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February 19<sup>th</sup>, 2013

Below are the endorsements to accept the changes in the B.S. in Computer Science Degree.

Leader, Initiating Department/Unit(s)

*G. Markowsky*

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College(s) Curriculum Committee Chair(s)

*Taina Artesani*

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Dean(s)

*Timothy M. Cole* *Timothy M. Cole* *02/22/2013*

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Associate Provost and Dean for Undergraduate Education

*Christina* *SM* *2/27/13*

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## Changes in the B.S. in Computer Science Degree

George Markowsky

December 21, 2012

Effective with the Spring 2013 semester the requirements for the B. S. in Computer Science have changed. This document will outline the changes. Students already in the program can either switch to the new requirements or continue with the requirements that were in place when the student started the program or requirements that the student might have changed to while in the program. All students entering the program starting with the Spring 2013 semester will be bound by the new requirements.

Students already in the program should discuss switching with their advisors. We believe that the new requirements will benefit just about every student, but you should investigate the question carefully. Speak with your advisor if you have any questions.

### **Change 1 (Mathematics Requirement):**

The B.S. will now just require MAT 126 with a grade of C or better and MAT 127 with a grade of C or better. MAT 228 is no longer required for the B.S., although it is highly recommended for students interested in taking advanced science and engineering courses.

MAT 434 is no longer required. We will now accept MAT 215, MAT 232 or any higher numbered statistics course. MAT 434 is still acceptable, but it is no longer a requirement.

#### **Reasons for the Change:**

The ACM curriculum recommendations are moving away from requiring much calculus. This seemed like a reasonable change for us to make at this time.

### **Change 2 (Oral and Written Communications Requirements):**

The B.S. program will no longer require CMJ 103. Students are still required to complete ENG 101 and ENG 317.

#### **Reasons for the Change:**

Many of the CS courses now require students to make oral presentations, and the faculty felt that there was no need to require CMJ 103. Students may still take it as an elective if they choose.

**Change 3 (Arts & Humanities and Social Sciences Requirements):**

The B.S. program will no longer require the 21 hours in Arts & Humanities and Social Sciences with at least 3 of the credits in the social sciences and at least 3 of the hours be upper level. Students must still fulfill all of the University's General Education Requirements.

**Reasons for the Change:**

This requirement was there for historical reasons and it was felt that it had served its purpose and there was no longer any rationale for this requirement.

**Change 4 (Capstone and Electives Requirement):**

Starting with Fall 2013, there will be a new Capstone I (COS 397) and Capstone II (COS 497) course. These will both be 3 credit courses and Capstone I will only be offered in the Fall and Capstone II will only be offered in the Spring. Anyone who completes COS 397 by the end of Spring 2013 will finish with the old Capstone sequence. Students who will not complete COS 397 by the end of Spring 2013 should consider switching to the new Capstone sequence. Any students who are already in the program and who want to complete the old Capstone sequence will have to make special arrangements to do so and will have to remain with the old requirements.

Because the old Capstone sequence was only 3 credits and the new Capstone sequence is 6 credits, we are reducing the number of electives required in the B.S. program from 3 to 2 so that the credit requirement remains at 50 credits.

**Reasons for the Change:**

The Capstone sequence was not getting people to graduation in a timely manner and had expanded to three semesters. The plan is to refocus the Capstone Sequence and have one faculty member oversee all the projects. Students will be encouraged to form groups of up to four members and to work collectively on larger projects. Other faculty may be used as consultants, but there will be one faculty member charged with overseeing the projects and making sure that students complete the Capstone Sequence in a timely manner.

**COMPUTER SCIENCE**  
**at the**  
**UNIVERSITY OF MAINE**  
<http://www.umcs.maine.edu>

**BACHELOR OF SCIENCE DEGREE IN COMPUTER SCIENCE**  
**BACHELOR OF ARTS DEGREE IN COMPUTER SCIENCE**

Computer science is the foundation of computing and information technology. Computer scientists study the theory, design, implementation, and performance of computers and computer software, including the study of computability and computation itself. Computer scientists bring their breadth and depth of knowledge to bear to efficiently solve computing problems. They design and implement software systems. They devise new uses for computers, both to solve new problems and to provide novel, innovative capabilities and services.

