**COMPUTER AND INFORMATION SCIENCE (CIS)**

Mei-Huei Tang, Ph.D., *Chairperson*

FACULTY: *Professors:* Mei-Huei Tang, Yunkai Liu. *Associate Professor:* Joshua C. Nwokeji. *Assistant Professors:* Sheheeda Mariam Manakkadu, Richard Matovu, Md Tajmilur Rahman, Jizhou Tong, Kefei Wang, Ronny C Bazan-Antequera, Rashid A Khan, Samuel K Tweneboah-Koduah. *Visiting Instructor*: Peter Capelli, Marwah B. Obaid, Qing Zhang.

The mission of CIS Department is to help students apply problem identification and problem- solving strategies to the development of complex computer-based systems, follow legal and ethical computing principles to analyze computing solutions for ethical ramifications such as global, cultural social, environmental or economic concerns. As a diverse team, the department strives to facilitate students learning to function and communicate effectively as a collaborative member or leader in a professional context and to demonstrate an ability to acquire and apply new knowledge or technology as needed.

The CIS Department maintains educational labs for teaching and project work, and servers using MAC OS X, WINDOWS and LINUX operating systems. The Mac lab offers the hardware and software environment needed for iOS app development. The general-purpose labs provide interactive environments for design and programming classes. The network lab offers hands- on exposure to the hardware and software layers of networks. The advanced systems lab hosts state-of-the-art creation, capture, editing, and synthesis hardware and software for multimedia productions and database functions. A project lab is maintained for faculty research, student work, and on-campus internship work.

A wide-variety of programming environments and application software are available at Gannon University. Specifically within the Department and through its course offerings

the following items are presented: Java, JavaScript, C++, Swift, C#, and COBOL are core programming environments; UML, IBM Rational Rhapsody™, Visual Paradigm™ and VISIO™ as modeling environments, and ORACLE™, SQL Server™, Microsoft Access and other database as database management systems. Gannon University is a CompTIA Authorized Academy Partner and qualifies for several CompTIA incentives, tools, resources, and benefits.

###### Programs

The Computer and Information Science department offers three Bachelors of Science (BS) degree programs in:

* Computer Science – described under **Computer Science**
* Cybersecurity – described under **Cybersecurity**
* Software Engineering – described under **Software Engineering**

Gannon’s Computer Science program is accredited by the Computing Accreditation Commission of ABET[, https://www](http://www.abet.org/).abet.or[g,](http://www.abet.org/) under the commission’s General Criteria and Program Criteria for Computer Science and Similarly Named Computing Programs. The Software Engineering program is accredited by the Engineering Accreditation Commission of ABET, [https://www](http://www.abet.org/).abet.or[g,](http://www.abet.org/) under the commission’s General Criteria and Program Criteria for Software and Similarly Named Engineering Programs. The Cybersecurity program is designed following the criteria set by the Computing Accreditation Commission of ABET and will be seeking accreditation from the Commission after the programs’ first round of students graduated.

All department programs include a study-abroad option in the Junior year. In addition to the traditional four-year model, the department supports different means for pursuing these degrees:

* Software Engineering International Dual Degrees (SEID) in cooperation with Esslingen University of Applied Science in *Computer Science (BS)/Software Technology (B.Eng)* or the *Software Engineering (BS)/Software Technology (B.Eng)*. These are described in the **Software Engineering International Degrees** section.
* Dual Major Program in Computer Science and Software Engineering – the curriculum is described in the **Computer Science-Software Engineering Dual Degree** section.
* Cooperative (CoOp) Programs: A five-year cooperative program is available for each of these degree programs. The student must meet the same requirements as the four- year programs, and spend a minimum of three semester equivalents in industry. See the **Computer and Information Science Co-Op Curriculum** section below.
* Accelerated 5-Year BS-MS-CIS Program: A set of five-year pathways for students in the Computer Science, Cybersecurity or Software Engineering degree programs to complete a Masters of Science in Computer and Information Science (MS-CIS) degree with options

in Data Science, Information Technology or Software Engineering available for students to enhance their professional competencies. See the **Accelerated 5-Year CS-MS-CIS** Program section below.

###### Aims and Objectives

At Gannon, all CIS programs aim to help students to become *employable, accountable professionals*, who act as *competent problem solvers* in multiple settings, and strive to be *selfless contributors* to their teams, community, church, profession and society. As employable professionals, CIS graduates are well prepared for employment or graduate work in their field, and to continue working in that field or related fields. This includes adaptability to different disciplines, environments, and tasks. CIS graduates are accountable for their professional roles, and pursue their profession in an ethical manner. This includes giving and receiving professional critique and review, communication and the responsibility for, and/or leadership. As competent problem solvers, their focus will be creative; however, they will have different skills and experience depending on the particular degree program(s) they pursue. And as selfless contributors, CIS graduates value collaborative teamwork and contribute to team accomplishment that goes beyond personal development. They voluntarily give their time, talent, and/or resources to their community, profession, church and/or society.

###### Department-Wide Outcomes

The computing degree programs managed by the CIS Department are all aimed at helping undergraduate students grow in their abilities to develop computer-based solutions to real problems. As such, all majors share expectations for what every CIS student will know and be able to do by the time they graduate. These department-wide outcomes include:

* Follow legal and ethical computing principles to analyze computing solutions for ethical ramifications such as global, cultural, social, environmental or economic concerns.
* Function and communicate effectively as a collaborative member or leader in a professional context.
* Demonstrate an ability to acquire and apply new knowledge or technology as needed, using appropriate learning strategies.
* Apply problem identification and problem solving strategies to the development of complex computer-based systems.

