

Computer Science and Engineering

Chair, Professor W. Toll
Professors F. Aguilar, A. White
Associate Professors S. Brandle, J. Cramer, J. Geisler, T. Nurkkala

In support of the overall University Mission, the mission of Computer Science and Engineering is to educate men and women who sense God's calling to technical professions in the disciplines of Computer Science, Systems, and Computer Engineering.

Six baccalaureate majors are offered by the department:

- **Computer Science (BA)**
- **Computer Science (BS)**
Designed primarily for students wishing to pursue graduate study in computer science.
- **Computer Science/Systems (BS)**
Systems analysis requirements in addition to the computer science curriculum of the BA.
- **Computer Science—New Media (BA)**
Computer Science core with courses from Computer Science, Art, and Communication Arts emphasizing media use and computation.
- **Computer Science—New Media/Systems (BS)**
Systems analysis requirements in addition to the Computer Science-New Media curriculum.
- **Computer Engineering (BS)**
Combination of fundamental engineering, computer science, and electronics curricula. Program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

The department has cooperated with the Center for Research and Innovation and the School of Business in developing an entrepreneurial curriculum. Computer science majors interested in this area are encouraged to pursue the entrepreneurship minor offered by the School of Business. The proper choice of concentration and electives within the computer science major allows the student to select courses that also apply to the entrepreneurship minor.

Systems for Bachelor of Science Degree

Program Director, Professor F. Aguilar

The purpose of the systems curriculum, coordinated by the Computer Science and Engineering department and combined with the courses in the major and the general education curriculum, is to prepare a student to acquire the knowledge and skills of a systems analyst. A systems analyst attempts to help an organization solve a problem, take advantage of an opportunity, or follow a directive coming from upper management, ownership, or the government in an effective and efficient manner. Analysts play a significant role in organizational development and operation of systems. In order to do so, they assist and frequently lead the effort to plan, analyze, design, implement and support the systems and improvements to them.

Systems analysts are required to know about information technology and its uses, how and why the organization functions, and the environment in which the organization carries out its mission. Analysts must also possess skills that allow them to speak and write effectively, work with others in projects, and be able to solve problems both in individual and group settings.

Systems may be combined with any baccalaureate major. Graduates have used what they have learned in systems in a variety of arenas, including those work-related and those of further formal education. For example, computer science graduates have designed computer-related solutions to take advantage of the interconnectedness of businesses that the Internet allows; business administration graduates have analyzed companies for their roles in the global business environment to determine if investment in them is wise for their clients; and accounting graduates have assisted organizations and individuals in making intelligent systematic decisions regarding federal, state and local taxes.

Others have used their systems knowledge in their endeavors in graduate school. For example, psychology graduates have used what they learned in advanced statistics to conduct their graduate statistical studies regarding human behavior; chemistry and physics majors have designed research projects more efficiently; and mathematics majors have applied their knowledge in studies of actuarial science.

Students choosing a career in systems analysis may combine any baccalaureate major with the systems analysis curriculum. *All courses required by the systems curriculum must be completed with a grade of C- or better.*

Systems Requirements

Systems Curriculum Requirements

COS 120	4	Introduction to Computer Science I
IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design
SYS 403	3	Operations Management
xxx 393	3-4	Practicum

Select one course from the following:

COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select one course from the following:

*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

Systems Electives

Select at least three hours of electives, in addition to those required in the major or systems.

COS 265	3	Data Structures and Algorithms
COS 382	3	Language Structures
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

*Course may not count in both areas.

Depending on the student's major and other areas of interest, other courses may be required in addition to or substituted for those listed above. For example, mathematics, physics, and chemistry majors take a different sequence of mathematics courses and may elect to take a computer science course other than COS 121 or 240, subject to Computer Science and Engineering departmental approval. Business majors are not required to take IAS 330. See *academic departments (pages 59-231)* for specific curriculum requirements.

Computer Science (BA)

The bachelor of arts degree with a major in computer science requires the completion of two years of one foreign language and 71 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project except for students in the Software Studio concentration where they are included in COS 472 Software Studio IV.

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 341	4	Database Concepts
*COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

*Not required for Software Studio concentration.

Select one course from the following:

COS 320	3	Algorithm Design
COS 382	3	Language Structures
COS 435	3	Theory of Computation

Select one course from the following:

COS 393	4	Practicum
COS 452	3	Research I

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Electives: (Courses fulfilling concentration requirements may not also be used as electives.)