Core areas of computer science include databases, high-performance computing, artificial intelligence, computer networks, computer graphics, software engineering, operating systems, programming languages, cybersecurity and computer organization and architecture. Computer science intersects other sciences to form such fields as computational biology and bioinformatics, medical informatics, computational chemistry, cognitive science, robotics, and computational linguistics. Knowledge of computer science, beyond simply what is needed to implement and use information systems, is increasingly important in medicine, business, law, and science, as well as being important for making informed decisions about technology.

The required course work in computer science provides the student with an understanding of the basic areas of computer science: structure of programming languages, operating systems, software engineering, algorithms and data structures, computer architecture, and the theory of computer science. Electives allow students to study additional topics such as database, high performance computing, networks, artificial intelligence and cybersecurity.

Minimum hours needed for graduation: 120 degree hours. Required GPA: 2.00. Required Major GPA: 2.00. At least 18 hours of computer science courses numbered 300 or above must be taken at Orono. All students must satisfy the general education requirements of both the College of Liberal Arts and Sciences and University. A University of Maine student who wishes to take a course elsewhere for the degree must have the course approved in advance by the department and the college.

The Bachelor of Science (B.S.) degree is our traditional computer science undergraduate degree. It prepares students to work in the computer industry or to study computer science in graduate school. The B. S. degree is also appropriate for students who wish to contribute a strong computer science background to an interdisciplinary team, such as one in bioinformatics. The B.S. degree is accredited by the Accreditation Board for Engineering and Technology (ABET). For details consult abet.org.

The Bachelor of Arts (B.A.) degree gives the student a strong foundation in computer science while providing more flexibility in coursework outside the major. It also prepares the student for a rewarding career in computing or for graduate work.

**BACHELOR OF SCIENCE DEGREE IN COMPUTER SCIENCE**

**DEGREE REQUIREMENTS FOR THE B.S. IN COMPUTER SCIENCE**  
(effective for class entering Fall 2013)

All students must satisfy the University requirements for graduation. All required courses required by the Computer Science Department must be taken for a grade; courses taken PASS/FAIL will not count.

**Computer Science Courses – 50 credit hours**

- \*COS 125 Introduction to Problem Solving using Computer Programming (3 cr.)
- \*COS 140 Foundations of Computer Science (3 cr.)
- \*COS 225 Introduction to Object-Oriented Programming and Design (4 cr.)
- COS 226 Introduction to Data Structures (3 cr.)

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\* A student must complete these courses with a grade of "C" or better in each; a grade of "C-" is not sufficient.

COS 250 Discrete Structures (3 cr.)  
COS 301 Programming Languages (3 cr.)  
COS 335 Computer Organization and Architecture (4 cr.)  
COS 350 Data Structures and Algorithms (3 cr.)  
COS 397 Computer Science Capstone 1 (3 cr.)  
COS 420 Introduction to Software Engineering (3 cr.)  
COS 431 Operating Systems (3 cr.)  
COS 451 Automata, Computability and Languages (3cr.)  
COS 490 Computers, Ethics and Society (3 cr.)  
COS 497 Computer Science Capstone 2 (3 cr.)  
Six additional credit hours from courses COS 3XX, COS 4XX and COS 5XX or approved substitutes.

**Mathematics Courses – 11-12 credit hours**

\* MAT 126 Calculus I (4 cr.)  
\* MAT 127 Calculus II (4 cr.)  
Statistics: one of MAT 215, MAT 232, MAT 332 or MAT 434 (3-4 cr.)

**Capstone Experience Requirement**

To meet the capstone requirement for the B.S. students must use their accumulated knowledge of the field in addressing a particular problem. Students must meet the capstone requirement through completing COS 397 and COS 497.