###### Computer and Information Science Co-Op Curriculum

*Cycles available for Computer Science, Information Systems or Software Engineering:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Plan A**  Year 1  Year 2  Year 3  Year 4  Year 5 | Fall 1  Fall 2  Fall 3  4 month WP  Fall 4 | Spring 1  Spring 2  4 month WP  Spring 3  Spring 4 | Summer vacation 4 month WP \*  Summer Courses \*\* 4 month WP  — |
| **Plan B** |  |  |  |
| Year 1 | Fall 1 | Spring 1 | Summer vacation |
| Year 2 | Fall 2 | 4 month WP | Summer Courses |
| Year 3 | 4 month WP | Spring 2 | 4 month WP |
| Year 4 | Fall 3 | Spring 3 | 4 month WP |
| Year 5 | Fall 4 | Spring 4 | — |
| **Plan C** |  |  |  |
| Year 1 | Fall 1 | Spring 1 | Summer vacation |
| Year 2 | Fall 2 | Spring 2 | 4 month WP |
| Year 3 | Fall 3 | 4 month WP | 4 month WP |
| Year 4 | 4 month WP | Spring 3 | Summer Courses |
| Year 5 | Fall 4 | Spring 4 | — |

*Additional cycle available for Information Systems:*

###### Plan D

|  |  |  |  |
| --- | --- | --- | --- |
| Year 1 | Fall 1 | Spring 1 | Summer vacation |
| Year 2 | Fall 2 | Spring 2 | 4 month WP \* |
| Year 3 | 4 month WP | Spring 3 | Summer Courses \*\* |
| Year 4 | Fall 3 | 4 month WP | 4 month WP |
| Year 5 | Fall 4 | Spring 4 | — |

*\* Work Period*

*\*\* Liberal Studies Core Courses*

NOTES:

1. Fall and Spring follow the regular curriculum schedule for a major.
2. For maximum financial aid, 12 credits of Liberal Studies Courses should be taken during the 4-month summer session listed.

**CIS COURSE DESCRIPTIONS**

CIS courses represent content that is cross-disciplinary or foundational to all computing degree requirements. CIS courses form the common core to the CS, SE and IS degrees.

###### CIS 150: Business Technology I\*

A hands-on introduction to the application of personal computers in a modern, networked business environment. Introduction to the Windows operating system, use of the Internet, the World Wide Web, and the components of Microsoft Office, with particular emphasis on Word, Excel, and Powerpoint. *3 credits*

###### CIS 170: PC OS/Internet\*

A detailed discussion of modern personal computers, peripheral devices, operating systems, graphical interfaces and use of the Internet. *1 credit*

###### CIS 171: PC Word Processing\*

An introduction to word processing on a personal computer. Both basic and advanced document preparation capabilities are presented. Use of a word processor to facilitate writing efforts is a course objective. *1 credit*

###### CIS 172: PC Electronic Spreadsheet

A detailed discussion of electronic spreadsheet functions and operations. Students receive extensive hands-on experience in creating and editing an electronic spreadsheet. *1 credit*

###### CIS 173: PC Database

An introduction to relational database processing on a personal computer. Database topics of data dictionary construction, data entry, and queries to the database using SQL, form design, reports and labels, and their connection to tables. *1 credit*

###### CIS 174: PC Graphical Presentation

A detailed discussion of computer-based graphical presentation software. Students receive extensive hands-on experience creating professional graphical presentations and

slide shows. *1 credit*

###### CIS 180: Problem Solving and Computer Programming

The course focuses on problem solving and its relationship to computer programming. The student is introduced to the tools for developing the solution to a problem, and its subsequent implementation as an algorithm in a computer program. Once the introductory concepts of computer algorithm development have been assimilated, the student progresses to creating programs in the Java programming language including sequence, condition, iteration, functional decomposition and object use.

Corequisite: CIS 181

Prerequisite: High School Trigonometry or equivalent *2 credits, Fall*

###### CIS 181: Problem Solving and Computer Programming Lab

The course focuses on problem solving and its relationship to computer programming. The student is introduced to the tools for developing the solution to a problem, and its subsequent implementation as an algorithm in a computer program. Once the introductory concepts of computer algorithm development have been assimilated, the student progresses to creating programs in the Java programming language including sequence, condition, iteration, functional decomposition and object use.

Corequisite: CIS 180

Prerequisite: High School Trigonometry or equivalent *1 credit, Fall*

###### CIS 182: Object-Oriented Programming

The course is aimed at developing advanced object-oriented programming skills, and assumes a foundation in the basic syntax of Java. The student will explore the basis of software development using the major constructs of encapsulation, polymorphism, inheritance

and dynamic binding. Topics include GUI objects, event-driven programming, threading, networking and exception handling.

Corequisite: CIS 183

Prerequisite: CIS 180 and CIS 181 *2 credits, Spring*

###### CIS 183: Object-Oriented Programming Lab

The course is aimed at developing advanced object-oriented programming skills, and assumes a foundation in the basic syntax of Java. The student will explore the basis of software development using the major constructs of encapsulation, polymorphism, inheritance

and dynamic binding. Topics include GUI objects, event-driven programming, threading, networking and exception handling.

Corequisite: CIS 182

Prerequisite: CIS 180 and CIS 181 *1 credit, Spring*

###### CIS 195: Principles of Systems

An overview course introducing the concepts and value of data, information, and systems to the decision-making and strategic capabilities of an organization.

Prerequisite: CIS 150 or CIS 180 *3 credits, Spring*

###### CIS 207: Introduction to Business Programming – COBOL

A competency-building course focusing on the basic syntax and semantics of the COBOL language. Programming projects are used to introduce the student to system design, documentation, and coordination of programs.

Prerequisite: CIS 180 and CIS 181 *3 credits, Fall Even Years*

###### CIS 210: Introduction to Data Analytics

This course introduces students to an analytic framework and prepares them to answer real world problems encountered by everyday individuals and organizations. The course will teach students how to employ structured analysis techniques used by intelligence

professionals to collect, process and analyze information to forecast future events. Emphasis is on analyzing both structured and unstructured data to convert data into executable queries to support decision- makers. Students will additionally learn to utilize information technology, data structures and languages to mirror the techniques executed by intelligence analysts. The conclusion of the course students will produce programs that answer specific questions problems.

Prerequisite: None *3 credits, Spring*

###### CIS 219: Linux Programming

This course introduces the students to the Linux boot and login processes, basic process management techniques, file system, user controlled software build process, and basic application software architecture using the operating system. This course applies the concepts of shells, shell programming, controlling tasks developed with high-level programming languages to understand co-operating tasks by using signals and inter-processing communication (IPC). By applying the various software techniques, the student will comprehend the basic Linux Operating System (OS) concepts.

Prerequisite: CIS 180 and CIS 181 or ECE 111 *3 credits*

###### CIS 239: The User Experience

This course deals with the study of the user experience (UX), and its relationship to human computer interaction. This course includes identifying and assessing usability issues, particularly as they apply to computer-based systems. Includes coverage of UX goals

and processes, usability factors and measurements, wireframes and other prototyping technologies, and introductory web implementation. Special attention is given to usability and usability testing. *3 credits, Fall*

###### CIS 240: Web Management and Design

The course aims at providing an introduction to the tools and knowledge necessary to design and manage a web site on the Internet. Topics include servers and clients, HTML, CGI scripting, languages, business and ethical aspects of the web. *3 credits, Fall*

###### CIS 245: Multimedia Production

Multimedia software uses text, graphics, sound, animation, and video to entertain, inform or educate its users. This course examines all parts of the multimedia software development

process and provides hands-on experience with the use of multimedia software authoring tools. Corequisite: CIS 246 *2 credits*

###### CIS 246: Multimedia Production Lab

Interactive lab taken concurrently with CIS 245.