Select additional electives to complete the 71 total hour requirement from the following:
COS 230, 240, 280, COS 300-/400-level courses
SYS 214, 352, 401, 402, 403, 411

Select one of the following concentration areas:

Graphics

SYS 214	3	Principles of Human Computer Interaction	COS 351	3	Computer Vision
COS 314	3	Human Computer Interaction	COS 424	3	Surfaces and Modeling
COS 350	3	Computer Graphics	COS 425	3	Animation

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence	SYS 352	3	Knowledge Based Systems
COS 351	3	Computer Vision	SYS 411	3	Machine Learning
COS 380	3	Natural Language Processing			

Scientific Computing

MAT 230	4	Calculus II	MAT 251	4	Differential Equations
MAT 240	4	Calculus III	MAT 310	3	Mathematical Modeling with Numerical Analysis
MAT 245	4	Linear Algebra			

Software Studio

COS 340	3	Software Engineering	COS 471	4	Software Studio III
*COS 371	4	Software Studio I	COS 472	4	Software Studio IV
COS 372	4	Software Studio II			

*COS 371 requires SYS 390 which does not count toward the major.

Computer Science (BS)

The bachelor of science degree with a major in computer science requires the completion of 87 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 453 Research II.

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 310	1	Current Literature Survey
COS 311	2	Ethics in Computer Science
COS 320	3	Algorithm Design
COS 341	4	Database Concepts
COS 382	3	Language Structures
COS 435	3	Theory of Computation
COS 452	3	Research I
COS 453	3	Research II
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select two courses from the following:

COS 381	3	Computer Architecture
COS 421	3	Operating Systems
COS 436	3	Distributed Processing

Electives: (Courses fulfilling concentration requirements may not also be used as electives.)

Select enough electives to complete the 87-hour total requirement from:

COS 230, 240 and 280, 300-/400-level course except COS 393
SYS 214, 352, 401, 402, 403, 411

Select one of the following concentration areas:

Graphics

COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
COS 425	3	Animation
SYS 214	3	Principles of Human Computer Interaction

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence
COS 351	3	Computer Vision
COS 380	3	Natural Language Processing
SYS 352	3	Knowledge Based Systems
SYS 411	3	Machine Learning

Scientific Computing

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis

Software Studio

COS 340	3	Software Engineering
COS 371 *	4	Software Studio I*
COS 372	4	Software Studio II
COS 471	4	Software Studio III
COS 472	4	Software Studio IV

*COS 371 requires SYS 390 which does not count toward the major.

Computer Science/Systems (BS)

The bachelor of science degree with a major in computer science/systems consists of the 71 hour major requirement and curriculum requirements in systems analysis. All systems curriculum courses must be completed with a grade of C- or better. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project except for students in the Software Studio concentration where they are included in COS 472 Software Studio IV. *Courses fulfilling major core, systems, concentration or elective requirements will not meet more than one requirement.*

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 341	4	Database Concepts
COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

Select one course from the following:

COS 320	3	Algorithm Design
COS 382	3	Language Structures
COS 435	3	Theory of Computation

Select one course from the following:

COS 393	4	Practicum
COS 452	3	Research I

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

*Not required for Software Studio concentration.

Major Electives

Select enough electives to meet the 71 total hour requirement from:
COS 230, 240, 280, 300-/400-level courses SYS 314, 352, 401, 403, 411.

Systems Requirements

IAS 330	3	Human Relations in Organizations
MAT 382	3	Advanced Statistical Methods
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 402	4	Modeling and Simulation

Select one course from the following:

COS 372	4	Software Studio II
SYS 394	3	Information Systems Design

Select one course from the following:

SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
SYS 401	4	Operations Research
SYS 403	3	Operations Management
ENT 420	3	Creativity and Concept Development

Select one of the following concentration areas: (Courses fulfilling concentration requirements may not also be used as electives.)

Business Information Systems

COS 240	3	Business Application Programming
COS 340	3	Software Engineering
MGT 201	3	Business Basics Boot Camp
SYS 214	3	Principles of Human Computer Interaction

Choose one of the following:

ACC 241	3	Principles of Accounting
ENT 422	3	New Venture Planning

Graphics

SYS 214	3	Principles of Human Computer Interaction
COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics

COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
COS 425	3	Animation

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence
COS 351	3	Computer Vision
COS 380	3	Natural Language Processing

SYS 352	3	Knowledge Based Systems
SYS 411	3	Machine Learning

Scientific Computing

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra

MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis

Software Studio

COS 340	3	Software Engineering
COS 371	4	Software Studio I
COS 372	4	Software Studio II

COS 471	4	Software Studio III
COS 472	4	Software Studio IV

Computer Science Minor

A computer science minor requires 32 hours.

