts and a Bachelor of Science. The B.S. degree is more science-oriented, and the B.A. degree may be combined with other programs [105].
- At the University of Colorado, Computer Science students are required to complete a track intended to provide an area of specialization that is reflective of the interdisciplinary nature of computer science. The tracks include general computing, computational biology and health informatics, computational science and engineering, digital and social systems, networked devices and systems, software engineering, and systems [93].

Beyond the Big 12, a search for other universities which offer undergraduate programs in interdisciplinary computing identified the following examples from five universities in the U.S. and one in the U.K:

- At Belmont University, students can pursue a B.S. degree in one of the three interdisciplinary programs, namely, web programming and development, neuroscience,

and applied discrete mathematics [8]. These programs are administrated by the Institute for Computing Related Disciplines, with the purpose of an interdisciplinary approach to combine Computer Science with another core discipline. The goal is to better prepare students for multidisciplinary occupations and graduate studies.

- Carnegie Mellon University offers a Bachelor of Computer Science and Arts, a collaborative effort by the College of Fine Arts and the School of Computer Science [16]. This degree integrates computing technology and arts, where the students choose among five arts concentration of Architecture, Art, Design, Drama, or Music.
- At Temple University, the Mathematics and Computer Science Interdisciplinary Program offers students a degree program to enable them to process and analyze theoretical and real-life quantitative data, and to be competent in software development [84].
- Students at the University of California San Diego can major in Interdisciplinary Computing and the Arts in the Music and Visual Arts Departments. The program integrates education in Computer Science, art, and cultural theory. The program aims to enable the students to be proficient in computing and the arts. An important objective of the program is to “give students’ sufficient understanding of the trajectories of development in computing so they can anticipate and work with the emerging trends, rather than being locked in particular software currently available on the market” [91].
- The Computer Science Department at the University of Virginia offers an interdisciplinary major in Computer Science, allowing the students to pursue a B.A. degree in the College of Arts and Sciences. The goal is to enable graduates to pursue areas integrating computing with the arts and sciences. The interdisciplinary nature of the program connects computing with other disciplines such as visual arts, music, life sciences, physical sciences, mathematics, and social sciences. The students are assigned a primary Computer Science advisor and a secondary Arts and Sciences advisor [107]. This program was constructed at University of Virginia in order to address the declining enrollment in undergraduate computer science programs [30].
- In U.K., the University of Bradford offers undergraduate programs in Information and Communication Technologies (ICT), administered by the School of Computing, Informatics and Media. The five interdisciplinary BS degrees offered are BSc ICT with business, law, marketing, media, and psychology. The graduates are expected to have the skills to address issues in Information and Communications Technology. It is argued that these interdisciplinary skills offer the graduates many exciting employment possibilities in all sectors of the economy [90].

In terms of graduate programs, a few universities in the U.S. offer graduate degrees in interdisciplinary computing. These programs can be of interest to the future graduates of the proposed BS IC program who wish to further continue their studies. These graduate programs include the Interdisciplinary M.S. in Computer Science at Clarkson University [19], M.S. and Ph.D. in Computational Science and Engineering at Georgia Tech [34], graduate degrees in Cognitive Science at Indiana University [42], M.A. in Interdisciplinary Computer Science at Mills College [62], Interdisciplinary Information Science Ph.D. at the University of North Texas [100], Interdisciplinary Ph.D. in Applied Mathematical Sciences at the University of Rhode Island [103], and interdisciplinary Ph.D. in Computer Science at the University of Vermont

[106]. In addition to educational programs in interdisciplinary computing, universities are focusing on the research aspects of integration of information technology with other disciplines. For instance, the Department of Informatics at the University of California, Irvine focuses on research on relationships between technological, organizational, cultural, and social aspects of information technology [27].

In Europe, the University of Bradford in U.K. offers a Multidisciplinary Computing MSc [90]. The graduate program in Computer Science at the University of Alcalá in Spain offers six specializations: software engineering, information systems, law and information technologies, electronic teaching and learning, information and communication technologies in humanities and cultural management, and informatics for clinical and health sciences management [23].

