Computer Science and Computer Engineering (CSCE)

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Department of Computer Science and Computer Engineering Website (https://computer-science-and-computer-engineering.uark.edu/)

The faculty of the Computer Science and Computer Engineering Department is engaged in multidisciplinary academic research, course offerings, and student projects in areas such as: networking, data security, low power chip design, Web search, embedded systems, and graphics.

The educational objectives of the department are to produce graduates who are recruited in a competitive market and make valuable contributions to a wide variety of industries, particularly in computer and information technology; succeed in graduate or professional studies; pursue life-long learning and continued professional development; and undertake leadership roles in their profession, in their communities, and in the global society.

Accreditations

The B.S. in Computer Engineering is accredited by the Engineering Accreditation Commission of ABET, www. abet.org (https://www.abet.org/). The B.S. in Computer Science is accredited by the Computing Accreditation Commission of ABET, www.abet.org (https://www.abet.org/).

Requirements for B.S. in Computer Engineering

The computer engineering degree has required sequences of courses in both hardware and software aspects of computer applications and design. Since almost all of today's complex systems encompass hardware and software elements, computer engineering graduates must acquire the skills required to design, build, and test complex digital systems. At the advanced level, students are exposed to hands-on experience with open-ended problems with opportunities for research and design.

The Bachelor of Science in Computer Engineering program culminates in a capstone project completed in two consecutive semesters. In the first semester, students form teams and develop a project proposal. In the second semester, students develop, implement, and present the final project.

Computer Engineering B.S.Cmp.E. Eight-Semester Degree Program

The following sections contain the list of courses required for the Bachelor of Science in Computer Engineering (B.S.Cmp.E.) with a suggested sequence below.

Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

First Year	Units	
	Fall	Spring
GNEG 11101 Introduction to Engineering I	1	
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405)[1]	4	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
U.S. History Elective (Satisfies General Education Outcomes 3.2 and 4.2) Choose from one of the following courses:	3	
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
GNEG 11201 Introduction to Engineering II		1
MATH 25004 Calculus II		4
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034) (Satisfies General Education Outcome 3.4)		4
Freshman Science Elective (Satisfies General Education Outcome 3.4) Choose one of the following science and corresponding lab options:		4
BIOL 10103 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture)		
BIOL 10101 Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)		
CHEM 14203 University Chemistry II (ACTS Equivalency = CHEM 1424 Lecture)		
CHEM 14201 University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab)		
GEOL 11103 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)		
GEOL 11101 Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
Year Total:	14	16

Second Year	Units	
	Fall	Spring
CSCE 20004 Programming Foundations I	4	
CSCE 21104 Digital Design	4	
MATH 26004 Calculus III	4	
PHYS 20404 University Physics II (ACTS Equivalency = PHYS 2044 Lecture) (Satisfies General Education Outcome 3.4)	4	
CSCE 20104 Programming Foundations II		4
CSCE 22104 Computer Organization		4

MATH 25804 Elementary Differential Equations		4
MATH 26103 Discrete Mathematics		3
Social Sciences Elective (Satisfies General Education Outcomes 3.3 and 4.1)[2]		3
Year Total:	16	18

Third Year		**Units**
	Fall	**Spring**
CSCE 31903 Programming Paradigms	3	
CSCE 36103 Operating Systems	3	
CSCE 39503 System Synthesis and Modeling	3	
Social Sciences Elective (Satisfies General Education Outcome 3.3)[3]	3	
INEG 33103 Engineering Probability and Statistics[4]	3	
CSCE 35103 Software Engineering (Satisfies General Education Outcome 6.1)		3
CSCE Elective (4000 level)		3
ELEG 39903 Circuits & Electronics		3
PHIL 31003 Ethics and the Professions (Satisfies General Education Outcome 5.1)		3
SPCH 10003 Public Speaking (ACTS Equivalency = SPCH 1003)		3
Year Total:	15	15

Fourth Year		**Units**
	Fall	**Spring**
CSCE 45601 Capstone I	1	
CSCE 41104 Embedded Systems	4	
CSCE Elective (4000 level)	3	
CSCE Elective (4000 level)	3	
Fine Arts Elective (Satisfies General Education Outcome 3.1)[5]	3	
General Elective	3	
CSCE 42103 Computer Architecture		3
CSCE 49603 Capstone II		3
CSCE Elective (4000 level)		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[3]		3
General elective		3
Year Total:	17	15

Total Units in Sequence:	**126**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

2 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 111H3, HIST 11293, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 20103, SOCI 201H3, or SOCI 20103.

3 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 201H3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

4 Student may petition to take the two-course sequence, STAT 30133 and STAT 31133, instead of INEG 33103.

5 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 10003, THTR 10103, or THTR 101H3.

Program Educational Objectives

For the B.S. degree program in computer engineering, the following set of program educational objectives describe what graduates are expected to attain within a few years after graduation.
Computer Engineering graduates will:

1. Be able to practice their profession in a competitive market. The competitive market includes being recruited by industrial firms, government agencies and graduate schools.
2. Make a significant contribution to society, including improving the standard of living particularly for the taxpayers of the state of Arkansas.
3. Understand the need for life-long learning and continued professional development for a successful and rewarding career.
4. Accept responsibility for leadership roles, in their profession, communities, and society.

