



**COMPUTER SCIENCE  
DEPARTMENT**

**Undergraduate Advisement  
Bulletin**

**2024-2025**

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## Admission & Graduation Requirements

- **To be eligible to declare a Computer Science Major**, students must be currently enrolled in or have completed Computer Science 221 Object-Oriented Design and Programming I or Computer Science 171 Object-Oriented Design and Programming.
- **To be eligible to declare a Software Technology Major**, students must be currently enrolled in or have completed Computer Science 221 Object-Oriented Design and Programming I or Computer Science 171 Object-Oriented Design and Programming, or have completed a Software Developer Associate in Applied Science (A.A.S.) degree from a Wisconsin technical college with which UW-Oshkosh has an appropriate articulation agreement.

To be eligible for graduation, students must meet all requirements for the degree being sought in addition to earning a minimum grade point average of 2.00 in all courses required for the major or minor.

In addition to University and College requirements, students must have a minimum grade point average of 2.00 in those computer science (CS) courses numbered 300 or above that are used to satisfy the requirements of the major excluding CS 399 and CS 490.

Please note that this statement implies that if a student completes more than the minimum number of courses required for a specific emphasis in a major, the student may designate those courses that will be used for computing the grade point average when more than one choice is possible. The resulting set of designated courses must satisfy the requirements of a specific emphasis of that major.

## Objectives

### **Three to five years after graduation, our typical alumni will:**

1. Advance beyond initial entry-level positions as computing professionals or have made significant progress toward a graduate degree in computing.
2. Use the background they have acquired in a wide range of areas in computer science during their undergraduate study as a basis for continued growth of their professional knowledge and skills.
3. Use teamwork skills effectively in the development of complex software systems.
4. Use communication skills to advantage within the organizational structure of workplaces that are becoming increasingly diverse and interconnected among different groups including, but not necessarily limited to, those groups based on racial, gender, age, and religious backgrounds.
5. Demonstrate strong professional ethics in all of their computing endeavors.

## Learning Outcomes

**These are the general outcomes that guide the specific learning outcomes for individual courses.**

**Students graduating with a degree in Computer Science, Computer Science with the Systems and Theory emphasis, or Software Technology will have the ability to:**

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

**In addition, students graduating with a degree in Computer Science, or Computer Science with the Systems and Theory emphasis will also have the ability to:**

6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

## Prerequisites and Repeating Courses

### Prerequisites

The computer science department has established prerequisites for each course so that students will be adequately prepared for the topics covered in the course. This allows the instructor to proceed with the course in a manner that ensures quality in the program.

**The department strictly enforces the prerequisite policy.** You should not take courses unless you satisfy the prerequisites. Otherwise, when the deficiency is detected, you will have to drop the course. All courses are checked.

### Repeating Courses

The College of Letters and Science and the computer science department permit students to repeat a given computer science course one time only. Note that this policy includes transfer courses. A very important consequence of this policy is that a student who does not earn a grade of C or better in certain courses that are prerequisites for a required course must withdraw from the appropriate major. For example, suppose a student earns a D grade in CS 271 (Data Structures). Then the student repeats it and earns a C- grade. Because CS 271 is a prerequisite for most 300-level courses, this student will not be permitted to major in Computer Science.

# Overview of Computer Science Programs

## Web Design Certificate (9 credits)

- **Minimum Math required:** Math 104
- 125, 142 and 247
- Exposure to web site development, usability design and basic programming
- **Primary Audience:** Students in all majors
- **Careers:** A job in any field that can benefit from web site design and basic programming

## Computer Programming Certificate (10-11 credits)

- **Minimum Math required:** Math 108
- 221, 262 and 251 or 271
- In-depth understanding of programming fundamentals and ability to develop low-level or more efficient programs
- **Primary Audience:** Students in any majors that have significant software coding needs, especially Math, Science and Engineering Technology
- **Careers:** A job in the student's major field, that involves significant coding/programming responsibilities

## Web and Mobile Development Minor (22 credits)

- **Minimum Math required:** Math 108
- 125, 142, 221, 247, 262, 344 or IS 433, 346 or IS 432
- In-depth understanding of web design, development and programming, usability design, and mobile application development
- **Primary Audience:** Students in any majors, that wish to have solid web and mobile development skills
- **Careers:** Web and mobile development careers, careers in other fields that can benefit from significant web and mobile development skills