(5) Characteristics of the Students

The characteristics of the students who will pursue the BS IC program will be similar to those of the incoming students to the EECS Department. The freshmen admitted to the EECS Department in the Fall 2008 had the following characteristics:

- (1) In State: 72.6%, Out of State: 21.1%, and International: 6.3%
- (2) Average Composite ACT score: 28.72
- (3) Average Math ACT score: 30.32
- (4) Average GPA 3.66

It is our hope that the percentages of female students and underrepresented students will increase as the result of the BS IC program. Admitted freshmen for the Fall 2008 had:

- (5) Percentage female students: 11.3%
- (6) Percentage underrepresented and unknown ethnicity: 17.1%

In order to be admitted to the EECS Department, students must meet or exceed the following: having a 3.0/4.0 grade point average, being in the top 50% of the graduating class, and having a mathematics ACT score of 28. These admission requirements will be used for future students who will be applying to the proposed BS IC program.

(B) Curriculum

Different universities offer a variety of tracks/specializations in their curriculum, in conjunction with the computing degrees. Many other options are proposed by those with interest in the education of computer scientists. The tracks/specializations have included computational mathematics, computational physics, bioinformatics, neuroscience, management information systems, art and computer graphics, and geographical information science [2]. Other options identified for interdisciplinary studies include bioinformatics, computer information systems, human-computer interaction, geographic information technology, computer and network security, information assurance, robotics, animation, game programming, web application development, embedded computing, wireless computing, visualization, multimedia, and gaming [22][116][118]. Other examples of interdisciplinary degrees include interactive digital media, internet legal and ethical issues, and electronic digital media, security policy work, and music [3][81].

We have initially identified five specializations for the proposed BS IC program at KU, and we have received support from those disciplines, which are Astronomy, Biology, Chemistry, Geography, and Physics. The nature of the proposed program allows us to incorporate additional specializations in the future without having to redefine the program, or to change its structure. As other disciplines are identified to be suitable, new specializations can be added to the BS IC program by identifying the appropriate set of courses in the new disciplines, in cooperation with the respective departments.

Computer science educators have had conversations with companies which hire their students, such as Electronic Arts, Microsoft Research, Disney Animation Studios, Pixar, Seven Studios, and Disney game studios. These companies are interested in interdisciplinary students who are experts in both computer science and art; . In addition, the top two major professional societies in computer science, namely ACM and IEEE-CS, have developed guidelines for undergraduate computer science education [38]. These lessons and guidelines have been considered in the process of developing a curriculum for the new BS IC degree.

(1) The Curriculum of the Proposed Program

The BS IC degree will initially be offered in conjunction with five areas of specialization: Astronomy, Chemistry, Biology, Geography, and Physics. Additional areas of specialization can be added later, as other disciplines are integrated into the BS IC program.

The curriculum, with total hours of 124 to 128, includes 18 hours of Mathematics, 12 hours of English, 15 hours of Humanities/Social Sciences, 47 hours of Computer Science, and 32 to 36 hours from the area of specialization.

Graduates of this program will be interdisciplinary computer scientists who will be able to assist other disciplines in solving problems. By studying computing within the context of other disciplines, they will be able to more efficiently and economically develop new applications and technologies for their field of specialization. By providing a “big picture” view of complex problems, the program will further enhance students’ critical thinking skills and their ability to collaborate with those from different professions.

Mathematics (18 hours)		
MATH 121	Calculus I	5
MATH 122	Calculus II	5
MATH 223	Vector Calculus	3
MATH 290	Elementary Linear Algebra	2
MATH 526	Applied Mathematical Statistics I	3

English (12 hours)		
ENGL 101	Composition	3
ENGL 102	Creative Reading and Writing	3
ENGL 362	Foundations of Technical Writing	3
COMS 130	Speaker-Audience Communications	3

Humanities/Social Sciences (15 hours)		
PHIL 375	Moral Issues in Computer Technology	3
2 Courses	Humanities	6
2 Courses	Social Sciences	6

Computer Science (47 hours)		
EECS 140	Introduction to Digital Logic Design	4
EECS 168	Programming I	4
EECS 210	Discrete Structures	4
EECS 268	Programming II	4
EECS 368	Programming Language Paradigms	3
EECS 388	Computer Systems & Assembly Language	4
EECS 448	Software Engineering I	4
EECS 560	Data Structures	4