Minor Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 311	2	Ethics in Computer Science
COS 331	3	Data Communications
COS 341	4	Database Concepts
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis

Select one course from the following:

COS 240	3	Business Application Programming
COS 280	3	Introduction to Artificial Intelligence
COS 350	3	Computer Graphics
SYS 394	3	Information Systems Design

Computer Science–New Media (BA)

The bachelor of arts degree with a major in computer science–new media consists of two years of one foreign language and 64 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project.

Core Requirements

ART 152	3	Visual Communication
ART 154	1	Digital Tools: Illustrator
ART 156	1	Digital Tools: Photoshop
ART 158	1	Digital Tools: Dreamweaver
ART 159	1	Digital Tools: Flash
ART 253	3	Digital Photography
ART 356	3	Web Design
ART 456	3	Web Animation
COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 311	2	Ethics in Computer Science
COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 393	4	Practicum
COS 425	3	Animation
COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
SYS 214	3	Principles of Human Computer Interaction
CNM 215	3	Digital Audio Production
CNM 220	3	Digital Video Production

Select one course from the following:

COS 331	3	Data Communications
COS 341	3	Database Concepts
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
SYS 310	3	E-Commerce

Select one course from the following:

ART 151	3	Two Dimensional Design
ART 251	3	Typography
ART 353	3	Digital Photography II
CNM 330	3	Scriptwriting
CNM 345	3	Web Writing and Production

Computer Science–New Media/Systems (BS)

The bachelor of science degree with a major in computer science–new media consists of the 64 hour major requirement and curriculum requirements in systems analysis. All systems curriculum courses must be completed with a grade of C- or better. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project.

Systems Requirements

IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 310	3	E-Commerce
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar

Select one course from the following:

COS 372	4	Software Studio II
SYS 394	3	Information Systems Design

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select one course from the following:

ENT 422	3	New Venture Planning
SYS 401	4	Operations Research
SYS 402	4	Modeling and Simulation
SYS 403	3	Operations Management

Computer Engineering (BS)

Intimate knowledge of both physics and computer science is the foundation of the design and development of powerful and efficient embedded computer systems. The computer engineering major is offered jointly by the computer science and engineering & physics and engineering departments and focuses on the theoretical and applied operation of computer hardware and software.

The computer engineering program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

Program Objectives:

1. Develop Christian leaders who serve God and humanity through active service to their family, church, job and global community.
2. Develop competent computer engineers who work in situations in which they apply their broad understanding of computer science, engineering, physics and mathematics.
3. Develop computer engineers who engage in lifelong learning by applying and adapting their understanding of fundamental principles in a constantly changing field.
4. Develop computer engineers who utilize their project experience to solve complex engineering problems using a formal design methodology.
5. Develop computer engineers with a strong work ethic, good communication skills, and who act in an ethically responsible manner.

The bachelor of science degree with a major in computer engineering requires 96 hours. Majors are required to pass a comprehensive examination during their senior year. This examination includes a major design and implementation project (COS 491, 494, 495), written and oral presentation of this work, and an oral examination over coursework in the major field.

Physics and Engineering Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II
ENP 104	2	Introduction to Engineering and Software Tools
ENP 252	4	Principles of Engineering
ENP 321	2	Applied Electromagnetics
ENP 331	4	Introduction to Electronics
ENP 332	4	Control Systems
ENP 333	3	Introduction to Solid State Devices
ENP 341	4	Microcomputer Interfacing
ENP 431	4	Advanced Electronics and Microcircuits

Mathematics Requirements

MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
MAT 352	4	Mathematical Statistics

Computer Science Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 331	3	Data Communications
COS 340	3	Software Engineering
COS 381	3	Computer Architecture
COS 393	2	Practicum
COS 421	3	Operating Systems
COS 491	2	Senior Engineering Project I
COS 493	1	Computer Science Senior Capstone
COS 494	3	Senior Engineering Project II
COS 495	1	Senior Engineering Project III

Management Information Systems (AA)

An associate of arts degree with a major in management information systems has been developed for those who wish to become information systems specialists. Students enrolled in this 2-year program are preparing for vocations in the fields of computer programming and information systems. The sequence includes a combination of business, computer science, and systems analysis courses built around a core of liberal arts studies. In the 4-course sequence of SYS 101, 390, 394 and COS 393, the student approaches systems in general and management information systems in particular and completes a practicum in a systems environment outside of Taylor University. The degree program requires 67-71 hours.