## Computer Science Minor (23 credits)

- **Minimum Math required:** Math 108
- 221, 251, 262, 271, 9 credits 300-400 level electives
- Significant understanding of software development theory and practice, and ability to further sub-specialize through appropriate elective choices in an area of the student's interest
- **Primary Audience:** Students in any majors, that wish to have significant training in software theory, development and practice. Option of a mini-specialization in an advanced subfield of Computer Science
- **Careers:** Software development careers, careers in other fields that can benefit from significant software development skills

## Software Technology Major (39 credits)

- **Minimum Math required:** Math 108
- Requires 23 additional credits beyond the Web and Mobile Development minor
- Solid understanding of software development including an in-depth understanding of Web and Mobile Development and exposure to Database Design and Networks
- **Primary Audience:** Students interested in Web and Mobile development
- **Careers:** Software development careers that are primarily focused on Web, Mobile and some application software development

## Computer Science Major (52 credits)

- **Minimum Math required:** Calculus I, Statistics
- In-depth understanding of computer science fundamentals, theory and practice, including large scale software development and optimization; ability to further specialize in an advanced computer science sub-field through appropriate elective choices
- **Primary Audience:** Students interested in Computer Science
- **Careers:** All software engineering or development careers, including those that require advanced knowledge in a sub-field of computer science

- **Minimum Math required:** Calculus II or Linear Mathematics, Statistics
- ABET accredited
- In-depth understanding of computer science fundamentals, theory and practice, including large scale software development and optimization, and strong foundations in architecture, security, systems and theory
- **Primary Audience:** Students interested in Computer Science
- **Careers:** All software engineering /development careers, including those that require advanced systems skills; excellent preparation for graduate studies in Computer Science

## Computer Science Major - Systems and Theory Emphasis (62-63 credits), ABET accredited



## Computer Science Major

### Core Courses

**These courses are required of all Computer Science majors and emphases within the Computer Science major.**

<u>Course</u>	<u>Credits</u>
CS 212 Discrete Structures	3 cr.
CS 221 Object Oriented Design and Programming I	3 cr.
CS 251 Computer Architecture and Assembly Language	3 cr.
CS 262 Object Oriented Design and Programming II	4 cr.
CS 271 Data Structures	4 cr.
CS 321 Algorithms	3 cr.
CS 331 Programming Languages	3 cr.
CS 341 Software Engineering	3 cr.
PHIL 350 Computing Ethics	3 cr.
INTRDSCP 208 Prof. Career Skills in Math and Natural Science	1 cr.

**One of the following:**

CS 399 Internship in Computer Science	3 cr.
CS 490 Practicum in Computer Science	<u>3 cr.</u>

**Total: 33 cr.**

## Computer Science Major

The Computer Science major focuses on knowledge and skills for the design, development, maintenance, and management of software, including software for the operation of instrumentation. It is appropriate for students preparing for careers as systems programmers, systems analysts, software engineers, or computer-based instrumentation specialists.

### Requirements in addition to the computer science core courses:

<b>Course</b>	<b>Credits</b>
Either Math 171 Calculus I or Math 206 Mathematics for Business Analysis II	4-5 cr.
Either Math 201 Applied Statistics, Math 301 Introduction to Probability and Statistics, or Econ 210 Economic and Business Statistics	3 cr.
Electives: 12 credits from the elective courses list.	12 cr.
<b>Total</b>	<b>19-20 cr.</b>

## **Computer Science Major - Systems and Theory Emphasis**

This emphasis focuses on the fundamental practical and theoretical foundations of computer science, providing an in-depth understanding of both the software and hardware components of computer systems. It is appropriate for students preparing for careers in scientific computing or research, and for students planning to pursue graduate degrees.

This emphasis is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 150, Baltimore, MD 21202-4012, telephone: (410) 347-7700.