**English – 6 credit hours**

\* ENG 101 College Composition (3 cr.)  
\* ENG 317 Business and Technical Writing (3 cr.)

**Science Requirement – 14 credit hours**

This must include a two-semester sequence of a laboratory science (e.g., PHY 121 and PHY 122), for a total of 8 hours, and an additional 6 hours of science courses. Courses fulfilling this requirement may be from any of the following areas:

Astronomy (AST; except AST 114)  
Biological Sciences (BIO)  
Biochemistry, Microbiology, and Molecular Biology (BMB; BMB 207 and above)  
Chemistry (CHY; CHY 121 and above)  
Earth Sciences (ERS; ERS 101 and above)  
Forest Ecosystem Science (FES)  
Marine Science (SMS; SMS 110 and above)  
Physics (PHY; PHY 121 and above)  
Wildlife Ecology (WLE; WLE 200 and above)

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\* A student must complete these courses with a grade of "C" or better in each; a grade of "C-" is not sufficient.

## MODEL CURRICULUM FOR THE B.S. IN COMPUTER SCIENCE

This schedule illustrates one way of meeting the degree requirements within four years. This is only one model. Sufficient hours must be included to reach the University degree minimum of 120. All Department, College and University requirements must be met. Electives may be moved around and some adjustments might need to be made if you take a 4 credit statistics course instead of a 3 credit course. You should work on your schedule with your advisor to make sure that you stay on track.

### FIRST YEAR

| <u>First Semester</u> (13 cr.) |   | <u>Second Semester</u> (17 cr.) |   |
|--------------------------------|---|---------------------------------|---|
| COS 125                        | 3 | COS 225                         | 4 |
| COS 140                        | 3 | ENG 101 or Elective             | 3 |
| MAT 126                        | 4 | MAT 127                         | 4 |
| ENG 101 or Elective            | 3 | General Education               | 3 |
|                                |   | Elective                        | 3 |

### SOPHOMORE YEAR

| <u>First Semester</u> (16 cr.) |   | <u>Second Semester</u> (14 cr.) |   |
|--------------------------------|---|---------------------------------|---|
| COS 226                        | 3 | COS 335                         | 4 |
| COS 250                        | 3 | COS 350                         | 3 |
| MAT 215                        | 3 | General Education               | 3 |
| Lab Science I                  | 4 | Lab Science II                  | 4 |
| Gen. Ed.                       | 3 |                                 |   |

### JUNIOR YEAR

| <u>First Semester</u> (15 cr.) |   | <u>Second Semester</u> (15 cr.) |   |
|--------------------------------|---|---------------------------------|---|
| COS 301                        | 3 | COS 420                         | 3 |
| COS 431                        | 3 | COS 451                         | 3 |
| ENG 317                        | 3 | COS Elective                    | 3 |
| Science*                       | 3 | Science*                        | 3 |
| General Education              | 3 | General Education               | 3 |

### SENIOR YEAR

| <u>First Semester</u> (15 cr.) |   | <u>Second Semester</u> (15 cr.) |   |
|--------------------------------|---|---------------------------------|---|
| COS 397                        | 3 | COS Elective                    | 3 |
| COS 490                        | 3 | COS 497                         | 3 |
| General Education              | 3 | Elective                        | 3 |
| Elective                       | 3 | Elective                        | 3 |
| Elective                       | 3 | Elective                        | 3 |

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\* This science course may be either with a laboratory (4 cr.) or without a laboratory (3 cr.). If you take a 4 credit course, you might want to adjust your schedule to avoid going over 120 credit hours total. It is not a problem if you earn more than 120 credits hours – it will just cost you more.