Student Learning Outcomes

- CE1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- CE2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- CE3. An ability to communicate effectively with a range of audiences.
- CE4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- CE5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- CE6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- CE7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Requirements for B.S.Cmp.E. with Cybersecurity Concentration

The computer engineering degree has required sequences of courses in both hardware and software aspects of computer applications and design. Since almost all of today's complex systems encompass hardware and

software elements, computer engineering graduates must acquire the skills required to design, build, and test complex digital systems. At the advanced level, students are exposed to hands-on experience with open-ended problems with opportunities for research and design.

The Bachelor of Science in Computer Engineering program culminates in a capstone project completed in two consecutive semesters. In the first semester, students form teams and develop a project proposal. In the second semester, students develop, implement, and present the final project.

Additional Requirements for the Cybersecurity Concentration:

The requirements for the Computer Engineering degree with Cybersecurity Concentration include completing the B.S. in Computer Engineering requirements and 9 semester credit hours in the area of cybersecurity. Courses satisfying the cybersecurity topics are listed below.

Choose three courses from the following list of CSCE Cybersecurity Electives:	9
CSCE 44303 Cryptography	
CSCE 47503 Computer Networks	
CSCE 47803 Cloud Computing and Security	
CSCE 48103 Computer Graphics	

Computer Engineering with Cybersecurity Concentration
Eight-Semester Degree Program

The following sections contain the list of courses required for the Bachelor of Science in Computer Engineering: Cybersecurity Concentration with a suggested sequence below.

Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

First Year	Units Fall	Units Spring
GNEG 11101 Introduction to Engineering I	1	
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013)	3	
U.S. History Elective (Satisfies General Education Outcomes 3.2 and 4.2) Choose from one of the following courses:	3	
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
GNEG 11201 Introduction to Engineering II		1
MATH 25004 Calculus II		4
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034) (Satisfies General Education Outcome 3.4)		4
Freshman Science Elective (Satisfies General Education Outcome 3.4) Choose one of the following science and corresponding lab options:		4
BIOL 10103 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture)		
BIOL 10101 Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)		
CHEM 14203 University Chemistry II (ACTS Equivalency = CHEM 1424 Lecture)		
CHEM 14201 University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab)		
GEOL 11103 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)		
GEOL 11101 Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023)		3
Year Total:	14	16

Second Year	Units Fall	Units Spring
CSCE 20004 Programming Foundations I	4	
CSCE 21104 Digital Design	4	
MATH 26004 Calculus III	4	
PHYS 20404 University Physics II (ACTS Equivalency = PHYS 2044 Lecture) (Satisfies General Education Outcome 3.4)	4	
CSCE 20104 Programming Foundations II		4
CSCE 22104 Computer Organization		4
MATH 25804 Elementary Differential Equations		4
MATH 26103 Discrete Mathematics		3
Social Sciences Elective (Satisfies General Education Outcomes 3.3 and 4.1)[2]		3
Year Total:	16	18

Third Year	Units Fall	Units Spring
CSCE 31903 Programming Paradigms	3	
CSCE 36103 Operating Systems	3	
CSCE 39503 System Synthesis and Modeling	3	
Social Sciences Elective (Satisfies General Education Outcome 3.3)[3]	3	
INEG 33103 Engineering Probability and Statistics[4]	3	
CSCE 35103 Software Engineering (Satisfies General Education Outcome 6.1)		3
CSCE Cybersecurity Elective (4000 level)		3
ELEG 39903 Circuits & Electronics		3
PHIL 31003 Ethics and the Professions (Satisfies General Education Outcome 5.1)		3
SPCH 10003 Public Speaking (ACTS Equivalency = SPCH 1003)		3
Year Total:	15	15

Fourth Year		Units
	Fall	Spring
CSCE 45601 Capstone I	1	
CSCE 41104 Embedded Systems	4	
CSCE Cybersecurity Elective (4000 level)	3	
CSCE Elective (4000 level)	3	
Fine Arts Elective (Satisfies General Education Outcome 3.1)[5]	3	
General Elective	3	
CSCE 42103 Computer Architecture		3
CSCE 49603 Capstone II		3
CSCE Cybersecurity Elective (4000 level)		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[3]		3
General elective		3
Year Total:	17	15
Total Units in Sequence:		**126**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

2 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 111H3, HIST 11293, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 20103, SOCI 201H3, or SOCI 20103.

3 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11013, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 201H3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

4 Student may petition to take the two-course sequence, STAT 30133 and STAT 31133, instead of INEG 33103.

5 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 10003, THTR 10103, or THTR 101H3.

Requirements for B.S. in Computer Science

Computer science core courses include the fundamentals of programming concepts, operating systems, algorithms, formal languages, and database management systems.

The Bachelor of Science in Computer Science program culminates in a capstone project completed in two consecutive semesters. In the first semester, students form teams and develop a project proposal. In the second semester, students develop, implement, and present the final project.

Computer Science B.S.C.S. Eight-Semester Degree Program

The following sections contain the list of courses required for the Bachelor of Science in Computer Science (B.S.C.S.) degree with a suggested sequence below.

Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

First Year		Units
	Fall	Spring
GNEG 11101 Introduction to Engineering I	1	
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
History Elective (Satisfies General Education Outcomes 3.2 and 4.2). Choose from one of the following courses:	3	
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
GNEG 11201 Introduction to Engineering II		1
MATH 25004 Calculus II		4
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034)		4
Freshman Science Elective (Satisfies General Education Outcome 3.4) Choose one of the following science and corresponding lab options:		4
BIOL 10103 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture)		
BIOL 10101 Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)		
CHEM 14203 University Chemistry II (ACTS Equivalency = CHEM 1424 Lecture)		
CHEM 14201 University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab)		
GEOL 11103 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)		
GEOL 11101 Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
PHYS 20404 University Physics II (ACTS Equivalency = PHYS 2044 Lecture) (For students who already have credit for PHYS 2054, they may wish to select PHYS 2074 for their Freshman Science Elective.)		

ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
Year Total:	14	16

Second Year	Units	
	Fall	Spring
CSCE 20004 Programming Foundations I	4	
CSCE 21104 Digital Design	4	
MATH 26103 Discrete Mathematics	3	
Fine Arts Elective (Satisfies General Education Outcome 3.1)[2]	3	
Social Sciences Elective (Satisfies General Education Outcomes 3.3 and 4.1)[3]	3	
CSCE 20104 Programming Foundations II		4
CSCE 22104 Computer Organization		4
MATH 30803 Linear Algebra		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[4]		3
Year Total:	17	14

Third Year	Units	
	Fall	Spring
CSCE 31903 Programming Paradigms	3	
CSCE 36103 Operating Systems	3	
INEG 33103 Engineering Probability and Statistics[5]	3	
PHIL 31003 Ethics and the Professions (Satisfies General Education Outcome 5.1)	3	
General Elective	3	
CSCE 35103 Software Engineering (Satisfies General Education Outcome 6.1)		3
CSCE 45203 Database Management Systems		3
CSCE Elective (4000 level)		3
MATH 31003 Combinatorics		3
SPCH 10003 Public Speaking (ACTS Equivalency = SPCH 1003) (Satisfies General Education Outcome 1.2)		3
Year Total:	15	15

Fourth Year	Units	
	Fall	Spring
CSCE 45601 Capstone I	1	
CSCE 41303 Algorithms	3	
CSCE 47503 Computer Networks	3	
CSCE Elective (4000 level)	3	
General Elective	3	
General Elective	3	
CSCE 49603 Capstone II		3
CSCE 43203 Formal Languages and Computability		3
CSCE Elective (4000 level)		3
General Elective		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[4]		3
Year Total:	16	15

Total Units in Sequence:	**122**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

2 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 1003, THTR 10103, or THTR 101H3.

3 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 111H3, HIST 1123, HIST 112H3, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 20103, SOCI 201H3, or SOCI 20103.

4 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 201H3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

5 Student may petition to take the two-course sequence, STAT 30133 and STAT 31133, instead of INEG 33103.

Program Educational Objectives

For the B.S. degree program in computer science, the following set of program educational objectives describe what graduates are expected to attain within a few years after graduation.

Computer Science graduates will:

1. Enhance Arkansas' and the nation's information technology industry.
2. Engage in advanced study of Computer Science and other fields, including engineering, law, medicine, and business.
3. Possess a sufficiently broad education to be inquisitive, well-informed reasoning members of their profession and society.
4. Understand human, social and ethical issues so that they will be good employees or employers, citizens and neighbors.

Student Learning Outcomes

- CS1. An ability to analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- CS2. An ability to design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
- CS3. An ability to communicate effectively in a variety of professional contexts.

- CS4. An ability to recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.
- CS5. An ability to function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
- CS6. An ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Requirements for B.S.C.S. with Cybersecurity Concentration

Computer science core courses include the fundamentals of programming concepts, operating systems, algorithms, formal languages, and database management systems.

The Bachelor of Science in Computer Science program culminates in a capstone project completed in two consecutive semesters. In the first semester, students form teams and develop a project proposal. In the second semester, students develop, implement, and present the final project.

Additional Requirements for the Cybersecurity Concentration:

Requirements for the Computer Science major with Cybersecurity Concentration include completing the B.S. in Computer Science requirements and 9 semester credit hours in the area of cybersecurity. Courses satisfying the cybersecurity topics are listed below.

Take the following CSCE Cybersecurity electives		
CSCE 44303	Cryptography	3
CSCE 47803	Cloud Computing and Security	3
CSCE 48503	Information Security	3
Total Hours		**9**

B.S. in Computer Science With Cybersecurity Concentration
Eight-Semester Degree Program

The following sections contain the list of courses required for the Bachelor of Science in Computer Science: Cybersecurity Concentration (CSCEBS-CYBR) degree with a suggested sequence below.

Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

First Year	Units	
	Fall	Spring
GNEG 11101 Introduction to Engineering I	1	
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
History Elective (Satisfies General Education Outcomes 3.2 and 4.2). Choose from one of the following courses:	3	
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
GNEG 11201 Introduction to Engineering II		1
MATH 25004 Calculus II		4
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034)		4
Freshman Science Elective (Satisfies General Education Outcome 3.4) Choose one of the following science and corresponding lab options:		4
BIOL 10103 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture)		
BIOL 10101 Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab)		
CHEM 14203 University Chemistry II (ACTS Equivalency = CHEM 1424 Lecture)		
CHEM 14201 University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab)		
GEOL 11103 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)		
GEOL 11101 Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
PHYS 20404 University Physics II (ACTS Equivalency = PHYS 2044 Lecture) (For students who already have credit for PHYS 2054, they may wish to select PHYS 2074 for their Freshman Science Elective.)		
ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
Year Total:	14	16