Course Requirements

ACC 241	3	Accounting Principles I
ACC 242	3	Accounting Principles II
BIB 110	3	Biblical Literature I
BIB 210	3	Biblical Literature II
COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming
COS 393	4	Practicum
ENG 110	3	Expository Writing
IAS 101	1	New Student Orientation
IAS 110	3	Foundations of Christian Thought
IAS 330	3	Human Relations in Organizations
MGT 352	3	Management Analysis and Practice
MAT 210	4	Introductory Statistics
PHP 100	1	Fitness for Life
PHP 200	1	General Physical Education
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design

Select one course from the following:

CAS 110	3	Public Speaking
CAS 120	3	Interpersonal Communication

Select one course from the following:

COS 104	2	Computing and Information Concepts
COS 106	2	Computing and Information Concepts

Select one course from the following:

HUM 230	4	Art as Experience
ENG 230	3	World Literature
ENG 240	3	American Literature
ENG 250	3	British Literature

Select one course from the following:

*MAT 110	3	Finite Mathematics
MAT 151	4	Calculus I

*MAT 110 will not meet the systems requirement for a baccalaureate degree.

Computer Science Courses

COS 104 2 hours
Computing and Information Concepts
An introduction to computing issues, information technology, and the field of computer science designed to provide a foundation for future course work directly related to the student's major. Topics discussed include hardware and software, operating systems, graphical user interfaces, data storage technologies, local and network information access, spreadsheets, concepts of computation, and ethical issues. The course is designed for those with little or no previous computer experience. Credit may not be earned in both COS 104 and COS 106. Two hours of lecture and one hour of lab. *Meets general education requirement.*

COS 106 2 hours
Computing and Information Concepts
An introduction to computing issues, information technology, and the field of computer science designed to provide a foundation for future course work directly related to the student's major. Topics discussed include hardware and software, operating systems, graphical user interfaces, data storage technologies, local and network information access, advanced spreadsheets, concepts of computation, and ethical issues. The course is designed for those with significant previous computer experience. Credit may not be earned in both COS 104 and COS 106. Two hours of lecture and one hour of lab. *Meets general education requirement.*

COS 120 4 hours
Introduction to Computer Science I
Problem solving and computer programming are stressed. Algorithms for text processing, information retrieval, mathematical manipulation, sorting, file handling, and introductory data structures are presented. Good algorithm design, style, program structure, documentation, code reading, and introductory software engineering techniques are emphasized. Three hours of lecture and two hours of lab per week. *Does not count as a general education requirement.*

COS 121 4 hours
Introduction to Computer Science II
This course is a continuation of COS 120 and includes the introduction of object-oriented programming, simple data structures such as lists, stacks, queues, and trees, and an introduction to computational complexity. Three hours of lecture and two hours of lab per week. *Prerequisite: COS 120.*

COS 170 1-4 hours
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

COS 230 3 hours
Missions Technology
A survey and in-depth study of technology applied to Christian missions. Theory and issues in application are developed. Interaction with missions agencies and a practical project are included. *Prerequisites: COS 120.*

COS 240 3 hours
Business Application Programming
File types and data structures typically found in business information systems are investigated. Students are given the opportunity to implement various application solutions. Most commonly used features of the Visual Basic language and GUI design are presented and practiced. Basic database concepts and database/interface integration are emphasized. *Prerequisites: COS 120, SYS 101.*

COS 264 3 hours
Interactive Application Development
Design and implementation for interactive computer applications are studied. Topics include web interaction, security, two- and three-tier applications, client-side and server-side scripting and event-based programming. XHTML, CSS, Perl, PHP, Javascript (including AJAX), MySQL, XML and other tools are utilized. *Prerequisite: COS 121.*

COS 265 3 hours
Data Structures and Algorithms
A survey of data structures and algorithms that operate on them, with an emphasis on abstract data types and analysis of computational complexity. *Prerequisite: COS 121.*

COS 270 1-4 hours
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

COS 280 3 hours
Introduction to Artificial Intelligence
A survey of the field of artificial intelligence. Major areas of exploration include search, logic, learning, knowledge representation, problem solving, natural language processing, computer vision, robotics, expert systems, and neural networks. An introduction to LISP is included. *Prerequisite: COS 121.*