Corequisite: CIS 245 *1 credit*

###### CIS 250: Business Technology II

A hands-on study of the application of personal computers in a modern, networked business environment. Builds on material covered in CIS 150 Business Technology I. Provides instruction in the use of Microsoft Office components, with particular emphasis on advanced modeling using Excel. Other topics covered will be creation of web pages via HTML and other web authoring tools, integration of various Microsoft Office applications.

Prerequisite: CIS 150 *3 credits, Spring*

###### CIS 255: Database Management and Administration

Develop skills in query statements usage for programming, database design, as well as implementing and managing SQL servers. The core concept of SQL database design, usage and server configuration will be first introduced. Query statements for programming and SQL server management will be substantially taught. Essential skills for administrating a database are covered. *3 credits, Spring*

###### CIS 277: Mobile Application Development I

This is an introductory course into the methods and tools for developing mobile applications for integrated devices such as iOS, Android and other mobile computing platforms. Topics include introduction to the coding and development platforms for one of the major mobile platforms (e.g., iOS or Android), unit testing, source code control, the development of prototype applications, and deployment.

Prerequisite or Corequisite: CIS 239 and CIS 287 *3 credits, Fall*

###### CIS 287: Object-Oriented Design Lab

An advanced treatment of methods for producing a software design. Includes treatment of the developing Unified Modeling Language (UML) models and their application to software development.

Corequisite: CIS 277

Prerequisite: CIS 182 and CIS 183 *1 credit, Fall*

###### CIS 290: Introduction to Networks

The theory and techniques of data communications design and analysis are studied. Topics include data communication concepts, terminology, and standards. Error correction and detection, LANs, ISO/OSI layers are also an integral part of this course. *3 credits*

###### CIS 305: Essentials of UNIX Administration

Essentials of UNIX administration such as account management, file structure, security features are presented.

Prerequisite: CIS 219 *1 credit, Spring*

###### CIS 326: Formal Methods in Software Development

Focusing on the issues and techniques needed to apply formal specification methods to the development of software, the course uses mathematical and logical formalism to develop a precise statement of what software is to do.

Prerequisite: CIS 182, CIS 183 and MATH 223 *3 credits, Fall even years*

###### CIS 350: Requirements and Project Management

Focusing on the management of software requirements and projects, particularly teams and stakeholders, the course includes coverage of requirements elicitation, analysis,

documentation, and negotiation. It also includes the roles and methods of effective technical project management. Typical coverage includes the cost of quality, and its implications for requirements and project management.

Corequisite or Prerequisite: MATH 213 or MATH 312 or BCOR 220 *3 credits, Fall*

###### CIS 353: Global Project Management

This course focuses on experiential learning emphasizing software development with remote, multinational teams using an open-ended group project approach. Students participating

in this course will be co-developing an IT project with other remote teams, for a project that is primarily sourced in an off-shore location. Students will help to identify the scope of the

overall project, as well as the assignment and responsibility for a portion of that project. Project responsibilities, software and team interfaces will all have to be defined and managed by the team members, facilitated by one or more faculty members from the participating institutions.

The heart of the experience is on project planning, scope management, and coordination amongst a culturally and linguistically diverse development team. Ultimately, the goal is to produce the requirements for, the planning of, and where appropriate, creation of a prototype system components for use by the off-shore stakeholder per their requirements. Students are required to travel to the off-shore location to meet with the client and the development teams as part of the project launch. This may include a second trip to close out the project with the client.

The Leadership Seminar introduces students to a three-dimensional model of leadership, including a repertoire of leadership skills and means of using those skills responsibly in the various communities to which they belong. In addition, the course helps students explore the relevance of leadership skills in the leadership process. Ethical reasoning and Catholic social justice teaching serve as the basis for students’ leadership development as reflected both in this course and in the corequisite Theology or Philosophy Series III course.

Prerequisite: Satisfactory Performance in MATH 312 (Probability and Statistics), BCOR 220 (Business statistics) or equivalent. Junior Standing in CEB programs. Permission of Instructor and agreement to course-deposit policy are required. Corequisite or Prerequisite: LTHE 101 or LTHE/LPHI III series course

Corequisite or Prerequisite: MATH 213 or MATH 312 or BCOR 220 *4 credits, Fall*

###### CIS 355: Web Programming and Implementation

Focuses on the development of web applications with user interface conventions that facilitate viewing, searching, and changing of information stored in a relational database. The student will also learn to set up and configure the development environment for applications requiring a web client, web server, application server and relational database.

Prerequisite: CIS 182/183 or ECE 111, and CIS 255 *3 credits, Fall*

###### CIS 375: Server Management

This course focuses on the configuration of networks for internet services, and how to deploy and maintain internet servers on multiple platforms. The course includes extensive laboratory work to support the installation and configuration of hardware and software to support networking, servers, and security for internet services, particularly on Windows and UNIX platforms. The course also includes discussion of the ramifications of internet service technologies. The course also includes building Network Balanced and High Availability Clusters that are the building blocks of forming a cloud.

Prerequisite: CIS 290

Corequisite or Prerequisite: CIS 219 *3 credits, Spring Even Years*

###### CIS 377: Mobile Application Development II

A project-based course for developing mobile applications for integrated devices such as iOS, Android and other mobile computing platforms. Includes introduction to the coding and

development platforms for one of the major mobile platforms (e.g., iOS or Android), unit testing, source code control, and deployment includes the development of useable applications. Prerequisite: CIS 277 and CIS 287 *3 credits, Spring, Odd Years*

###### CIS 381: Directed Research

Directed research and development in software and its applications.

Prerequisite: Permission of the instructor *1 credit*

###### CIS 382: Directed Research

Directed research and development in software and its applications.

Prerequisite: Permission of the instructor *2 credits*

###### CIS 383: Directed Research

Directed research and development in software and its applications.

Prerequisite: Permission of the instructor *3 credits*

###### CIS 385: Network Design and Management

An advanced network design course covering contemporary network computing, including data, voice, multimedia, WAN and intranets. Detailed discussions along with hands-on laboratory experience with various hardware and software components that comprise these networks. Network analysis to monitor traffic flow and to optimize overall network design is included.