EECS 678	Introduction to Operating Systems	4
4 Courses	EECS Senior Electives	12

Astronomy Specialization (33 hours)		
MATH 220	Applied Differential Equations	3
PHSX 211	General Physics I	4
PHSX 212	General Physics II	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory I	1
ASTR 391	Physical Astronomy	3
ASTR 503	Undergraduate Research	2
ASTR 591	Stellar Astronomy	3
ASTR 592	Galactic and Extragalactic Astronomy	3
ASTR 596	Observational Astrophysics	1
2 Courses	500 level and above ASTR MATH 581 Numerical Methods MATH 611 Time Series Analysis PHSX 615 Numerical and Computations Methods in Physics	6

Biology Specialization (36 hours)		
CHEM 184	Foundations of Chemistry I	5
CHEM 188	Foundations of Chemistry II	5
BIOL 150	Principles of Molecular and Cellular Biology	4
BIOL 152	Principles of Organismal Biology	4
BIOL 350	Principles of Genetics	3
1 Course	BIOL 400 Fundamentals of Microbiology BIOL 600 Introductory Biochemistry	3
BIOL 408	Physiology of Organisms	3
BIOL 412	Evolutionary Biology	3
2 Courses	BIOL 413 History and Diversity of Organisms BIOL 414 Principles of Ecology BIOL 416 Cell Structure and Function BIOL 417 Biology of Development BIOL 435 Introduction to Neurobiology BIOL 550 Introduction to Systematics	6

Chemistry Specialization (34 hours)		
PHSX 211	General Physics I	4
PHSX 212	General Physics II	4
CHEM 184	Foundations of Chemistry I	5
CHEM 188	Foundations of Chemistry II	5
CHEM 624	Organic Chemistry I	3

CHEM 625	Organic Chemistry I Laboratory	2
CHEM 646	Physical Chemistry I	4
CHEM 647	Physical Chemistry I Laboratory	2
CHEM 648	Physical Chemistry II	3
CHEM 649	Physical Chemistry II Laboratory	2
Geography Specialization (33 hours)		
PHSX 211	General Physics I	4
GEOG 311	Map Conception and Development	4
GEOG 358	Principles of Geographic Information Systems	4
GEOG 526	Remote Sensing of Environment I	4
GEOG 558	Intermediate Geographical Information Systems	4
2 Courses	300 level and above courses in categories defined in the Undergraduate Study in Geography and Atmospheric Science handbook as: Physical Studies, Geographic Information Science, Human Studies, Regional Studies, and Atmospheric Science	6
7 hours	GEOG 513 Cartographic Design GEOG 517 Data Handling and Map Symbolization GEOG 726 Remote Sensing of Environment II GEOG 758 Geographic Information Science (prerequisite of GEOG 316 Methods of Analyzing Geographical Data should be taken as an elective)	7

Physics Specialization (32 hours)		
MATH 220	Applied Differential Equations	3
PHSX 211	General Physics I	4
PHSX 212	General Physics II	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory I	1
PHSX 503	Undergraduate Research	2
PHSX 521	Mechanics I	3
PHSX 531	Electricity and Magnetism	3
PHSX 511	Introductory Quantum Mechanics	3
2 Courses	600 level and above PHSX	6

(C) Program Faculty

(1) Quality of the Faculty

The EECS Department has 34 tenure-track and tenured faculty who will be able to meet the teaching needs of the programs, as no new classes are being introduced. Therefore, no new faculty positions are required in order to meet the needs of the proposed BS IC program. Information on the faculty can be found on the EECS Department website [93]. The faculty curriculum Vitae are provided.