Second Year	Units	
	Fall	Spring
CSCE 20004 Programming Foundations I	4	
CSCE 21104 Digital Design	4	
MATH 26103 Discrete Mathematics	3	
Fine Arts Elective (Satisfies General Education Outcome 3.1)[2]	3	
Social Sciences Elective (Satisfies General Education Outcomes 3.3 and 4.1)[3]	3	
CSCE 20104 Programming Foundations II		4
CSCE 22104 Computer Organization		4
MATH 30803 Linear Algebra		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[4]		3
Year Total:	17	14

Third Year	Units	
	Fall	Spring
CSCE 31903 Programming Paradigms	3	
CSCE 36103 Operating Systems	3	
INEG 33103 Engineering Probability and Statistics[5]	3	
PHIL 31003 Ethics and the Professions (Satisfies General Education Outcome 5.1)	3	
General Elective	3	
CSCE 35103 Software Engineering (Satisfies General Education Outcome 6.1)		3
CSCE 45203 Database Management Systems		3
CSCE Cybersecurity Elective (4000 level)		3
MATH 31003 Combinatorics		3
SPCH 10003 Public Speaking (ACTS Equivalency = SPCH 1003) (Satisfies General Education Outcome 1.2)		3
Year Total:	15	15

Fourth Year	Units	
	Fall	Spring
CSCE 45601 Capstone I	1	
CSCE 41303 Algorithms	3	
CSCE 47503 Computer Networks	3	
CSCE Cybersecurity Elective (4000 level)	3	
General Elective	3	
General Elective	3	
CSCE 49603 Capstone II		3
CSCE 43203 Formal Languages and Computability		3
CSCE Cybersecurity Elective (4000 level)		3
General Elective		3
Social Sciences Elective (Satisfies General Education Outcome 3.3)[4]		3
Year Total:	16	15

Total Units in Sequence:	122

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

2 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 10003, THTR 10103, or THTR 101H3.

3 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 10103, SOCI 101H3, or SOCI 20103.

4 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 2013, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 101H3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

5 Student may petition to take the two-course sequence, STAT 30133 and STAT 31133, instead of INEG 33103.

Requirements for B.A. in Computer Science

The Bachelor of Arts in Computer Science degree has the same educational objectives as the Bachelor of Science degree. However, the course requirements differ greatly to allow students to double major or pursue other interests.

Humanities and social science electives are selected from the State Minimum Core Requirements listed in the Catalog of Studies. To satisfy the State Minimum Core, all CSCE students are required to take the following 18 hours of humanities/social science courses:

PHIL 31003	Ethics and the Professions	3
Fine Arts from Category "A"		3
U.S. History		3
Social Science		9

The Undergraduate Handbook has a list of approved basic science, mathematics, and technical electives. Any course not included in these lists requires faculty approval.

Degree Program Changes

Students must meet all requirements of their degree programs and are expected to keep informed concerning current regulations, policies, and program requirements in their fields of study. Changes made in the curriculum at a level beyond that at which a student is enrolled might become graduation requirements for that student. Changes made in the curriculum at a level lower than the one at which a student is enrolled are not required of that student. Students should consult their departmental adviser for additional information.

Computer Science B.A. Eight-Semester Degree Program

The following sections contain the list of courses required for the Bachelor of Arts in Computer Science (B.A.) degrees with a suggested sequence below.

Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program.

Scholarship students may need to take General Elective hours in First Year, Fall and Spring Semesters, as well as the Third Year, Spring Semester for 15 semester hours.

First Year	Units	
	Fall	Spring
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	

MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
Social Sciences Elective Satisfies General Education Outcomes (3.3 and 4.1) [2]	3	
Select one of the following Satisfies General Education Outcomes (3.2 and 4.2)	3	
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
CSCE 20004 Programming Foundations I		4
CSCE 21104 Digital Design		4
ENGL 10203 Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.1) or ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023)		3
MATH 26103 Discrete Mathematics		3
Year Total:	13	14

Second Year		**Units**
	Fall	**Spring**
CSCE 20104 Programming Foundations II	4	
CSCE 22104 Computer Organization	4	
Fine Arts Elective (Satisfies General Education Outcome 3.1)[3]	3	
Social Sciences Elective (Satisfies General Education Outcome 3.3)[4]	3	
General Elective	3	
CSCE 31903 Programming Paradigms		3
SPCH 10003 Public Speaking (ACTS Equivalency = SPCH 1003) (Satisfies General Education Outcomes 1.2 and 5.1)		3
MATH 21003 Principles of Statistics (ACTS Equivalency = MATH 2103)		3
Two General Electives		6
Year Total:	17	15

Third Year		**Units**
	Fall	**Spring**
CSCE 35103 Software Engineering (Satisfies General Education Outcome 6.1)	3	
ENGL 30503 Technical and Professional Writing (ACTS Equivalency = ENGL 2023)	3	
Science Elective (Meets State Minimum Core and Satisfies General Education Outcome 3.4)	4	
Two General Electives	6	
PHIL 31003 Ethics and the Professions[5]		3
CSCE 36103 Operating Systems		3
Social Science Elective (Satisfies General Education Outcome 3.3)[3]		3
Two General Electives		5
Year Total:	16	14

Fourth Year		**Units**
	Fall	**Spring**
Two CSCE electives (3000 level or higher)	6	
Science Elective (Meets State Minimum Core and Satisfies General Education Outcome 3.4)	4	
Two General Electives (3000 level or higher)	6	
Two CSCE electives (3000 level or higher)		6
Three General Electives (3000 level or Higher)		9
Year Total:	16	15

Total Units in Sequence:	**120**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

2 The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 11293, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 10103, SOCI 201H3, or SOCI 20103.