Prerequisite: CIS 290 or permission of instructor

Corequisite: CIS 386 *2 credits, Fall Odd Years*

###### CIS 386: Network Design and Management Lab

Interactive laboratory to be taken concurrently with CIS 385.

Corequisite: CIS 385 *1 credit, Fall Odd Years*

###### CIS 387: System and Network Security

The course reviews standard computer security for desktop and server-based systems. Coverage includes network security issues and techniques. Ethical hacking and defenses against unethical hacking and other computer and network intrusions are discussed.

Prerequisite: CIS 290 and written permission of the instructor. *3 credits, Fall*

###### CIS 390: Distributed Programming

An introduction to the fundamental techniques and tools used developing programs that rely on inter-process communication. Topics include TCP/IP, client-server paradigm, daemon programs, client socket calls, server socket calls, concurrent vs. iterative servers, connectionless and connection-oriented server paradigms, advanced topics.

Prerequisite: CSC 330 *3 credits, Spring*

###### CIS 391-396: Special Topics in Computer and Information Science

Special courses developed from student interest in all areas of computer and information science. A brief description of current content to be announced and may be included in the schedule of classes. The course number may be taken more than once.

Prerequisite: Permission of the Chair of the department *3 credits*

###### CIS 400: Internship

In conjunction with a local industry or business, the student participates in practical training related to his/her major. Academic requirements are specified by the department. *1-3 credits*

###### CIS 438: Human Interface Design and Maintenance

The course deals with human-computer interaction and covers a wide range of topics, including software tools, usability issues, direct manipulation, command and natural languages, and multiple-window strategies. The course includes identifying and assessing the issues surrounding the maintenance of code, particularly in the context of HCI. Special emphasis is also given to design and maintenance issues for web-enabled systems.

Prerequisite: CIS 355 or CIS 277 *3 credits, Fall*

###### CIS 445: Advanced Multi-Media

The course covers advanced multimedia concepts such as graphics, animation, video and sound; as well as the tools used to create multimedia applications. In addition, the course presents the design principles and management skills needed to develop dynamic, interactive multimedia products.

Prerequisite: CIS 245, CIS 246 or permission of the instructor *3 credits, Spring*

###### CIS 457: Senior Design I

CIS 457 is the first class in a 2-semester capstone design sequence with emphasis on working effectively in a team environment. Students review systems requirements gathering and design techniques, form teams, and begin the development of an end product. Course topics include systems analysis, language and presentation skills, team building, project management, ethical issues in the digital world.

Prerequisite: Senior status in a CIS Program,

{CIS 287 or IS 335 or CYSEC 301}, and ENG 380 *3 credits, Fall*

###### CIS 458: Senior Design II Lab

The completion of the capstone design sequence. Students develop and deliver a completed end product. Emphasis is on working effectively in cross-disciplinary teams. Course topics include organizational behavior, quality assurance, documentation, design process and process metrics, risk management, written and oral presentation skills, ethical issues in the digital world.

Prerequisite: CIS 457 *3 credits, Spring*

**SEECS 101, 102, 201, 202, 301, 302, 401, 402: Professional and Personal Enrichment Seminar** The series of seminars for SEECS students is built around a curriculum that addresses both the professional and personal growth of the scholars. Each semester of the seminar includes a design component, a professional development component, and a personal development

component. Considerable interaction among SEECS students and the faculty members fosters a sense of professional community among the students. Developmental workshops are offered to build academic, career, and social skills. Organizational and leadership skills are developed through team activities, colloquium speakers, and field trips. The course features a project where SEECS students from different academic levels and majors work together along with a community non-profit organization to identify, design, and implement a solution to a

technological problem to aid the organization. *0 credit*

###### SEECS 101: Professional and Personal Enrichment Seminar

*See course description above*

In the first semester the SEECS seminar focuses on preparation for lifelong learning experiences. Prerequisite: SEECS recipient with Freshman standing at Gannon University *0 credit, Fall*

###### SEECS 102: Professional and Personal Enrichment Seminar

*See course description above*

In the second semester the SEECS seminar focuses continues to focus on preparation for lifelong learning experiences.

Prerequisite: SEECS recipient with Freshman standing at Gannon University *0 credit, Spring*

###### SEECS 201: Professional and Personal Enrichment Seminar

*See course description above*

This semester the SEECS seminar focuses on the exploration of the roles of STEM professionals, specifically engineers and computer scientists, in society.

Prerequisite: SEECS recipient with Sophomore standing at Gannon University *0 credit, Fall*

###### SEECS 202: Professional and Personal Enrichment Seminar

*See course description above*

This semester the SEECS seminar continues to focus on the exploration of the roles of STEM professionals, specifically engineers and computer scientists, in society.

Prerequisite: SEECS recipient with Sophomore standing at Gannon University *0 credit, Spring*

###### SEECS 301: Professional and Personal Enrichment Seminar

*See course description above*

This semester the SEECS seminar focuses on the interaction with professionals and society, and preparation for professional practice or advanced education.

Prerequisite: SEECS recipient with Junior standing at Gannon University *0 credit, Fall*

###### SEECS 302: Professional and Personal Enrichment Seminar

*See course description above*

This semester the SEECS seminar continues to focus on the interaction with professionals and society, and preparation for professional practice or advanced education.

Prerequisite: SEECS recipient with Junior standing at Gannon University *0 credit, Spring*

###### SEECS 401: Professional and Personal Enrichment Seminar

*See course description above*

In the first semester the SEECS seminar focuses on preparation for potential educational and career paths taken after graduation from Gannon University and on personal growth.

Prerequisite: SEECS recipient with Senior standing at Gannon University *0 credit, Fall*

###### SEECS 402: Professional and Personal Enrichment Seminar

*See course description above*

In this semester the SEECS seminar continues to focus on preparation for potential educational and career paths taken after graduation from Gannon University, and on personal growth.

Prerequisite: SEECS recipient with Senior standing at Gannon University *0 credit, Spring*

**COMPUTER SCIENCE (CS)**

The Computer Science (CS) major is designed to develop the analytical ability and expertise in computer, both in software creation and usage, which are necessary in the fields of science, technology, and industry. In addition to the computer courses, the program provides a concentration of mathematics and physics courses which are necessary for the development of scientific applications. The curriculum is oriented towards preparing students for graduate studies or career opportunities in software development where mathematical and technical skills are necessary to analyze and solve computing problems.