# BACHELOR OF ARTS DEGREE IN COMPUTER SCIENCE

## DEGREE REQUIREMENTS FOR B. A. IN COMPUTER SCIENCE

(Effective entering class – Fall 2013)

### Computer Science Courses – 47 credit hours

- \*COS 125 Introduction to Problem Solving Using Computer Programming (3 cr.)
  - \*COS 140 Foundations of Computer Science (3 cr.)
  - \*COS 225 Introduction to Object-Oriented Programming and Design (4 cr.)
  - COS 226 Introduction to Data Structures (3 cr.)
  - COS 250 Discrete Structures (3 cr.)
  - COS 301 Programming Languages (3 cr.)
  - COS 335 Computer Organization and Architecture (4 cr.)
  - COS 350 Data Structures and Algorithms (3 cr.)
  - COS 397 Computer Science Capstone I (3 cr.)
  - COS 420 Introduction to Software Engineering (3 cr.)
  - COS 431 Operating Systems (3 cr.)
  - COS 451 Automata, Computability, and Languages (3 cr.)
  - COS 490 Computers, Ethics and Society (3 cr.)
  - COS 497 Computer Science Capstone (3 cr.)
- Three additional credit hours from course COS 3XX, COS 4XX and COS 5XX.

### Other Required Courses

- \*MAT 126 Calculus I
- \*MAT 127 Calculus II
- Statistics: one of MAT 215, MAT 232, MAT 332 or MAT 434 (3-4 cr.)
- \*ENG 101 College Composition
- \*ENG 317 Business & Technical Writing (Gen. Ed. Writing Intensive)

### Minor

Students must take an approved minor in some department outside their home department. Minors typically require 18-21 credit hours. Also note students must have a minimum of 72 credit hours outside the academic major.

## MODEL CURRICULUM FOR THE B.A. IN COMPUTER SCIENCE

This schedule illustrates one way of meeting the degree requirements within four years. This is only one model. Sufficient hours must be included to reach the University degree minimum of 120. All Department, College and University requirements must be met. Students should use electives to complete University general education requirements, and to meet the requirements for a minor. A single course may meet more than one of these requirements. You will have to adjust the model curriculum if your minor requires some number of credit hours that is not 18. Electives may be moved around and some adjustments might need to be made if you take a 4 credit statistics course instead of a 3 credit course. You should work on your schedule with your advisor to make sure that you stay on track.

### FIRST YEAR

#### First Semester (13 cr.)

|                     |   |
|---------------------|---|
| COS 125             | 3 |
| COS 140             | 3 |
| ENG 101 or Elective | 3 |
| MAT 126             | 4 |

#### Second Semester (17 cr.)

|                     |   |
|---------------------|---|
| COS 225             | 4 |
| General Education   | 3 |
| ENG 101 or Elective | 3 |
| MAT 127             | 4 |
| Minor               | 3 |

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\* A student must complete these courses with a grade of "C" or better in each; a grade of "C-" is not sufficient.

## SOPHOMORE YEAR

### First Semester (16 cr.)

|                   |   |
|-------------------|---|
| COS 226           | 3 |
| COS 250           | 3 |
| MAT 215           | 3 |
| Minor             | 3 |
| Gen. Ed. Lab Sci. | 4 |

### Second Semester (14 cr.)

|                               |   |
|-------------------------------|---|
| COS 335                       | 4 |
| COS 350                       | 3 |
| Minor                         | 3 |
| Gen. Ed. Science <sup>1</sup> | 4 |

## JUNIOR YEAR

### First Semester (15 cr.)

|                   |   |
|-------------------|---|
| COS 301           | 3 |
| COS 431           | 3 |
| ENG 317           | 3 |
| General Education | 3 |
| Minor             | 3 |

### Second Semester (15 cr.)

|                   |   |
|-------------------|---|
| COS 420           | 3 |
| COS 451           | 3 |
| COS Elective      | 3 |
| General Education | 3 |
| Minor             | 3 |

## SENIOR YEAR

### First Semester (15 cr.)

|                   |   |
|-------------------|---|
| COS 397           | 3 |
| COS 490           | 3 |
| General Education | 3 |
| Minor             | 3 |
| Elective          | 3 |