EECS Faculty	Ph.D. Institution	Ph.D. Year
Arvin Agah	University of Southern California	1994
Perry Alexander	University of Kansas	1992
Chris Allen	University of Kansas	1984
Shannon Blunt	University of Missouri	2002
Frank Brown	University of Edinburgh	1978
Swapan Chakrabarti	University of Nebraska	1986
Xue-wen Chen	Carnegie Mellon University	2001
Ken Demarest	Ohio State University	1980
Gunes Ercal-Ozkaya	University of California, Los Angeles	2008
Joe Evans	Princeton University	1989
Victor Frost	University of Kansas	1982
Andy Gill	University of Glasgow	1996
Prasad Gogineni	University of Kansas	1984
Jerzy Grzymala-Busse	Technical University of Poznan, Poland	1969
Jun Huan	University of North Carolina	2006
Rongqing Hui	Politecnico di Torino, Italy	1993
Nancy Kinnersley	Washington State University	1989
Man Kong	University of Nebraska	1986
Prasad Kulkarni	Florida State University	2007
Carl Leuschen	University of Kansas	2001
Bo Luo	Pennsylvania State University	2008
James Miller	Purdue University	1979
Gary Minden	University of Kansas	1982
Doug Niehaus	University of Massachusetts at Amherst	1994
Erik Perrins	Brigham Young University	2005
Dave Petr	University of Kansas	1990
Brian Potetz	Carnegie Mellon University	2008
Glenn Prescott	Georgia Tech	1984
James Rowland	Purdue University	1966
Hossein Saiedian	Kansas State University	1989
Sarah Seguin	Missouri Univ. of Science & Technology	2009
Sam Shanmugan	Oklahoma State University	1970
James Sterbenz	Washington University in St. Louis	1991
James Stiles	University of Michigan	1995

(2) Graduate Assistants

The EECS Department employs a number of Graduate Teaching Assistants who are sufficient for meeting the needs of the proposed degree. Therefore, there is no need for additional Graduate Teaching Assistants.

(D) Academic Support

While the proposed BS IC program itself is new, it draws upon existing courses in the School of Engineering EECS Department and existing courses in five departments within the College of Liberal Arts and Sciences. Accommodation of class schedules will be required among participating departments, but because faculty will be teaching their regular courses to a broader range of students, no additional academic support is required, nor will there be an implementation cost or increased cost to offer the program. The proposed program offers the capability of leveraging existing resources in a way that provides additional opportunity for students.

(1) Academic Support Services

The current academic support services in the EECS Department will meet the needs of the proposed program, including advising. Each BS IC student will be assigned a faculty member as an advisor. The advisors will provide support to the BS IC students, guide them in terms of curriculum and classes to take each semester, answering questions, and ensuring that the students are making progress towards their degree. In addition to individual advisors, the department will designate one faculty member as the BS IC program coordinator who will serve as the point of contact for students and faculty.

(2) New Library Materials and other Forms of Academic Support

The current library materials and other resources, at KU libraries in general, and the School of Engineering library in particular, will meet the needs of the proposed program.

(3) New Supporting Staff

The current EECS staff will meet the needs of the proposed program, and no new supporting staff is needed.

(E) Facilities and Equipment

(1) Anticipated Facilities Requirements

The current facilities in the EECS Department and School of Engineering will meet the needs of the proposed program.

(2) New Equipment Required

The existing equipment in the EECS Department laboratories will meet the need of the BS IC students; no new equipment is required.

(F) Program Review, Assessment and Accreditation

(1) Program Review Process or Evaluation Methods

The proposed BS IC program will be reviewed as part of the EECS Department's ongoing program review cycles, including internal reviews, reviews by the departmental advisory board, periodic program reviews by the School of Engineering, and university reviews. The results of such reviews will be reported to the Kansas Board of Regents.

(2) Student Learning Outcomes Measures

The current EECS department program outcomes will be used as a template to develop student learning outcomes measures for the proposed interdisciplinary program. These outcomes will ensure that the proposed program will enable students to upon their graduation achieve:

- (a) An ability to apply knowledge of computing and mathematics appropriate to their specialized discipline
- (b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- (c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- (d) An ability to function effectively on teams to accomplish a common goal
- (e) An understanding of professional, ethical, legal, security, and social issues and responsibilities
- (f) An ability to communicate effectively with a range of audiences
- (g) An ability to analyze the local and global impact of computing on individuals, organizations, and society
- (h) Recognition of the need for and an ability to engage in continuing professional development
- (i) An ability to use current techniques, skills, and tools necessary for computing practice

The EECS Department's listed learning outcomes align well with the skill set which is identified by the Kansas Board of Regent [47] in *Foresight 2020: A Strategic Agenda for Higher Education in Kansas* [49]. The skill set is part of pillar #4 of the report on ensuring that students possess the required skills:

- (1) Oral and written communication skills
- (2) General technical and numerical literacy
- (3) Critical thinking and problem-solving capacity
- (4) The ability to work collaboratively and in teams

Skill set 1 is met by outcome (f), set 2 is met by outcome (a), set 3 is met by outcome (b), and set 4 is met by outcome (d). Because we have been able to demonstrate meeting the listed outcomes, the skill set identified by pillar #4 will be met by the graduates of the proposed program.