### **Requirements in addition to the computer science core courses:**

<b>Course</b>	<b>Credits</b>
CS 310 Computer Organization and Design	3 cr.
CS 326 Computer Security	3 cr.
CS 381 Theory of Computing	3 cr.
CS 391 Computer Networks	3 cr.
CS 421 Operating Systems	3 cr.
CS 499 Computer Science Assessment	0 cr.
Math 171 Calculus I	5 cr.
Math 172 Calculus II or Math 256 Linear Mathematics	3-4 cr.
Math 201 Applied Statistics or Math 301 Introduction to Probability and Statistics	3 cr.
Electives: 3 credits from the elective courses list. The chosen electives must not appear above as requirements for the Systems and Theory emphasis.	3 cr.
<b>Total</b>	<b>29-30 cr.</b>

### **Important Notes:**

1. The Systems and Theory (ST) emphasis is open only to students pursuing the B.S. degree.
2. CS 499 is open only to ST emphasis students who are in their final semester. Enrolled students must take the Major Field Test in Computer Science. Students should apply for graduation for a specific semester and then contact the department chair to get permission to add the course, BEFORE the start of that semester. Enrollment into this course will NOT happen automatically, and students are responsible for initiating this registration process.
3. The math and science requirements of the ST emphasis necessitate completion of 15 credits of Mathematics covered by MATH 171, 172 or 256, 201 or 301, and CS 212 and 381; plus

an additional 6 credits of natural science courses, that have a laboratory component. These 6 credits of natural science coursework must be selected from the following list:

- BIOLOGY 105: Biological Concepts- Unity,
- BIOLOGY 106: Biological Concepts - Diversity,
- BIOLOGY 108 (Honors): Biological Concepts - Unity,
- BIOLOGY 211: Human Anatomy,
- BIOLOGY 212: Human Physiology,
- BIOLOGY 230: Biology of Animals,
- BIOLOGY 231: Biology of Plants and Microbes,
- BIOLOGY 233: Microbial Survey,
- BIOLOGY 304: Plant Taxonomy,
- BIOLOGY 308: Comparative Anatomy,
- BIOLOGY 309: Bacteriology,
- BIOLOGY 319: General Animal Physiology,
- BIOLOGY 321: Mycology,
- BIOLOGY 326: Introductory Limnology,
- BIOLOGY 332: Entomology,
- CHEM 105: General Chemistry I,
- CHEM 106: General Chemistry II,
- GEOG 121: Phys Geog I: Weather and Climate,
- GEOG 221: Phys Geog II: Landforms/Soils,
- GEOLOGY 102: Physical Geology,
- GEOLOGY 150: Environmental Geology,
- GEOLOGY 109: Evolution of the Earth,
- GEOLOGY 110 Honors: Geology,
- GEOLOGY 112: Dinosaurs: Age of Reptiles,
- GEOLOGY 205: Mineralogy,
- PHYS/AST 191: University Physics I,
- PHYS/AST 192: University Physics II

## **Computer Science Major - Elective Courses**

- CS 300 Artificial Intelligence
- CS 310 Computer Organization and Design
- CS 326 Computer Security
- CS 344 Mobile Application Development
- CS 346 Web Software Development
- CS 361 Database Systems
- CS 371 Computer Graphics
- CS 381 Theory of Computing
- CS 391 Data Communication and Computer Networks
- CS 421 Operating Systems
- CS 431 Compilers
- CS 474 Honors: Thesis (up to 3 credits)
- CS 480 Topics in CS

## Software Technology Major

<u>Course</u>	<u>Credits</u>
CS 221 Object Oriented Design and Programming I	3 cr.
CS 247 Introduction to Usability	3 cr.
CS 262 Object Oriented Design and Programming II	4 cr.
CS 271 Data Structures	4 cr.
CS 341 Software Engineering	3 cr.
CS 344 Mobile Application Development	3 cr.
CS 346 Web Software Development	3 cr.
CS 399 Internship in Computer Science	3 cr.
PHIL 350 Computing Ethics	3 cr.
INTRDSCP 208 Prof. Career Skills in Math and Natural Science	1 cr.
INFO SYS 315 Database Systems in Business	3 cr.
INFO SYS 316 Networking and Data Communication	3 cr.
<b>One of the following:</b>	
INFO SYS 318 Agile Application Development	3 cr.
INFO SYS 432 Agile Web Design and Development	<u>3 cr.</u>

**Total: 39 cr.**

## Computer Science Minor

### The Common Core (14 credits)

These courses are required of all computer science minors.

Course	Credits
CS 221 Object Oriented Design and Programming I	3 cr.
CS 251 Computer Architecture and Assembly Language	3 cr.
CS 262 Object Oriented Design and Programming II	4 cr.
CS 271 Data Structures	4 cr.
<b>Total</b>	<b>14 cr.</b>

### Elective Computer Science Courses (9 credits)

Any **three** courses may be selected from the following upper-division offerings.