3 The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 10003, THTR 10103, or THTR 101H3.

4 The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 2813H, PSYC 20003, RESM 28503, SOCI 20103, SOCI 201h3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

5 PHIL 31003 also meets Humanities Elective for State Minimum Core and Satisfies General Education Outcomes 3.2 and 5.1.

Requirements for a Minor in Computer Science:

CSCE 20004	Programming Foundations I	4
CSCE 20104	Programming Foundations II	4
CSCE 31903	Programming Paradigms	3
Three additional CSCE courses numbered above 2000.		9
Total Hours		**20**

Requirements for Departmental Honors in Computer Science and Computer Engineering

The Honors Program in Computer Science and Computer Engineering is designed for the superior student and is intended to help the student develop a more comprehensive view of Computer Science and Computer Engineering. The program provides a vehicle for the recognition of achievements beyond the usual course of study. Higher degree distinctions are recommended only in truly exceptional cases and are

based upon the candidate's whole program of honors studies. A minimum of 12 hours of honors coursework is required.

The following requirements are necessary for graduation with honors in either the Computer Engineering or Computer Science Bachelor of Science program:

1. The candidate must satisfy the requirements set forth by the College of Engineering.
2. The student must obtain at least a 3.50 grade-point average in required Computer Engineering and/or Computer Science courses.
3. The student must complete 6 hours of Honors credit in the major, which includes 3 hours of Honors Thesis taken as successive semesters of CSCE 491HV and 3 hours of CSCE coursework.

Faculty

Andrews, David, Ph.D. (Syracuse University), M.S., B.S.E.E. (University of Missouri-Columbia), Professor, Department of Electrical Engineering and Computer Science, Thomas Mullins Chair of Computer Science and Computer Engineering, 2008.
Di, Jia, Ph.D. (University of Central Florida), M.S., B.S. (Tsinghua University), Professor, Department of Electrical Engineering and Computer Science, 21st Century Research Leadership Chair, 2004, 2014.
Dix, Jeffrey, Ph.D., M.S., B.S.E.E., (University of Tennessee, Knoxville), Assistant Professor, Department of Electrical Engineering and Computer Science, 2018.
Gashler, Michael, Ph.D., M.S., B.S. (Brigham Young University), Teaching Associate Professor, Department of Electrical Engineering and Computer Science, 2023.
Gauch, John Michael, Ph.D. (University of North Carolina at Chapel Hill), M.Sc., B.Sc. (Queen's University, Canada), Professor, Department of Electrical Engineering and Computer Science, 2008.
Gauch, Susan E., Ph.D. (University of North Carolina at Chapel Hill), M.Sc., B.Sc. (Queen's University, Canada), Professor, Department of Electrical Engineering and Computer Science, 2007.
Huang, Miaoqing, Ph.D. (George Washington University), B.S. (Fudan University), Associate Professor, Department of Electrical Engineering and Computer Science, 2010, 2016.
Jin, Kevin, Ph.D., M.S., (University of Illinois at Urbana-Champaign), B.E. (Nanyang Technological University, Singapore), Associate Professor, Department of Electrical Engineering and Computer Science, , 2021.
Le, Thi Hoang Ngan, Ph.D. (Carnegie Mellon University), M.S., B.S. (University of Natural Sciences, Ho Chi Minh City, Vietnam), Assistant Professor, Department of Electrical Engineering and Computer Science, 2019.
Li, Qinghua, Ph.D. (Pennsylvania State University), M.S. (Tsinghua University), B.E. (Xi'an Jiaotong University), Associate Professor, Department of Electrical Engineering and Computer Science, 2013.
Luu, Khoa, Ph.D. (Concordia University), Assistant Professor, Department of Electrical Engineering and Computer Science, 2018.
Nakarmi, Ukash, Ph.D. (University at Buffalo), M.S. (Oklahoma State University), Assistant Professor, Department of Electrical Engineering and Computer Science, 2020.
Nelson, Alexander H., Ph.D. (University of Maryland), M.S., B.S. (University of Arkansas), Associate Professor, Department of Electrical Engineering and Computer Science, 2017, 2023.
Pan, Yanjun, Ph.D., (University of Arizona), B.E. (Nanjing University of Aeronautics and Astronautics, China), Assistant Professor, Department of Electrical Engineering and Computer Science, 2022.
Panda, Brajendra Nath, Ph.D. (North Dakota St. University), M.S. (Utkal University, India), Professor, Department of Electrical Engineering and Computer Science, 2001, 2007.
Parkerson, Pat, Ph.D., B.S. (University of Arkansas), Associate Professor, Department of Electrical Engineering and Computer Science, 1990, 2005.
Patitz, Matthew J., Ph.D., M.S., B.S. (Iowa State University), Associate Professor, Department of Electrical Engineering and Computer Science, 2012, 2018.
Peng, Yarui, Ph.D., M.S. (Georgia Institute of Technology), B.S. (Tsinghua University), Assistant Professor, Department of Electrical Engineering and Computer Science, 2017.
Streeter, Lora, Ph.D., M.S. (University of Arkansas, Fayetteville), Teaching Assistant Professor, Department of Electrical Engineering and Computer Science, 2019.
Thompson, Dale R., Ph.D. (North Carolina State University), M.S., B.S. (Mississippi State University), Professor, Department of Electrical Engineering and Computer Science, 2000, 2022.
Wu, Xintao, Ph.D. (George Mason University), M.E. (Chinese Academy of Space Technology), B.S. (University of Science and Technology of China), Professor, Department of Electrical Engineering and Computer Science, Charles D. Morgan/Acxiom Graduate Research Chair, 2014, 2019.
Zhang, Lu, Ph.D. (Nanyang Technological University, Singapore), Assistant Professor, Department of Electrical Engineering and Computer Science, 2018.