The learning outcomes of (a) through (i) are evaluated by the EECS Department using feedback from the students, the faculty, and the employers. The department has been using surveys to elicit feedback from the students as they graduate. Faculty surveys are used for every class to check on whether the students are gaining the requisite knowledge and abilities. Employers are sent questionnaires to further evaluate the graduates' capabilities, knowledge, and skills. All such feedback is utilized by the department in order to revise and enhance the curriculum. The results affect individual courses, including course revision, course removal, and introduction of new courses.

In addition, we have been providing opportunities for the students in the EECS Department to interact with each other both in curricular and extracurricular activities. These opportunities include:

- Team projects in classes where the students are required to work in teams on class projects. The students in the BS IC program will be taking courses with students majoring in computer science, computer engineering, and electrical engineering. These team projects will provide the BS IC students with opportunities to interact with others in the department.
- BS IC students will be taking a number of courses in their discipline-based departments (Astronomy, Chemistry, Biology, Geography, Physics), which will allow them to interact with students with similar interests.
- BS IC students will have the opportunity to join and participate in student chapters of professional societies, such as ACM (Association for Computing Machinery) and IEEE (Institute of Electrical and Electronics Engineers). The student chapter of ACM will be a very suitable organization for BS IC students, as ACM is the largest educational and scientific computing society. The local chapter has organized events such as programming contests for students. This will be an excellent venue for students to be exposed to the broad range of engineering applications.
- BS IC students will be encouraged to participate in the KU Engineering Student Council (ESC), which is a student organization that helps student groups within the School of Engineering, providing funding for activities, welcoming the freshmen, and supporting students through a mentoring program. ESC will provide BS IC students with many opportunities to interact with one another and other students at KU.
- The department schedules meetings for the students in order for them to provide feedback to the department as part of the accreditation process. The BS IC students will be invited and will get a chance to interact with other student and the department in such meetings.

(3) Plans regarding Program Accreditation

The undergraduate degree programs currently offered by the EECS Department are accredited by ABET, which is the accreditor for university programs in computing and engineering [1]. The Computer Science programs are accredited by the Computing Accreditation Commission (CAC)

of ABET. Accreditations are peer reviews and intended to ensure high quality of undergraduate education. Currently, the Computer Science program at KU is accredited, along with Computer Engineering and Electrical Engineering. We will seek accreditation for the proposed BS IC program through the same channels.

Currently, there are no specific guidelines for accreditation of interdisciplinary computing programs in the U.S. This may change in the future, as more interdisciplinary computing programs are being introduced across the nation. In Canada, there are accreditation criteria for undergraduate interdisciplinary programs in which Computer Science is taught alongside one or more disciplines, requiring that Computer Science is the equal of the other disciplines, i.e., computer science minors are not eligible [12].

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New Degree Request - University of Kansas

<u>Criteria</u>	<u>Program Summary</u>
1. Program Identification	Bachelor of Science in Interdisciplinary Computing
2. Academic Unit	Department of Electrical Engineering and Computer Science (EECS) School of Engineering University of Kansas
3. Program Description	<p>The proposed program transcends traditional academic boundaries, allowing students to study computing within the context of other disciplines. A deep-rooted understanding of biology, geography, arts, or other disciplines, enables future graduates to more efficiently and economically develop new applications and technologies for their field of specialization. By providing a “big picture” view of complex problems, the program will further enhance students’ critical thinking skills and their ability to collaborate with those from different professions. A BS IC degree will better prepare the students to fill an urgent industry need—fluency in Computer Science and another discipline.</p> <p>The proposed degree is in response to a national need for graduates who can effectively integrate computing with other disciplines to address the challenges within those disciplines. The proposed program will utilize the existing faculty, staff, and resources in the EECS Department in order to provide future students with the opportunity to pursue an undergraduate degree in Interdisciplinary Computing. The BS IC program will offer five areas of specialization, namely, Astronomy, Chemistry, Biology, Geography, and Physics. Additional areas can be added, as other disciplines are integrated into the BS IC program.</p>
4. Demand/Need for the Program	<p>Computer science departments are experiencing increased interest in interdisciplinary programs such as computational biology or interactive media. The objective of the proposed program is to meet such demands. The proposed program will enable the EECS Department to recruit bright students who are attracted to the interdisciplinary nature of the program. The BS IC program will address the recruiting and retention of female students and students from underrepresented groups.</p> <p>The graduates of the BS IC program will be able to pursue careers in a wide range of fields in the industry, government, and academics. Science industries, business, government, and military sectors are making it a priority to hire people with expertise in computing; and industry has identified interdisciplinary computing as an important need. It is reported that the careers that combine computing with other fields will be the new jobs of the future. Numerous reports indicate the excellent career prospects for future BS IC graduates.</p>