- CS 300 Artificial Intelligence
- CS 310 Computer Organization and Design
- CS 321 Algorithms (Additional prerequisite of CS 212 required)
- CS 326 Computer Security
- CS 331 Programming Languages
- CS 341 Software Engineering
- CS 344 Mobile Application Development
- CS 346 Web Software Development
- CS 361 Database Systems
- CS 371 Computer Graphics
- CS 381 Theory of Computing (Additional prerequisite of CS 212/281 required)
- CS 391 Computer Networks
- CS 421 Operating Systems
- CS 431 Compilers
- CS 480 Topics in CS
- CS 490 Practicum in Computer Science

**Total: 23 cr.**

## Web and Mobile Development Minor

<u>Course</u>	<u>Credits</u>
CS 125 Web Site Development	3 cr.
CS 142 Introduction to Computer Science and Programming	3 cr.
CS 221 Object Oriented Design and Programming I	3 cr.
CS 247 Introduction to Usability	3 cr.
CS 262 Object Oriented Design and Programming II	4 cr.
<b>One of the following:</b>	
CS 344 Mobile Application Development	3 cr.
INFO SYS 433 Mobile Application Development	3 cr.
<b>One of the following:</b>	
CS 346 Web Development	3 cr.
INFO SYS 432 Agile Web Design and Development	<u>3 cr.</u>
<b>Total: 22 cr.</b>	



## Computer Programming Certificate

<u>Course</u>	<u>Credits</u>
CS 221 Object Oriented Design and Programming I	3 cr.
CS 262 Object Oriented Design and Programming II	4 cr.
<b>One of the following:</b>	
CS 251 Computer Architecture and Assembly Language	3 cr.
CS 271 Data Structures	<u>4 cr.</u>

**Total: 10-11 cr.**

## Web Design Certificate

**Course**

CS 125 Web Site Development

CS 142 Introduction to Computer Science and Programming

CS 247 Introduction to Usability

**Credits**

3 cr.

3 cr.

3 cr.

**Total: 9 cr.**

## **Courses**

### **Course Rotation Schedule – Oshkosh campus**

The computer science department will attempt to offer courses according to the following rotation.  
**The schedule could be altered due to lack of resources or low enrollments.**

#### **The following courses will be offered every semester (Fall, Spring):**

CS 125 Web Site Development  
CS 142 Introduction to Computer Science and Programming  
CS 221 Object Oriented Design and Programming I  
CS 251 Computer Architecture and Assembly Language  
CS 262 Object Oriented Design and Programming II  
CS 271 Data Structures  
CS 212 Discrete Structures

#### **The following courses will be offered once per year:**

<b>Fall Semester</b>	<b>Spring Semester</b>
CS 247 Introduction to Usability	CS 331 Programming Languages
CS 321 Algorithms	CS 361 Database Systems
CS 341 Software Engineering	
CS 346 Web Software Development	

**The following courses are currently scheduled to be offered every third semester**  
**Please note that these schedules are very tentative and are subject to change at any time.**

#### **Fall 2024**

CS 300 Artificial Intelligence  
CS 326 Computer Security  
CS 381 Theory of Computing

#### **Spring 2025**

CS 310 Computer Organization and Design  
CS 421 Operating Systems  
CS 431 Compilers  
~~CS 371 Computer Graphics~~

#### **Fall 2025**

CS 344 Mobile Application Development  
CS 371 Computer Graphics  
CS 391 Computer Networks

#### **Spring 2026**

CS 300 Artificial Intelligence  
CS 326 Computer Security  
CS 381 Theory of Computing

## Course Descriptions

### Courses

**100 Level: 125, 131Q1, 142, 171**

**200 Level: 221, 246, 247, 251, 262, 271, 281**

**300 Level: 300, 310, 321, 326, 331, 332, 341, 342, 344, 346, 351, 361, 371, 381, 391, 399**

**400 Level: 421, 431, 474, 480, 490**

### CS 125 World Wide Web Site Development (XS) (3 units)

This is an introductory course on website design and development. Topics covered include: web history and protocols, front-end website development using HTML and CSS, and web design basics. The expectations for prerequisite knowledge are only basic computer skills.