Courses

CSCE 20004. Programming Foundations I. 4 Hours.
Introductory programming course for students majoring in computer science or computer engineering. Software development process: problem specification, program design, implementation, testing and documentation. Programming topics: data representation, conditional and iterative statements, functions, arrays, strings, file I/O and classes. Using C++ in a UNIX environment. Corequisite: Lab component. Prerequisite: MATH 24005 or MATH 24004 with a grade of C or better, a College of Engineering (ENGR) student, a Computer Science Minor (CSCE-M), or a math major (MATHBS or MATHBA). (Typically offered: Fall and Spring)

CSCE 20104. Programming Foundations II. 4 Hours.
This course continues developing problem solving techniques by focusing on fundamental data structures and associated algorithms. Topics include: abstract data types, introduction to object-oriented programming, linked lists, stacks, queues, hash tables, binary trees, graphs, recursion, and searching and sorting algorithms. Using C++ in a UNIX environment. Corequisite: Lab component. Prerequisite: CSCE 20004 with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 20203. Introduction to Programming in Java. 3 Hours.
Introduction to programming in Java with emphasis on engineering applications. Programming techniques: data representation and expressions, conditional and iterative statements, arrays, lists, file I/O, methods. Object oriented programming: designing, implementing and using classes, collections and composite objects. Students will gain hands-on programming experience and exposure to classic engineering problem solving techniques. Prerequisite: MATH 24005 or MATH 24004 or MATH 24004, each with a grade of C or higher. (Typically offered: Irregular)

CSCE 21104. Digital Design. 4 Hours.
Introduction to the hardware aspects of digital computers, logic gates, flip-flops, reduction, finite state machines, sequential logic design, digital systems, software design tools, hardware description language (VHDL), and implementation technologies. Corequisite: Lab component. Prerequisite: MATH 24004 or MATH 24004 with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 22104. Computer Organization. 4 Hours.
Presents the relationship between computing hardware and software with a focus on the concepts for current computers. CPU design topics are covered including various techniques for microprocessor design and performance evaluation. Corequisite: Lab component. Prerequisite: CSCE 21104 with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 31903. Programming Paradigms. 3 Hours.
Programming in different paradigms with emphasis on object oriented programming and network programming. Survey of programming languages, event driven programming, and concurrency. Prerequisite: CSCE 20104 or DASC 21003, each with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 319H3. Honors Programming Paradigms. 3 Hours.
Programming in different paradigms with emphasis on object oriented programming and network programming. Survey of programming languages, event driven programming, and concurrency. Prerequisite: Honors standing and (CSCE 20104 or DASC 21003, each with a grade of C or better). (Typically offered: Fall and Spring)

CSCE 35103. Software Engineering. 3 Hours.
A modern approach to the current techniques used in software design and development. This course emphasizes the use of modern software development tools, multi-module programming, and team design and engineering. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 36103. Operating Systems. 3 Hours.
An introduction to operating systems including topics in system structures, process management, storage management, files, distributed systems, and case studies. Prerequisite: CSCE 20104 and CSCE 22104, each with a grade of C or better. (Typically offered: Fall and Spring)

CSCE 361H3. Honors Operating Systems. 3 Hours.
An introduction to operating systems including topics in system structures, process management, storage management, files, distributed systems, and case studies. Prerequisite: CSCE 20104 and CSCE 22104, each with a grade of C or better. (Typically offered: Spring)

CSCE 39503. System Synthesis and Modeling. 3 Hours.
This course instructs the students in the use of modern synthesis and modeling languages and approaches for design automation. This course will teach students the use of HDLs and modeling languages for representing and implementing digital computer systems. Prerequisite: CSCE 22104 with a grade of C or better. (Typically offered: Fall)

CSCE 40103. Special Topics. 3 Hours.
Consideration of computer science topics not covered in other courses. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Irregular) May be repeated for up to 12 hours of degree credit.

CSCE 40403. RFID Information Systems Security. 3 Hours.
Radio frequency identification (RFID) information systems provide information to users about objects with RFID tags. They require the application of information systems security (INFOSEC) to protect the information from tampering, unauthorized information disclosure, and denial of service to authorized users. This course addresses security and privacy in an RFID system. Prerequisite: INEG 23104. (Typically offered: Irregular)

CSCE 41104. Embedded Systems. 4 Hours.
The architecture, software, and hardware of embedded systems. Involves a mixture of hardware and software for the control of a system (including electrical, electro-mechanical, and electro-chemical systems). They are found in a variety of products including cars, VCRs, HDTVs, cell phones, pacemakers, spacecraft, missile systems, and robots for factory automation. Corequisite: Lab component. Prerequisite: CSCE 22104 with a grade of C or better. (Typically offered: Fall)