COS 284 3 hours
Introduction to Computer Systems
This course provides an integrated introduction to computer hardware architecture, operating systems, and their interaction. Assembly language and operating system programming are emphasized. *Prerequisite: COS 121, MAT 215.*

COS 310 1 hour
Current Literature Survey
A survey of classical and current literature in computer science. A goal of the course is to produce a concept for a research proposal with literature survey appropriate for an undergraduate research project. Students lead discussions on papers and topics of interest. *Prerequisite: one 300-level COS course.*

COS 311 2 hours
Ethics in Computer Science
A study of the ethical implications of computers in society and the role of Christians as computer science and engineering professionals. Several of the major ethical issues in the field, such as privacy, piracy, liability, equity, and whistle-blowing are explored. Professional society codes of conduct are examined and discussed. Legal and ethical issues such as piracy, copyright and fair use related to media are also addressed. Ethical concerns of computer science and systems analysis and their relationship to one's faith are an integral part of this course.

COS 314 3 hours
Human Computer Interaction
This course builds on concepts from SYS 214 and implementation techniques from COS 264 as well as introducing additional implementation strategies. Interfaces for web and standalone applications are studied and implemented. *Prerequisites: SYS 214, COS 264.*

COS 320 3 hours
Algorithm Design
Algorithms and related data structures from a variety of areas are examined and analyzed. Parallel processing paradigms and theoretical topics, such as complexity models, are introduced. *Prerequisites: COS 265, MAT 215.*

COS 331 3 hours
Data Communications
A study of the nature and applications of data communications in use today. Fundamental concepts of types, modes, and media of transmission are studied. Communication protocols and their encompassing architectures are analyzed and compared. Practical applications of data communications concepts are demonstrated through networking projects and development of communications software. *Prerequisite: COS 121.*

COS 340 3 hours
Software Engineering
A study of the concepts, procedures, and tools of large system software project development, including project estimation and management, software technical metrics, configuration management, and software testing. Concepts of software engineering are introduced using the development of a large software system as an instructional illustration. The project is designed and its development managed using the methods and techniques examined in the course. *Prerequisite: COS 121.*

COS 341 4 hours
Database Concepts
A study of the fundamental concepts of relational database technology. Topics include data modeling, physical database design with emphasis on implementing integrity constraints, SQL query language, stored procedures and triggers, indexes, and transaction management. Students work primarily with the SQL Server database product. *Prerequisites: COS 121, SYS 101, MAT 215.*

COS 342 3 hours
Information Security
An overview of the issues involved in making information secure, including policies, protection models, authentication, auditing, intrusion detection, and access control. The design and implementation of secure software is emphasized. *Prerequisite: COS 121.*

COS 350 3 hours
Computer Graphics
An introductory course in computer graphics with an emphasis on 3D image production using a variety of approaches, including OpenGL programming. Basic algorithms, data structures, and GUI programming are introduced. *Prerequisite: COS 121.*

COS 351 3 hours
Computer Vision
A study of the fundamental concepts of digital image acquisition, manipulation, enhancement, representation, analysis and understanding. *Prerequisite: COS 121. Offered spring semester of even years.*

COS 360 1-4 hours
Independent Study
An individualized, directed study involving a specified topic.

COS 370 1-4 hours
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements. Prerequisites: Two courses in computer science.*

COS 371 4 hours
Software Studio I
The first course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio I and III will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the two year span of this set of courses. Department approval is required based on student ability and the availability of appropriate projects. *Corequisites: SYS 390.*

COS 372 4 hours
Software Studio II
The second course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio II and IV will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the 2 year span of this set of courses. *Prerequisite: COS 371.*

COS 380 3 hours
Natural Language Processing
A study of the automation of human communication abilities, covering both textual and vocal aspects. Major topics include language understanding, representation, enhancement, generation, translation, and speaker/author recognition. *Prerequisite: COS 280. Offered spring semester of odd years.*

COS 381 3 hours
Computer Architecture
A study of the hardware structure of computer systems, including arithmetic/logic units, memory organization, control unit design, pipelining, and instruction set design. A brief introduction to advanced topics, such as out-of-order execution, branch prediction, multi-core systems, and parallel processing will prepare the student for graduate level courses in architecture. *Prerequisites: COS 284, MAT 215.*

COS 382 3 hours
Language Structures
A study of the features and implementation issues of programming languages, including a survey of language paradigms. Grammars, syntax, semantics, translation, lexical analysis, and parsing are introduced. *Prerequisite: COS 265.*