This course does not apply toward the Computer Science major or minor. Not open to students who have completed Computer Science 271 and/or Computer Science 346.

*Prerequisite:* None.

### CS 131Q1 Computational Thinking (XM) (3 units)

This course introduces computational thinking, a problem-solving approach ubiquitous throughout Computer Science. Computational thinking involves structuring a given problem and its corresponding data in such a way so that it can be processed in an accurate, systematic and efficient manner by a computer. Computational thinking concepts emphasized will include: problem decomposition, abstraction, recognizing and analyzing patterns in data and formulation of efficient algorithmic solutions to problems. Computational thinking concepts will be applied to solve computer programming exercises using a real-world computer programming language. Computational thinking concepts will also be discussed in the context of sustainability, defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs....A world in which poverty and inequity are endemic will always be prone to ecological and other crises. Sustainable development requires meeting the basic needs of all and extending to all the basic opportunity to satisfy their aspirations for a better life.” (Brundtland Commission, United Nations, 1987). In this course, applications of computational thinking concepts will be applied to investigate the following signature question: “How do people understand and create a more sustainable world?”. This course assumes no prior computational thinking experience and is open to all students with an interest in computational thinking.

*Prerequisite:* None.

*USP designation:* Quest I, and non Quest

*Explore Category:* Explore mathematics (XM)

### **CS 142 Introduction to Computer Science and Programming (3 units)**

In this course, students will be introduced to the science of computing. The history of Computer Science, Elementary computer organization, big ideas in computing, algorithmic problem solving, and introductory programming concepts will be discussed. Programming concepts include data types, expressions, input/output, conditional statements, repetition, data processing, procedures and basic object-oriented principles. Programming concepts will be taught through the use of a specific programming language. The course assumes no previous programming experience. This course does not apply toward the Computer Science major or minor.

*Prerequisite:* Math 103 or PBIS 187 or PBIS 188 or PBIS 189 with a grade of C or better, or qualifying for either Math 104 or Math 171 via Math Placement Test. Not open to students who have completed CS 271.

### **CS 171 Object-Oriented Design and Programming (4 units)**

This introductory course covers problem solving, software design, and programming fundamentals. Topics include data types, input/output, control structures (selection, repetition), functions/methods, debugging, recursion, file I/O, as well as object-oriented design concepts such as classes, encapsulation, inheritance, and polymorphism.

*Prerequisite:* A grade of C or better in Computer Science 131, Math 104 or Math 108 or Math 206, or qualifying for Math 171 via the Mathematics Placement Exam.

### **CS 212 Discrete Structures (3 units)**

This course focuses on discrete mathematical structures that are essential to computer scientists. In this course, students will develop their analytic and algorithmic thinking skills through practice with propositional and first-order predicate logic, various proof techniques, mathematical and structural induction, sets, functions, sequences, recurrence relations, algorithm analysis and computational complexity, the basics of counting, and an introduction to discrete probability.

*Prerequisite:* A grade of C or better in CS 262 AND (Math 171 or Math 206).

### **CS 216 Problem Solving and Programming Techniques in C++ (4 units)**

Program design using both modular and object-oriented methods. Topics covered to include stream I/O, recursion, multi-dimensional arrays, sorting and searching, pointers and dynamic memory allocation, classes and abstract data types, and operator overloading.

*Prerequisite:* Advanced high school mathematics, or previous programming experience, or consent of instructor.

### **CS 221 Object-Oriented Design and Programming I (3 units)**

A first course in computer programming, problem solving and software design using an object-oriented language. Programming topics include: data types and variables, assignment and expressions, standard input/output, branches/selection, repetition, arrays, functions/methods, and objects. Problem solving and software design techniques include: algorithm development and pseudocode, debugging, and UML class diagrams.

*Prerequisite:* A grade of C or better in Math 104 or Math 108 or Math 206 or CS 142, or qualifying for Math 171 via the Mathematics Placement Exam.

### **CS 247 Introduction to Usability (3 units)**

This course presents the theory of and techniques for design and usability, with an emphasis on human-computer interaction. Topics covered include: usability and user-centered design, user research, user-related psychology and cognitive aspects for design, prototyping, and evaluation techniques.

*Prerequisites:* A grade of C or better in Comp Sci 142 or Comp Sci 221 or Info Sys 318.