### Second Semester (15 cr.)

|                   |   |
|-------------------|---|
| COS 497           | 3 |
| General Education | 3 |
| General Education | 3 |
| Elective          | 3 |
| Elective          | 3 |

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In complying with the letter and spirit of applicable laws and in pursuing its own goals of pluralism, the University of Maine System shall not discriminate on the grounds of race, color, religion, sex, sexual orientation, national origin or citizenship status, age, disability, or veteran's status in employment, education, and all other areas of the University. The University provides reasonable accommodations to qualified individuals with disabilities upon request. Questions and complaints about discrimination in any area of the University should be directed to the Director of Equal Opportunity, 101 North Stevens Hall, 581-1226 (Voice and TTY).

<sup>1</sup> This is shown as a 4 credit hour course. If you take it without a laboratory this will only provide 3 credits and you will have to find some way to make up the extra credit.



## APPENDIX B

### COMPUTER SCIENCE COURSE DESCRIPTIONS

**COS 125 Introduction to Problem Solving Using Computer Programming** Students are introduced to programming as a tool for problem solving. Basic programming practices, data structures and the analysis of algorithms are introduced. A language such as Scheme, ML, or Python will be used in the course. This is the introductory programming course required for majors. Prerequisites: None. Cr. 3.

**COS 140 Foundations of Computer Science** This course introduces students to the discipline of computer science. Several core areas of computer science (e.g. digital logic, computer organization and architecture, programming languages, operating systems, computer networks, artificial intelligence, and professional ethics) are covered. In each area, particular solutions to fundamental problems in the area are studied in depth. No programming is taught in the course. Prerequisite: None. Cr. 3.

**COS 198 Topics in Computer Science.** Topics not regularly covered in other courses. Content is not fixed, but can be varied to suit current needs. May be taken more than once. Prerequisite: permission. Cr. 1-3.

**COS 225 Introduction to Object-Oriented Programming and Design** This course introduces the student to the fundamental principles of object-oriented design and programming using a high-level object-oriented language. The course will focus on the specification, design, and implementation of classes and the interactions between classes. It will also cover more advanced object-oriented concepts such as inheritance, abstract classes, and polymorphism. Satisfies the General Education Mathematics Requirement. Prerequisites: COS 125. Cr. 4.

**COS 226 Introduction to Data Structures** This course introduces the student to the fundamental principles of data structure usage, specification, and implementation using a high-level, object-oriented language. This course will be driven by the use of object-oriented techniques for program specification and modeling. It will focus on how data structure implementation choices affect and are affected by application needs. Satisfies the General Education Mathematics Requirement. Prerequisites: COS 225. Cr. 3.

**COS 250 Discrete Structures.** Introduction to discrete structures used in various areas of computer science. Topics include logic, sets, relations, functions, cardinality, enumeration, and computability. The topics will be presented in a framework useful for further study in computer science. Prerequisites: COS 225, MAT 126. Cr. 3.

**COS 298 Topics in Computer Science.** Topics not regularly covered in other courses. Content is not fixed, but can be varied to suit current needs. May be taken more than once. Prerequisite: permission. Cr. 3.

**\*\*COS 301 Programming Languages.** Formal description of programming languages including specification of syntax and semantics. Discussion of infix, prefix, and postfix notation with translation techniques. Topics include branching, grouping of statements, storage allocation, list and string processing, and relation of language design on efficiency. Prerequisite: COS 226 and 250. Cr. 3.

**COS 335 Computer Organization and Architecture** This course examines the architecture and organization of the computer including digital logic, the CPU, busses, internal and external memory, computer number representation and arithmetic, computer instructions and some advanced topics (e.g., RISC machines). Particular attention is paid to assembly language as a mechanism for better understanding the architecture, and students will be expected to write significant programs in assembly language. Prerequisites: COS 140 and COS 226. Cr. 4.