CSCE 41203. Programming Challenges. 3 Hours.
This course studies the principle methods used in the solution of programming contest problems, e.g., data structures strings, sorting, machine arithmetic and algebra, combinatorics, number theory, backtracking, graph traversal, graph algorithms, dynamic programming, grids, and computational geometry. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 41303. Algorithms. 3 Hours.
Provides an introduction to formal techniques for analyzing the complexity of algorithms. The course surveys important classes of algorithms used in computer science and engineering. Prerequisite: (CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better) and (MATH 26103 or MATH 28003). (Typically offered: Fall)

CSCE 41403. Data Mining. 3 Hours.
The course focuses on the principles, theory, design, and implementation of data mining algorithms for large-scale data. Topics include foundations of data mining; preprocessing; mining frequent patterns, associations and correlations; supervised learning including decision tree induction, naïve Bayesian classification, support vector machine, logistic regression, Bayesian network, and K-nearest neighbor learning; unsupervised learning including K-means clustering, hierarchical clustering, density-based clustering, and grid-based clustering; outlier analysis; graph mining; scalable and distributed data mining. Prerequisite: (CSCE 31903 or CSCE 319H3 or DASC 21003) or (CSCE 20104 and INEG 23303 and INEG 23104) or (CSCE 20104 and STAT 30133 and STAT 30043)). (Typically offered: Fall)

CSCE 42103. Computer Architecture. 3 Hours.
The architecture of modern scalar and parallel computing systems. Techniques for dynamic instruction scheduling, branch prediction, instruction level parallelism, shared and distributed memory multiprocessor systems, array processors, and memory hierarchies. Prerequisite: CSCE 22104 with a grade of C or better. (Typically offered: Spring)

CSCE 42303. Low Power Digital Systems. 3 Hours.
The reduction of power consumption is rapidly becoming one of the key issues in digital system design. Traditionally, digital system design has mainly focused on performance and area trade-offs. This course will provide a thorough introduction to digital design for lower consumption at the circuit, logic, and architectural level. Prerequisite: CSCE 22104 with a grade of C or better. (Typically offered: Irregular)

CSCE 42503. Concurrent Computing. 3 Hours.
Programming concurrent processes; computer interconnection network topologies; loosely coupled and tightly coupled paralleled computer architectures; designing algorithms for concurrency; distributed computer architectures. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Irregular)

CSCE 42603. Advanced Data Structures. 3 Hours.
This course continues the study of data structures, algorithmic analysis for these data structures, and their efficient implementation to support standard library in programming languages. Topics include: AVL trees, Red-Black trees, Splay trees, Optimal Binary Search trees, 2-3 tree, 2-3-4 tree, B-trees, Segment trees, Leftist Heaps, Binomial Heaps, Fibonacci Heap, Disjoint Set, Hashing, and big integer with hundreds to thousands of digits. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 42703. Big Data Analytics and Management. 3 Hours.
Introduction to tools and techniques for distributed data computing and management, big data analytics, scalable machine learning, and real-time streaming data analysis. Students cannot receive credit for both CSCE 42703 and CSCE 52703. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Irregular)

CSCE 43203. Formal Languages and Computability. 3 Hours.
Finite Automata and regular languages, regular expressions, context-free languages and pushdown automata, nondeterminism, grammars, and Turing machines. Church's thesis, halting problem, time complexity, space complexity and undecidability. Prerequisite: (CSCE 31903 or CSCE 319H3, each with a grade of C or better) and (MATH 26103 or MATH 28003). (Typically offered: Spring)

CSCE 43303. Introduction to Integrated Circuit Design. 3 Hours.
Design and layout of large scale digital integrated circuits using CMOS technology. Topics include MOS devices and basic circuits, integrated circuit layout and fabrication, dynamic logic, circuit design and layout strategies for large scale CMOS circuits. Students may not receive credit for both CSCE 43303 and CSCE 52203. Prerequisite: ELEG 32103 or ELEG 39903 and MATH 25804 (Typically offered: Fall)

CSCE 43503. CPLD/FPGA-Based System Design. 3 Hours.
Field Programmable Logic devices (FPGAs/CPLDs) have become extremely popular as basic building blocks for digital systems. They offer a general architecture that users can customize by inducing permanent or reversible physical changes. This course will deal with the implementation of logic options using these devices. Prerequisite: CSCE 22104 with a grade of C or better. (Typically offered: Irregular)

CSCE 43703. Electronic Design Automation. 3 Hours.
This course studies physical design, analysis and optimization of VLSI circuits and systems with emphasis on computational realizations and optimization. We start with some related topics such as graph algorithms and discuss various well-known algorithms and methodologies in the design process of VLSI circuits, including design partitioning, logic synthesis, floorplanning, routing, static timing analysis and performance-driven layout. It requires a basic knowledge of digital circuit design, data structure, and object-oriented programming. Students cannot receive credit for both CSCE 43703 and CSCE 53703. Prerequisite: CSCE 39503 and CSCE 31903, each with a C or higher. (Typically offered: Irregular)

CSCE 44203. Computer Systems Modeling. 3 Hours.
Basic concepts of problem analysis, model design, and simulation experiments. A simulation will be introduced and used in this course. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 44303. Cryptography. 3 Hours.
This course provides a general introduction to modern cryptography. Topics include: stream ciphers, block ciphers, message authentication codes, public key encryption, key exchange, and signature schemes. Prerequisite: (CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better) and (MATH 26103 or MATH 28003). (Typically offered: Irregular)