The Computer Science curriculum is delivered in five different ways –

1. CS: four-year degree program, described here.
2. CS-CoOp: five-year cooperative mode, described in the **CIS Department** section above.
3. CS-SE: dual degree program where students complete both the Computer Science and the Software Engineering degree requirements simultaneously described in the **Computer Science-Software Engineering Dual Degree** section.
4. SEID-CS: multi-degree, where students complete the additional requirements for a Bachelors of Engineering (B.Eng) degree in Software Technology at Esslingen University of Applied Science described in the **Software Engineering International Degrees** section.
5. CS-MS-CIS: Accelerated 5-year program culminating in a four year BS degree followed by one year to complete one of the MS-CIS program options, described below.

###### Opportunities

The field of computer science is one of the fastest-growing employment markets in today’s society. Consequently, employment and research opportunities continue to be available to program participants before graduation. Applications of the training provided in the program include a wide range of specialization, including research, statistics, and scientific applications on mobile, workstation and microprocessor computer systems.

###### Aims and Program Educational Objectives (PEO)

The CS major prepares its graduates to achieve significant career and professional accomplishments in four ways: as employable and accountable professionals, competent problem solvers, and selfless contributors.

1. *Employable Professional:* CS graduates are well prepared for employment or graduate work in their field, and to continue working in that field or related fields. This includes adaptability to different disciplines, environments, and tasks. They are fully prepared for employment in chosen post-graduate pursuits.
2. *Accountable Professional:* CS graduates are accountable for their professional roles, and pursue their profession in an ethical manner. This includes giving and receiving professional critique and review, communication and the responsibility for, and/or leadership in:
   * Research/development projects or teams,
   * Aspects of major system components, or
   * Business development work.
3. *Competent CS Problem Solver:* CS problem solving focuses on computing technology – leveraging theoretical and mathematical foundations in exploring and implementing algorithms, languages as well as the techniques and methods to innovate and develop computing systems and technologies. CS graduates apply current computing knowledge, technology, skills, techniques and methods to:
   * Identify, analyze and develop effective solutions for problems,
   * Improve product, process and/or organizational elements, and
   * Apply creativity in design thinking and innovate where appropriate.
4. *Selfless Contributors:* CS graduates value collaborative teamwork and contribute to team accomplishment that goes beyond personal development. They voluntarily give their time, talent, and/or resources to their community, profession, church and/or society.

###### Program Specific Outcomes

Gannon’s Computer Science program is accredited by the Computing Accreditation Commission of ABET[, https://www](http://www.abet.org/).abet.or[g,](http://www.abet.org/) under the commission’s General Criteria and Program Criteria for Computer Science and Similarly Named Computing Programs. Gannon’s Computer Science program has enjoyed a long history of successful students who have learned to design and build software and to apply computer science methods in both development and research domains.

Gannon’s Computer Science program has a strong focus on problem-solving beginning with the very first course in computing (**CIS 180 Problem Solving and Computer Programming**) and carried through into the senior design sequence (**CIS 457/458 Senior Design**). Throughout the learning process, students learn how to effectively define and represent both problems and the solutions needed to solve those problems. Throughout the course of study, students learn and practice making ethical decisions.

All CIS students will learn to acquire and utilize information and changing computer technology used in computing-based systems, as well as to understand its global and local impacts. Through this learning process, we expect students to function in a team environment and demonstrate effective communication skills.

Besides the Department-Wide outcomes, Computer Science students completing our program will also learn to:

* Design, implement and evaluate a computing-based solution to meet a given set of computing requirements.
* Apply computer science theory and software development fundamentals to produce computing-based solutions.

###### ABET Student Outcomes

With the combination of Department-Wide and computer science Program Specific outcomes, Gannon’s Computer Science program graduates will have an ability to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program’s discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program’s discipline.
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

###### Integration

One of the hallmarks of Gannon’s Computer Science (CS) degree is its integration with traditional liberal-studies education. Gannon’s CS majors not only learn computing well, but also learn how to synthesize, think critically, and communicate well.

###### The Program:

The CS degree requires 129 credits to graduate. These are divided into two primary sources, a Computer and Information Science (CIS) core, and a Computer-Science core. These, integrated with the Core of Discovery provide the breadth and depth to the program. The program also provides a one-semester study abroad option.

###### CIS Core Courses

CIS 180/181 Problem Solving and Computer Programming and Lab

CIS 182/183 Object-Oriented

Programming and Lab CIS 219 Programming in UNIX CIS 239 The User Experience

CIS 255 Database Management

and Administration

CIS 290 Introduction to Networks

CIS 387 System and Network Security CIS 457 Senior Design I

CIS 458 Senior Design II Lab

###### Computer Science Courses

CSC 220 Data Structures and Algorithms CSC 223 Algorithm Development Lab CIS 277 Mobile Appl. Development I CIS 287 Object-Oriented Design Lab SOFT 210 Software Engineering

CIS 326 Formal Methods in Software Development

CSC 330 Operating Systems

CSC 360 Comparative Languages CIS 390 Distributed Programming ECE 337 Computer Architecture MATH 314 Numerical Analysis MATH 310 Number Theory and

Cryptography

*All CIS course descriptions are provided in the section* ***Computer and Information Science***

*All CSC course descriptions are provided in the section* ***Computer Science***

*All CYSEC course descriptions are provided in the section* ***Cybersecurity***

*All ECE course descriptions are provided in the section* ***Electrical and Cyber Engineering***

*All SOFT course descriptions are provided in the section* ***Software Engineering***