**COS 350 Data Structures and Algorithms.** Introduction to abstract data types as a unifying concept in the study of data structures. Topics include lists, queues, multi-linked lists, priority queues, trees, and graphs. The impact of these structures on algorithm design is explored. External memory management is discussed. Prerequisite: (COS 221 or COS 226) and COS 250. Cr. 3.

**\*COS 397 Computer Science Capstone 1.** The first of a two-course sequence, designed to guide the student in proposing the Capstone project in either an independent study, group project, or field experience format. The focus is on the early stages of project work, including finding a suitable topic and project advisor, investigating related work, and writing a thorough project proposal. The relevant skills are covered and practiced by studying a collection classic and topical papers. Open only to computer science majors. Prerequisite: junior standing and permission of the department. Cr. 2.

**COS 398 Topics in Computer Science.** Topics not regularly covered in other courses. Content is not fixed, but can be varied to suit current needs. May be taken more than once. Prerequisite: permission. Cr. 3.

**COS 400 Introduction to Compiler Construction.** This covers the basic concepts of programming language translation, compiler design and construction. Topics include the compilation process; language definition; lexical analysis; syntax analysis and error detection and error recovery; grammars; compiler design issues; symbol tables; storage allocation, code generation and machine-independent code improvement. Programming projects to illustrate the various concepts are used. Prerequisite: COS 301 and 350 or permission. Cr. 3.

**COS 415 Computer Simulation and Modeling, from Development to Display.** The process of designing and using a computer model is examined in detail. The development of the model equations, numerical techniques for solving them and basic graphical techniques for displaying the results of the calculations will be presented. Prerequisite: Familiarity with a programming language and/or permission. Cr. 3.

**COS 416 Parallel Programming.** Introduce the students to a realistic programming environment where they can experience the differences and difficulties of programming in a multi-processor or multi-computer architecture. Prerequisite: permission. Cr. 3.

**COS 420 Introduction to Software Engineering.** A broad view of software engineering which introduces a variety of software engineering techniques, which can be applied to practical software projects. Topics include process models, human factors, software specification, software design, programming techniques and tools and validation. Prerequisite: Junior standing and COS 431 or permission. Cr. 3.

**COS 430 Introduction to Cybersecurity.** An overview of Cybersecurity as information security, policies, guidelines, and legal issues; the nature of network and computer attacks, system vulnerabilities and defense; implementation issues in Unix/Linux. Projects include system setup, attack, and defense. Prerequisites: COS 335 and COS 431. Cr. 3.

**COS 431 Operating Systems.** Study of the structure of current computer operating systems. Topics include I/O management, memory management, multiprogramming, linking loaders, real and virtual systems, batch and time-sharing. Prerequisites: COS 226, COS 335, or permission. Cr. 3.

**COS 440 Computer Networks.** This course covers data and computer communications using the ISO model as a basis of presentation. Discussion of physical media, communication protocols, and network architectures including wide area and local area networks. Examples of networks currently in use are included. Prerequisite: COS 431 or permission. Cr. 3.

**COS 441 Computer Networks II.** A continuation of COS 440, Computer Networks. This course is an in depth study of computer network protocols and certain network applications. Concentration is on network to application layers of the OSI model. Presently specific emphasis is on the Internet Protocol TCP/IP with examples from different protocols. Prerequisite: COS 440 or permission. Cr. 3.

**COS 451 Automata, Computability, and Languages.** Fundamentals of formal languages and the mathematical theory of computation; finite-state automata, nondeterminism, regular expressions, and Kleene's Theorem; context-free grammars, pushdown automata, the correspondence theorem and the pumping lemma; computability, Turing machines, and the halting problem. Prerequisites: COS 250. Cr. 3.

**COS 460 Interactive Computer Graphics.** Topics include I/O devices: plotter, CRT, light pen, etc.; vector generation; transformation of two and three-dimensional objects; clipping and windowing; hidden line removal; interrupt handling; interactive techniques; data structures for graphics; and various display algorithms. Prerequisites: COS 226 or equivalent, MAT 126 and junior standing. Cr. 3.