COS 393 4 hours
Practicum
Supervised learning involving a first-hand field experience or a project. Practicum course credit requires 320 hours of work experience. *Grade only. Offered primarily during summer.*

COS 421 3 hours
Operating Systems
A study of the design considerations of computer operating systems and their interaction with hardware features. Topics covered include process management, storage management, protection and security, and distributed systems. *Prerequisites: COS 265, 284.*

COS 424 3 hours
Surfaces and Modeling
An advanced graphics course with emphasis on curve and surface representation and geometric modeling. Mathematics and algorithms are studied. Topics include Bezier and B-spline curves and surfaces and geometric modeling techniques. *Prerequisite: COS 350.*

COS 425 3 hours
Animation
An advanced graphics course with emphasis on techniques for rendering and animation. Mathematics and algorithms are studied. Topics include light and illumination models, ray tracing, methods to enhance realism, and standard animation techniques. A professional software package will be used to create a significant animation. *Prerequisite: COS 350.*

COS 435 3 hours
Theory of Computation
A theoretical treatment of what can be computed and how efficiently computation can be done. Topics include models of computation and automata, deterministic and non-deterministic computations, and formal language theory. *Prerequisite: COS 265*

COS 436 3 hours
Distributed Processing
A study of concepts and models of distributed and parallel computing, including concurrency, synchronization, theoretical design, algorithms, implications of hardware organization, clusters, grid computing, and common programming environments. *Prerequisite: COS 265.*

COS 450 1-4 hours
Directed Research
Independent or small group projects. *May be taken by any COS major with instructor approval.*

COS 452 3 hours
Research I
Participation in a research project under faculty direction. *May be repeated. Permission of the instructor required.*

SYS 390 3 hours
Information Systems Analysis
A study of the knowledge and skills needed to conduct the definition and analysis phases of an information system project. Central concepts are quality management and business process reengineering. Problem definition, information gathering, data and process modeling, and specification of logical system requirements using a business event methodology are emphasized. Learning is by doing: a major project is begun in this course and completed in SYS 394. *Prerequisites: Junior standing, COS 121 or 240; SYS 101.*

SYS 392 1 hour
Systems Seminar
This course provides a survey of systems topics with an emphasis on current development in many disciplines. Guest, faculty, and student presentations, plus occasional panel discussions, provide the format. May be taken twice. *Prerequisite: SYS 101.*

SYS 393 1-4 hours
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

SYS 394 3 hours
Information Systems Design
A study of the knowledge and skills needed to conduct the design and construction phases of an information system project. Central concepts are: translating a logical design into a physical design, project management, and client-server architectures. Students will learn and use application technologies powering the World Wide Web. Learning is by doing: the major project defined and analyzed in SYS 390 will be designed and built. *Prerequisite: SYS 390.*

SYS 401 4 hours
Operations Research
Examination of mathematical techniques used in systems analysis, including mathematical programming, probability models, optimization, and statistical techniques, with an emphasis on applications using computer assisted instruction. *Prerequisites: The following courses (or their approved substitutes) must have been completed with a grade of C- or better: SYS 101, COS 121 or 240, MAT 210 or 352, MAT 146 or 151.*

SYS 402 4 hours
Modeling and Simulation
A study of mathematical modeling and simulation methods, focusing on discrete systems. A variety of simulation languages are reviewed, but Extend is used extensively. Many applications are surveyed and group term projects are carried out. *Prerequisites: The following courses (or their approved substitutes) must have been completed with a grade of C- or better: COS 121 or 240, MAT 210 and 382 or 352, MAT 146 or 151. (MAT 382 may be taken as a corequisite.)*

SYS 403 3 hours
Operations Management
This course presents the design (quality management, process design, and statistical process control) and operations (supply chain management, forecasting, inventory management, and resource planning) of productive systems. Quality, competitiveness in a global economy, and quantitative management are emphasized throughout the course. *Prerequisite: MAT 151.*

SYS 411 3 hours
Machine Learning
Classification learning systems of various types are explored. These include statistical pattern recognition, neural networks, genetic algorithms, and methods for inducing decision trees and production rules. Existing systems are reviewed. Group term projects allow development of and experimentation with a system of interest. *Prerequisite: COS 280.*

SYS 450 1-4 hours
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

SYS 480 1-4 hours
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

SYS 490 1-2 hours
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.0 GPA in the major field.

Notes