5. Comparative /Locational Advantage	<p>Currently, none of the Kansas Regents Universities offers a degree in interdisciplinary computing.</p> <p>A search for other universities, which offer undergraduate programs in interdisciplinary computing, identified five universities in the U.S. (Belmont University, Carnegie Mellon University, Temple University, University of California San Diego, and University of Virginia) and one in U.K (University of Bradford).</p>
6. Curriculum	<p>The BS IC degree will initially be offered in conjunction with five areas of specialization: Astronomy, Chemistry, Biology, Geography, and Physics. Additional areas of specialization can be added later, as other disciplines are integrated into the BS IC program.</p> <p>The curriculum, with total hours of 124 to 128, includes 18 hours of Mathematics, 12 hours of English, 15 hours of Humanities/Social Sciences, 47 hours of Computer Science, and 32 to 36 hours from the area of specialization.</p> <p>The curriculum is specified in detail in the proposal.</p>
7. Faculty Profile	<p>The EECS Department has 34 tenure-track and tenured faculty who will be able to meet the teaching needs of the programs. No new faculty positions are required.</p>
8. Student Profile	<p>The characteristics of the students will be similar to those of the incoming students to the EECS Department. The freshmen admitted to the EECS Department in the Fall 2008 were 72.6% in state, 21.1% out of state, and 6.3% international; and had average composite ACT score of 28.72, average math ACT score of 30.32; and had average GPA of 3.66.</p>
9. Academic Support	<p>The current academic support services will meet the needs of the proposed program.</p>
10. Facilities and Equipment	<p>The current facilities and equipment will meet the needs of the proposed program.</p>
11. Program Review, Assessment, Accreditation	<p>The program will be reviewed as part of the EECS Department's ongoing program review cycles.</p> <p>The undergraduate degree programs currently offered by the EECS Department are accredited by ABET, which is the accreditor for university programs in computing and engineering. Computer Science programs are accredited by the Computing Accreditation Commission (CAC) of ABET. We will seek accreditation for the proposed program through the same channels.</p>
12. Costs, Financing	<p>No additional costs/financing is required.</p>

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CURRICULUM OUTLINE

NEW DEGREE PROPOSALS

Kansas Board of Regents

I. Identify the new degree:

Bachelor of Science in Interdisciplinary Computing

II. Provide courses required for each student in the major:

Course Name & Number	Credit Hours
Core Courses	
MATH 121 Calculus I	5
MATH 122 Calculus II	5
MATH 223 Vector Calculus	3
MATH 290 Elementary Linear Algebra	2
MATH 526 Applied Mathematical Statistics I	3
ENGL 101 Composition Composition	3
ENGL 102 Creative Reading and Writing	3
ENGL 362 Foundations of Technical Writing	3
COMS 130 Speaker-Audience Communications	3
PHIL 375 Moral Issues in Computer Technology	3
EECS 140 Introduction to Digital Logic Design	4
EECS 168 Programming I	4
EECS 210 Discrete Structures	4
EECS 268 Programming II	4
EECS 368 Programming Language Paradigms	3
EECS 388 Computer Systems & Assembly Language	4
EECS 448 Software Engineering I	4
EECS 560 Data Structures	4
EECS 678 Introduction to Operating Systems	4
Electives	
2 Courses Humanities	6