**COS 461 Advanced Computer Graphics.** This course builds on COS 460 Interactive Computer Graphics, and continues with advanced topics. Topics include three-dimensional transformations, hidden line and surface algorithms, color and raster graphics. Prerequisites: COS 460 and MAT 126. Cr. 3.

**COS 470 Introduction to Artificial Intelligence.** This course will survey a number of the fundamental areas of research in and techniques employed in Artificial Intelligence. Some of the former includes knowledge representation, vision, planning, logic, learning, expert systems, and natural language comprehension. Examples of techniques covered will include predicate calculus, backtracking, tree searching, and semantic networks amongst others. A segment of the course will cover LISP, a principal Artificial Intelligence programming language. Prerequisite: COS 350 or permission. Cr. 3.

**COS 480 Database Management Systems.** This course covers database management systems from the perspective of database designers and database application programmers. Topics include Entity-Relationship modeling, relational databases, transactions and isolation, and Web-database applications. The course includes both individual programming assignments and semester-long group projects culminating in demonstrations of substantial database applications. Prerequisite: COS 350 or permission. Cr. 3.

**\*\*COS 490 Computers, Ethics, and Society.** Consideration of the human and social consequences of the technological development and application of computers as viewed from the standpoints of the computer customer, the computer specialist, and the public. Prerequisite: COS 431 and ENG 317. Cr. 3.

**\*COS 497 Computer Science Capstone 2.** The second of a two-course sequence, designed to guide the student in completing the Capstone project in either an independent study, group project, or field experience format. The focus is on the later stages of project work, including completing the programming tasks, evaluating the implemented systems, documenting all work in a project report, demonstrating the work in action and making a public oral presentation. The relevant skills are covered and practiced by studying a collection classic and topical papers. Open only to computer science majors. Prerequisites: COS 397 and permission of the department. Cr. 1.

**COS 498 Topics in Computer Science.** Topics not regularly covered in other courses. Content is not fixed, but can be varied to suit current needs. May be taken more than once. Prerequisite: permission. Cr. 3.

### **Graduate Courses** *(can be taken by computer science undergraduates with permission of the instructor)*

**COS 515 Topics in Scientific Computing: Simulation and Modeling.** The purpose of designing and using a computer model is examined in detail. The development of the model equations, numerical techniques for solving them and basic graphical techniques for displaying the results of the calculations will be presented. Prerequisite: Familiarity with a programming language and/or permission. Cr. 3.

**COS 516 Topics in Scientific Computing: Parallel Programming.** Introduce the students to a realistic programming environment where they can experience the differences and difficulties of programming in multi-processor or multi-computer architecture. Prerequisite: permission. Cr. 3.

**COS 520 Software Engineering I.** Provides the knowledge and tools necessary for the specification, design, implementation, and maintenance of reliable non-trivial software. Various specification and design methodologies are explored with Ada as the implementation tool. Students are assigned problems in both an individual and group setting. Prerequisites: COS 350 and COS 431. Cr. 3.

**COS 521 Topics in Software Engineering.** May be repeated. Prerequisite: permission.

**COS 550 Theoretical Computer Science I.** A survey of automata theory, formal languages, undecidability and computational complexity. Prerequisites: COS 301 and COS 250.

**COS 554 Algorithms.** This course surveys the classes of important algorithms and how they may be adapted to solving specific problems. Students will be expected to program some of the algorithms discussed in class. Prerequisite: COS 350.

**COS 570 Topics in Artificial Intelligence.** May be repeated. Prerequisite: permission.

**COS 598 Advanced Topics in Computer Science.** Topics in computer science not regularly covered in other courses. May be repeated for credit. Prerequisite: permission.

**COS 599 Graduate Project.** Cr. Ar.

**COS 600 Research Seminar.** Cr. 1

**COS 699 Graduate Thesis.** Cr. Ar.

\* Satisfies the General Education Capstone Experience requirement

\*\* Satisfies the General Education Writing Intensive in the major requirement