###### Computer Science Curriculum

*(Numerals in front of courses indicate credits)*

FRESHMAN

*Fall*

* 1. Intro to Engineering/ENG 102
  2. Problem Solv. and Computer Prog./ CIS 180

1 Problem Solv. and Computer Prog. Lab/ CIS 181

3 Quantitative Reasoning: Calculus 1/ MATH 140

3 Intro. Networks/CIS 290

3 Foundational English

3 Foundations of Theology

0 Gannon 101

16

*Spring*

2 Object-Oriented Program./CIS 182

1 Object-Oriented Program. Lab/CIS 183

3 Calculus 2/MATH 141

3 Integrative History

3 Foundational Philosophy

3 Fund. Physics 1: Mechanics/PHYS 210

1 Fund. Physics 1 Mechanics Lab/ PHYS 211

16

SOPHOMORE

*Fall*

3 Data Structures and Algorithms/ CSC 220

3 The User Experience/CIS 239

3 Discrete Mathematics 1/MATH 222

3 Mobile Application Devl./CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Integrative Communication

16

*Spring*

3 Database Management and Admin./ CIS 255

1 Algorithm Development Lab/CSC 223

3 Discrete Mathematics 2/MATH 223

3 Numerical Analysis MATH 314

3 Software Engineering/SOFT 210

3 Physics 3: E&M/PHYS 214 *or* PHYS 212

1 Physics 3: E&M Lab/PHYS 215 *or*

PHYS 213

17

JUNIOR

*Fall*

3 Web Programming and Impl./CIS 355

3 Formal Methods in Software/CIS 326

3 Linux Programming/CIS 219

3 Applied Statistics MATH 213

*or* MATH 312

3 Professional Ethics/Leadership

3 Integrative Theology 18

*Spring*

1 Professional Seminar/ENG 380

3 Number Theory and Cryptogr./ MATH 310

3 CIS Technical Elective

3 Integrative Philosophy

3 Computer Architecture/ECE 337

3 Professional Communication 16

SENIOR

*Fall*

3 Senior Design I/CIS 457

3 Comparative Languages/CSC 360

3 System and Network Security/CIS 387

3 Global Citizenship

3 Operating Systems/CSC 330 15

*Spring*

3 Senior Design II Lab/CIS 458

3 Distributed Programming/CIS 390

3 Integrative English

3 Aesthetic Reasoning

3 CIS Technical Elective 15

###### Total Credits: 129

The writing and wellness requirements will be met in the LS core. Students will select courses with that designation to meet the requirements.

###### Technical Electives

Students choose two technical electives with approval of their academic advisor. Most CIS, CYSEC, CYENG, SOFT, ENGR 3xx or 4xx courses are eligible as technical electives. Courses typical for CS Technical Electives include:

CIS 207 Introduction to Business Programming: COBOL

CIS 240 Web Management and Design CIS Multimedia Prod. and Lab 245/246

SOFT 410 Software Maint. and Deployment SOFT 320 Software Architecture

CIS 353 Global Project Management CIS

385/386 Network Design and Management and Lab

CIS 375 Server Management CIS 391-6 Special Topics in CIS CIS 400 Internship

SOFT 310 Software Testing and Quality Assurance

CIS 438 Human Interface Design and Maintenance

CIS 445 Advanced Multimedia

###### Computer Science Study Abroad Curriculum

*(Numerals in front of courses indicate credits)*

FRESHMAN

*Fall*

1. Intro to Engineering/ENG 102
2. Problem Solv. and Computer Prog./ CIS 180

1 Problem Solv. and Computer Prog. Lab/ CIS 181

3 Quantitative Reasoning: Calculus 1/ MATH 140

3 Intro. Networks/CIS 290

3 Foundational English

*Spring*

2 Object-Oriented Program./CIS 182

1 Object-Oriented Program. Lab/CIS 183

3 Calculus 2/MATH 141

3 Integrative History

3 Foundational Philosophy

3 Fund. Physics 1: Mechanics/PHYS 210

1 Fund. Physics 1 Mechanics Lab/ PHYS 211

3 Foundations of Theology

16 16

SOPHOMORE

*Fall*

3 Data Structures and Algorithms/ CSC 220

3 The User Experience/CIS 239

3 Discrete Mathematics 1/MATH 222

3 Mobile Application Devl./CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Integrative Communication

16

*Spring*

3 Database Management and Admin./ CIS 255

1 Algorithm Development Lab/CSC 223

3 Discrete Mathematics 2/MATH 223

3 Numerical Analysis MATH 314

3 Professional Communication

1 Physics 3: E&M Lab/PHYS 215 *or*

PHYS 213

3 Physics 3: E&M/PHYS 214 *or* PHYS 212

17

JUNIOR

*Fall*

3 Web Programming and Impl./CIS 355

3 Formal Methods in Software/CIS 326

3 Linux Programming/CIS 219

3 Applied Statistics MATH 213 *or* MATH 312

3 Professional Ethics/Leadership

3 Integrative Theology 18

*Spring*

1 Professional Seminar/ENG 380

3 CIS Technical Elective

3 CIS Technical Elective

3 Computer Architecture/ECE 337

3 Software Engineering/SOFT 210 13

SENIOR

*Fall*

3 Senior Design I/CIS 457

3 Comparative Languages/CSC 360

3 System and Network Security/CIS 387

3 Global Citizenship

3 Operating Systems/CSC 330

3 Integrative Philosophy 18

*Spring*

3 Senior Design II Lab/CIS 458

3 Integrative English

3 Aesthetic Reasoning

3 Number Theory and Cryptogr./ MATH 310

3 Distributed Programming/CIS 390 15

###### Total Credits: 129

The writing and wellness requirements will be met in the LS core. Students will select courses with that designation to meet the requirements.

###### Accelerated 5-Year CS-MS-CIS Program

The Computer Science (CS) program provides an excellent pathway to the programs in Master of Science in Computer and Information Science (MS-CIS). Students apply to the accelerated MS program during junior year, prior to registration as a junior or senior for graduate courses. The Accelerated Program Application will be approved by the department and the dean, then sent to the registrar’s office to make a note on the student’s profile. In the Senior Year, students apply to the graduate program through Graduate Admissions to officially become a graduate student. Students have to select one of the available MS-CIS program options: Data Science (DS), Information Technology (IT) or Software Engineering (SE).

To remain in the accelerated program, students are required to maintain a 3.00 GPA in their undergraduate courses. When accepted, students rearrange their graduation plan to match one of the patterns provided below. Six credits of identified undergraduate work can be counted toward the MS-CIS degree; other MS-Equivalent courses can be counted for placement, but not credit toward MS-CIS degree requirements. The total credit count to complete the BS-CS and the MS-CIS is 129 + 24 = 153 credits.