2 Courses Social Sciences	6
4 Courses EECS Senior Electives	12

Astronomy Specialization

MATH 220 Applied Differential Equations	3
PHSX 211 General Physics I	4
PHSX 212 General Physics II	4
PHSX 313 General Physics III	3
PHSX 316 Intermediate Physics Laboratory I	1
ASTR 391 Physical Astronomy	3
ASTR 503 Undergraduate Research	2
ASTR 591 Stellar Astronomy	3
ASTR 592 Galactic and Extragalactic Astronomy	3
ASTR 596 Observational Astrophysics	1
2 Courses:	6
500 level and above ASTR	
MATH 581 Numerical Methods	
MATH 611 Time Series Analysis	
PHSX 615 Numerical and Computations Methods in Physics	

Biology Specialization

CHEM 184 Foundations of Chemistry I	5
CHEM 188 Foundations of Chemistry II	5
BIOL 150 Principles of Molecular and Cellular Biology	4
BIOL 152 Principles of Organismal Biology	4
BIOL 350 Principles of Genetics	3
1 Course:	3
BIOL 400 Fundamentals of Microbiology	
BIOL 600 Introductory Biochemistry	
BIOL 408 Physiology of Organisms	3

BIOL 412 Evolutionary Biology	3
2 Courses:	6
BIOL 413 History and Diversity of Organisms	
BIOL 414 Principles of Ecology	
BIOL 416 Cell Structure and Function	
BIOL 417 Biology of Development	
BIOL 435 Introduction to Neurobiology	
BIOL 550 Introduction to Systematics	

Chemistry Specialization

PHSX 211 General Physics I	4
PHSX 212 General Physics II	4
CHEM 184 Foundations of Chemistry I	5
CHEM 188 Foundations of Chemistry II	5
CHEM 624 Organic Chemistry I	3
CHEM 625 Organic Chemistry I Laboratory	2
CHEM 646 Physical Chemistry I	4
CHEM 647 Physical Chemistry I Laboratory	2
CHEM 648 Physical Chemistry II	3
CHEM 649 Physical Chemistry II Laboratory	2

Geography Specialization

PHSX 211 General Physics I	4
GEOG 311 Map Conception and Development	4
GEOG 358 Principles of Geographic Information Systems	4
GEOG 526 Remote Sensing of Environment I	4
GEOG 558 Intermediate Geographical Information Systems	4
2 Courses: 300 level and above courses in categories defined in the Undergraduate Study in Geography and Atmospheric Science handbook as: Physical Studies, Geographic Information Science, Human Studies, Regional Studies, and Atmospheric Science	6
7 Hours: GEOG 513 Cartographic Design GEOG 517 Data Handling and Map Symbolization GEOG 726 Remote Sensing of Environment II GEOG 758 Geographic Information Science (prerequisite of GEOG 316 Methods of Analyzing Geographical Data should be taken as an elective)	7

Physics Specialization

MATH 220 Applied Differential Equations	3
PHSX 211 General Physics I	4
PHSX 212 General Physics II	4
PHSX 313 General Physics III	3
PHSX 316 Intermediate Physics Laboratory I	1
PHSX 503 Undergraduate Research	2
PHSX 521 Mechanics I	3
PHSX 531 Electricity and Magnetism	3
PHSX 511 Introductory Quantum Mechanics	3
2 Courses: 600 level and above PHSX	6

Research

Not Applicable

Practica

Not Applicable

Total 124-128

Fiscal Summary for the Proposed Academic Program

Institution: University of Kansas - Lawrence

Proposed Program: Bachelor of Science in Interdisciplinary Computing

Part I. Anticipated Enrollment

	Implementation Year		Year 2		Year 3	
	Full-Time	Part-Time	Full-Time	Part-Time	Full-Time	Part-Time
A. Headcount	10	0	20	0	30	0
B. Total SCH taken by all students in the program	270		540		810	

Part II. Program Cost Projection

A. In the implementation year, list all identifiable **General Use** costs to the academic unit(s) and how they will be funded.

In subsequent years, please include **only** the additional amount budgeted.

	Implementation Year	Year 2	Year 3
<u>Base Budget</u>			
Salaries	0	0	0
OOE	0	0	0
Total	0	0	0

Indicate source and amount of funds if **other than** internal reallocation:

All funds for the proposed program will be from internal reallocation; no new courses are introduced.

Approved: _____