CSCE 44803. Wearable and Ubiquitous Computing. 3 Hours.
This course will introduce wearable and ubiquitous computing paradigms with emphasis on the engineering and development. Three key themes that will be taught during this course the systems and infrastructures which compose IoT and wearable systems, the devices and techniques for gathering data and communicating with the user, and the applications of these technologies including the user experience. Students cannot receive credit for both CSCE 44803 and CSCE 54803. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 45203. Database Management Systems. 3 Hours.
Introduction to database management systems, architecture, storage structures, indexing, relational data model, E-R diagrams, query languages, SQL, ODBC, transaction management, integrity, and security. Students may not receive credit for both CSCE 45203 and CSCE 55203. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Spring)

CSCE 45403. Software Architecture. 3 Hours.
A study of software architecture through the use of case studies drawn from real systems designed to solve real problems from technical as well as managerial perspectives. Techniques for designing, building, and evaluating software architectures. Prerequisite: CSCE 41303 and CSCE 35103. (Typically offered: Irregular)

CSCE 45503. Information Retrieval. 3 Hours.
The objective of this course is to give students a hands-on introduction to information retrieval systems. Classical textual information retrieval systems are studied, including text preprocessing, file structures, term-weighting schemes, and web search engines. Students may not receive credit for both CSCE 45503 and CSCE 55303. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 45601. Capstone I. 1 Hour.
CSCE students complete a comprehensive software capstone project during their final year of undergraduate studies. The project is done over 2 semesters in phases: concept, formal proposal, implementation, and presentation. The projects include and may require the integration of software and human factors and hardware elements and are developed to software engineering methodologies. Prerequisite: CSCE 35103 and (CSCE 36103 or CSCE 361H3) and completion of 91 credit hours. (Typically offered: Fall)

CSCE 46103. Artificial Intelligence. 3 Hours.
Introduction to intelligent agents, AI languages, search, first order logic, knowledge representation, ontologies, problem solving, natural language processing, machine vision, machine learning, and robotics. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Irregular)

CSCE 46203. Mobile Programming. 3 Hours.
An introduction to software development on mobile devices. The major topics covered in this course include underlying concepts and principles in mobile programming, as well as hands-on programming experience on mobile devices with an emphasis on smartphones. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 46403. Graphics Processing Units Programming. 3 Hours.
This course provides an introduction to massively parallel programming using Graphics Processing Units (GPUs). Topics include basic programming model, GPU thread hierarchy, GPU memory architecture, and performance optimization techniques and parallel patterns needed to develop real-life applications. Prerequisite: CSCE 20104 with a grade of C or better. (Typically offered: Irregular)

CSCE 47503. Computer Networks. 3 Hours.
This course is an introductory course on computer networks. Using the Internet as a vehicle, this course introduces underlying concepts and principles of modern computer networks, with emphasis on protocols, architectures, and implementation issues. Students cannot receive graduate credit for CSCE 47503. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 47803. Cloud Computing and Security. 3 Hours.
Cloud computing has entered the mainstream of information technology, providing highly elastic scalability in delivery of enterprise applications and services. In this course, we will focus on the architecture of today's cloud computing, the technologies used within them, application development using contemporary cloud computing tools, and the security risks and management in the cloud. Students cannot receive credit for both CSCE 47803 and CSCE 57803. Prerequisite: CSCE 36103 or CSCE 361H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 48103. Computer Graphics. 3 Hours.
Introduction to the theory and algorithms used in computer graphics systems and applications. Topics include: 2D and 3D geometric models (points, lines, polygons, surfaces), affine transformations (rotation, translation, scaling), viewpoint calculation (clipping, projection), lighting models (light-material interactions, illumination and shadow calculation). Students will implement their own graphics pipeline to demonstrate many of these techniques. Higher level computer graphics applications will be created using OpenGL. Prerequisite: CSCE 31903 or CSCE 319H3, each with a grade of C or better. (Typically offered: Irregular)

CSCE 48503. Information Security. 3 Hours.
This course covers principles, mechanisms, and policies governing confidentiality, integrity, and availability of digital information. Topics to be covered include security concepts and mechanisms, security policies, multilevel security models, system vulnerability, threat and risk assessment, basic cryptography and its applications, intrusion detection systems. Prerequisite: CSCE 31903 or CSCE 319H3 or DASC 21003, each with a grade of C or better. (Typically offered: Irregular)

CSCE 4900V. Individual Study. 1-6 Hour.
Individual study directed by faculty in current research topics, state of the art, or advanced methodology in one of the major computer science or computer engineering areas. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

CSCE 49104. Advanced Digital Design. 4 Hours.
To master advanced logic design concepts, including the design and testing of synchronous and asynchronous combinational and sequential circuits using state of the art CAD tools. Corequisite: Lab component. Prerequisite: CSCE 21104 or ELEG 29004. (Typically offered: Irregular)

CSCE 491HV. Honors Thesis. 1-3 Hour.
To provide honors students with experience in presenting their research accomplishments to their peers and faculty. Prerequisite: Honors standing. (Typically offered: Fall and Spring) May be repeated for up to 3 hours of degree credit.

CSCE 49603. Capstone II. 3 Hours.
CSCE students complete a comprehensive capstone project during their final year of undergraduate studies. The project is done over two consecutive semesters in phases: concepts, formal proposal, implementation, and presentation. The projects include and may require the integration of software, human factors, and hardware elements and are developed using software engineering methodologies. Prerequisite: CSCE 45601. (Typically offered: Spring)