###### BS Computer Science + MS Data Science or Information Technology Accelerated 5-year Program

*(Numerals in front of courses indicate credits)*

FRESHMAN

*Fall*

1. Intro to Engineering/ENG 102
2. Problem Solv. and Computer Prog./ CIS 180

1 Problem Solv. and Computer Prog. Lab/ CIS 181

3 Quantitative Reasoning: Calculus 1/ MATH 140

3 Intro. Networks/CIS 290

3 Foundational English

*Spring*

2 Object-Oriented Program./CIS 182

1 Object-Oriented Program. Lab/CIS 183

3 Calculus 2/MATH 141

3 Integrative History

3 Foundational Philosophy

3 Fund. Physics 1: Mechanics/PHYS 210

1 Fund. Physics 1 Mechanics Lab/ PHYS 211

3 Foundations of Theology

16 16

SOPHOMORE

*Fall*

3 Data Structures and Algorithms/ CSC 220

3 The User Experience/CIS 239

3 Discrete Mathematics 1/MATH 222

3 Mobile Application Devl./CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Integrative Theology

16

*Spring*

3 Database Management and Admin./ CIS 255

1 Algorithm Development Lab/CSC 223

3 Discrete Mathematics 2/MATH 223

3 Numerical Analysis MATH 314

3 Software Engineering/SOFT 210

1 Physics 3: E&M Lab/PHYS 215 *or*

PHYS 213

3 Physics 3: E&M/PHYS 214 *or* PHYS 212

17

JUNIOR

*Fall*

3 Web Programming and Impl./CIS 355

3 Formal Methods in Software/CIS 326

3 Linux Programming/CIS 219

3 Applied Statistics MATH 213 *or* MATH 312

3 Professional Ethics/Leadership

3 Integrative Communication

18

*Spring*

1. Number Theory and Cryptogr./ MATH 310

3 Requirements and Project Management/ CIS 350

3 Integrative Philosophy

3 Computer Architecture/ECE 337

3 Professional Communication

1 Professional Seminar/ENG 380 16

SENIOR

*Fall*

3 Senior Design I/CIS 457

3 Comparative Languages/CSC 360

3 System and Network Security/CIS 387

3 Global Citizenship

3 Operating Systems/CSC 330

3 Data Centric Systems/GCIS 516 18

*Spring*

3 Senior Design II Lab/CIS 458

3 Distributed Programming/CIS 390

3 Integrative English

3 Aesthetic Reasoning

3 Statistical Computing/GCIS 523

3 Cloud Architecture/GCIS 583 18

GRADUATE

*Fall*

3 GCIS 66x *or* GCIS65x (track dependent)

3 GCIS 66x *or* GCIS65x (track dependent)

3 Scholarship Seminar/GCIS 605 9

*Spring*

3 GCIS 66x *or* GCIS65x (track dependent)

3 GCIS Elective

3 Directed Project/GCIS 698 9

###### Total Credits: 153

The writing and wellness requirements will be met in the LS core. Students will select courses with that designation to meet the requirements.

###### BS Computer Science + MS Software Engineering Accelerated 5-year Program

*(Numerals in front of courses indicate credits)*

FRESHMAN

*Fall*

1. Intro to Engineering/ENG 102
2. Problem Solv. and Computer Prog./ CIS 180

1 Problem Solv. and Computer Prog. Lab/ CIS 181

3 Quantitative Reasoning: Calculus 1/ MATH 140

3 Intro. Networks/CIS 290

3 Foundational English

*Spring*

2 Object-Oriented Program./CIS 182

1 Object-Oriented Program. Lab/CIS 183

3 Calculus 2/MATH 141

3 Integrative History

3 Foundational Philosophy

3 Fund. Physics 1: Mechanics/PHYS 210

1 Fund. Physics 1 Mechanics Lab/ PHYS 211

3 Foundations of Theology

16 16

SOPHOMORE

*Fall*

3 Data Structures and Algorithms/ CSC 220

3 The User Experience/CIS 239

3 Discrete Mathematics 1/MATH 222

3 Mobile Application Devl./CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Integrative Theology

16

*Spring*

3 Database Management and Admin./ CIS 255

1 Algorithm Development Lab/CSC 223

3 Discrete Mathematics 2/MATH 223

3 Numerical Analysis MATH 314

3 Software Engineering/SOFT 210

1 Physics 3: E&M Lab/PHYS 215 *or*

PHYS 213

3 Physics 3: E&M/PHYS 214 *or* PHYS 212

17

JUNIOR

*Fall*

3 Web Programming and Impl./CIS 355

3 Formal Methods in Software/CIS 326

3 Linux Programming/CIS 219

3 Applied Statistics MATH 213 *or* MATH 312

3 Professional Ethics/Leadership

3 Integrative Communication

18

*Spring*

1. Number Theory and Cryptogr./ MATH 310

3 Requirements and Project Management/ CIS 350

3 Integrative Philosophy

3 Computer Architecture/ECE 337

3 Professional Communication

1 Professional Seminar/ENG 380 16

SENIOR

*Fall*

3 Senior Design I/CIS 457

3 Comparative Languages/CSC 360

3 System and Network Security/CIS 387

3 Global Citizenship

3 Operating Systems/CSC 330

3 Data Centric Systems/GCIS 516 18

*Spring*

3 Senior Design II Lab/CIS 458

3 Distributed Programming/CIS 390

3 Integrative English

3 Aesthetic Reasoning

3 Software Architecture/SOFT 320

3 Advanced Programming/GCIS 521 *or* 522

18

GRADUATE

*Fall*

3 Software Maint. and Deploy/GCIS 634

3 Interactive Software Dev./GCIS 639

3 Scholarship Seminar/GCIS 605 9

*Spring*

3 GCIS Elective

3 GCIS Elective

3 Directed Project/GCIS 698 9

###### Total Credits: 153

The writing and wellness requirements will be met in the LS core. Students will select courses with that designation to meet the requirements.

###### Computer Science Minor Requirements (19 credits)

*(Numerals in front of courses indicate credits)*

3 Problem Solving and Computer Programming and Lab/CIS 180 and CIS 181

3 Object-Oriented Programming and Lab/CIS 182 and CIS 183

3 Data Structures and Algorithms/CSC 220

3 The User Experience/CIS 239

3 Mobile Application Development I/CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Introduction to Networks/CIS 290 19

**COURSE DESCRIPTIONS**

###### CSC 220: Data Structures and Algorithms

An in-depth programming-based study of data structures and of algorithms for their manipulation. Arrays, tables, stacks, queues, trees, linked lists, sorting, searching and hashing are topics considered.

Prerequisite: CIS 182 and CIS 183 *3 credits, Fall*

###### CSC 223: Algorithm Development Lab

This course provides a closer analysis of algorithms introduced in MATH 223 and gives the student an opportunity to implement the algorithms in computer code. Fundamental techniques, searching, sorting, tree, graph and backtracking algorithms are covered.

Corequisite or Prerequisite: MATH 223

Prerequisite: CSC 220 *1 credit, Spring*

###### CSC 320: Analysis and Design of Algorithms

Focusing on the study of the design, analysis, and complexity of algorithms, fundamental techniques, searching, sorting and order statistics, and basic graph algorithms are reviewed.

The course introduces the ideas of time and space complexity. Emphasis is on providing the student with a firm background to be used for further study of algorithms using more advanced techniques.

Prerequisite: CSC 220 and MATH 222 *3 credits, Fall*

###### CSC 325: Formal Languages and Automata

The course presents the abstract models of computers (finite automata, pushdown automata, and Turing machines) and the language classes they recognize or generate (regular, context-free, and recursively enumerable). Topics include Turing machines, recursive functions, Church’s thesis, undecidability, and the halting problem. Applications of these models to compiler design, algorithms, and complexity theory are also presented.

Prerequisite: CSC 220 and MATH 222 *3 credits, Fall*

###### CSC 330: Operating Systems

An introduction to the study of operating systems. Topics covered include: process manipulation and synchronization, processor management, storage management, security, I/O and file systems, and basic distributed system concepts.

Prerequisite: CSC 220 and CIS 219 *3 credits, Fall*

###### CSC 360: Comparative Languages

An introduction to modern computing concepts and computational models as embodied in a number of different classes of languages. The course includes an introduction to (1) function- based languages such as ML. LISP, Scheme; (2) logic-based languages such as Prolog, Parlog, Strand, OPS; and (3) object-oriented languages such as JAVA, Smalltalk, Eiffel.

Prerequisite: CIS 277 *3 credits, Fall*

###### CSC 370: Compilers and Language Design

Introduction to the basic concepts of compiler design and implementation including: lexical, syntactic, semantic analysis, and target code generation. Topics are presented from an implementation point of view.

Prerequisite: CIS 219 *3 credits*

**COMPUTER SCIENCE-SOFTWARE ENGINEERING**

**DUAL DEGREE (CS-SE)**

Computer Science and Software Engineering are closely related disciplines. Software engineering focuses on engineering software into valuable products. Computer science focuses on the practice and theory supporting innovation in the computing field. The dual CS-SE major is designed to bring the two disciplines together to develop a student’s analytical ability and expertise in both software creation and usage.

This particular offering is aimed at attracting academically-gifted students, and presents all of the requirements for both of the CS and SE degrees in such a way that a student can complete the requirements in four years. As an honors program, it is ideal for students who enjoy the challenge of hard work, intellectually-engaged courses and have the desire to use computing to make a difference in the world. Due to the intense requirements, study abroad options would require an additional semester to complete.

The program is designed to allow a talented student to dive deeply into the foundational and practical aspects of computing, this program has additional admissions requirements,

and requires that all students maintain C or better in all major courses and also must maintain a 3.0 QPA.

###### Aims and Objectives

The CS-SE dual degree has the same aims as both the Software Engineering and Computer Science degree programs. It prepares its graduates to achieve significant career and professional accomplishments in four ways: as employable and accountable professionals, competent problem solvers, and selfless contributors. For more detailed descriptions, please see the aims and program educational objectives for these degree programs in the Computer Science and Software Engineering sections.

###### Program Outcomes

Gannon’s Computer Science-Software Engineering Dual Degree program has the same outcomes as both the accredited Software Engineering and Computer Science degree programs. Please see the ABET student learning outcomes for these programs in the **Computer Science** and **Software Engineering** sections.

*All CIS course descriptions are provided in the section* ***Computer and Information Science***

*All CSC course descriptions are provided in the section* ***Computer Science***

*All CYSEC course descriptions are provided in the section* ***Cybersecurity***

*All ECE course descriptions are provided in the section* ***Electrical and Cyber Engineering***

*All SOFT course descriptions are provided in the section* ***Software Engineering***

###### Computer Science-Software Engineering Dual Degree Curriculum

*(Numerals in front of courses indicate credits)*

FRESHMAN

*Fall*

1. Intro to Engineering/ENG 102
2. Problem Solv. and Computer Prog./ CIS 180

1 Problem Solv. and Computer Prog. Lab/ CIS 181

3 Quantitative Reasoning: Calculus 1/ MATH 140

3 Intro. Networks/CIS 290

3 Foundational English

*Spring*

2 Object-Oriented Program./CIS 182

1 Object-Oriented Program. Lab/CIS 183

3 Calculus 2/MATH 141

3 Integrative History

3 Foundational Philosophy

3 Fund. Physics 1: Mechanics/PHYS 210

1 Fund. Physics 1 Mechanics Lab/ PHYS 211

3 Foundations of Theology

16 16

SOPHOMORE

*Fall*

3 Data Structures and Algorithms/ CSC 220

3 The User Experience/CIS 239

3 Discrete Mathematics 1/MATH 222

3 Mobile Application Devl./CIS 277

1 Object-Oriented Design Lab/CIS 287

3 Integrative Communication

16

*Spring*

3 Database Management and Admin./ CIS 255

1 Algorithm Development Lab/CSC 223

3 Discrete Mathematics 2/MATH 223

3 Numerical Analysis MATH 314

3 Software Engineering/SOFT 210

3 Applied Statistics MATH 213 *or* MATH 312

3 Mobile Application Development II/

CIS 377

19

JUNIOR

*Fall*

3 Web Programming and Impl./CIS 355

3 Requirements and Project Management/ CIS 350

3 Linux Programming/CIS 219

3 Software Testing and Quality Assurance/ SOFT 310

3 Global Citizenship

*Spring*

1 Professional Seminar/ENG 380

3 Integrative Theology

3 Integrative Philosophy

3 Software Architecture/SOFT 320

3 Computer Architecture/ECE 337

3 Physics 3: E&M/PHYS 213 *or* PHYS 212

1 Physics 3: E&M Lab/PHYS 215 *or*

3 Professional Ethics/Leadership

PHYS 213

18 17

SENIOR

*Fall*

3 Senior Design I/CIS 457

3 Operating Systems/CSC 330

3 Software Maintenance and Deploy./ SOFT 410

3 Comparative Languages/CSC 360

3 Formal Methods in Software/CIS 326

*Spring*

3 Senior Design II Lab/CIS 458

3 Distributed Programming/CIS 390

3 Integrative English

3 Aesthetic Reasoning

3 Professional Communication

3 Number Theory and Cryptogr./

3 System and Network Security/CIS 387

MATH 310

18 18

###### Total Credits: 138

The writing and wellness requirements will be met in the LS core. Students will select courses with that designation to meet the requirements.