### **CS 251 Computer Architecture and Assembly Language (3 units)**

This course aims to give students an overview of processor and memory hardware, and to teach them how high-level language programs map onto some Reduced Instruction Set Architecture or RISC computer. Students will learn how computer hardware supports the instruction set architecture. Students will be able to analyze why programs behave the way they do, how they can misbehave (e.g., buffer overflows), and how inefficiencies arise. Students will learn how to implement pointers and references in machine language.

*Prerequisite:* CS 221 with a grade of C or better.

### **CS 262 Object-Oriented Design and Programming II (4 units)**

A second course in problem solving, software design, and computer programming using an object-oriented language. Problem solving/software design topics include: abstract data types, universal modeling language (UML), simple recursion, unit testing, event-handling, simple concurrency. Data structures and algorithms include: binary search, simple sorting algorithms, use of collection classes and their iteration protocols, sequential file processing. Additional topics include: inheritance, polymorphism, graphical user interfaces, simple use of threads.

*Prerequisite:* Mathematics 108 or equivalent with a grade of C or better, or qualifying for a higher level mathematics course via the Mathematics Placement exam, and CS 221 or equivalent with a grade of C or better.

### **CS 271 Data Structures (4 units)**

A course surveying the fundamental methods of representing data and the algorithms that implement and use those data representation techniques. Data structures and algorithms include; linked lists, stacks, queues, trees, heaps, priority queues, hashing, searching, sorting, data compression, graphs, recursion. Analysis topics include: elementary big-O analysis, empirical measurements of performance, time/space trade-offs, and identifying differences among best, average, and worst case behaviors.

*Prerequisite:* CS 262 with a grade of C or better AND, for Computer Science majors, either Completion (with a grade of C or better) of or concurrent enrollment in CS 251.

### **CS 300 Artificial Intelligence (3 units)**

This course is an introduction to the field of artificial intelligence. It is a survey of classical search in artificial intelligence and machine learning and an in-depth examination of a specific application area such as robotics, theorem proving, computer vision, natural language processing, etc. Students are expected to demonstrate mastery via computer programs using the techniques of artificial intelligence.

*Prerequisite:* CS 271 with a grade of C or better.

### **CS 310 Computer Organization and Design (3 units)**

An introduction to digital logic and computer hardware organization. Emphasis is given to the design of Central Processing Units, Arithmetic and Logic Units, and main memories.

*Prerequisite:* A grade of C or better in CS 251

### **CS 321 Algorithms (3 units)**

An introduction to the design and analysis of algorithms. Algorithm analysis topics include asymptotic analysis, recurrence relations, loop invariants, and amortized analysis and parallel algorithms. Algorithm design techniques include divide and conquer, the greedy method, and dynamic programming. Additional topics include graph algorithms and NP-completeness.

*Prerequisite:* A grade of C or better in CS 212 and CS 271.

### **CS 326 Computer Security (3 units)**

This course is an introduction to computer security with an emphasis on software design principles and technical controls that help secure computer systems. After discussing foundational concepts in information security and assurance (e.g., the CIA triad, authentication, nonrepudiation, threats, attack vectors, risk assessment, security controls, plans, and policies), we will delve into the following topics: principles of secure software design and defensive programming, authorization and access control, and cryptography.

*Prerequisites:* A grade of C or better in Computer Science 271.

### **CS 331 Programming Languages (3 units)**

This course provides an introduction to fundamental issues in the design and implementation of programming languages. It covers the following topics: grammars and formal syntax; the functional programming paradigm, including the MapReduce model applied to some data-parallel computations; recursion; scope and lexical structure of programs; the lambda calculus as a formal model of functional languages; writing interpreters for small languages; evaluation order and parameter-passing; type systems.

*Prerequisite:* CS 271 with a grade of C or better.

### **CS 341 Software Engineering I (3 units)**

Students will study the history and theory of software engineering and apply that theory by implementing, in teams, an extensive software project. Topics will include traditional and modern software development processes, and the tools and techniques that they will encounter in industry.

*Prerequisite:* CS 271 with a grade of C or better OR Junior-level standing and CS 262 with a grade of C or better.

### **CS 342 Software Engineering II (3 units)**

Software Engineering is the second of a two-semester sequence on the topic of modern Software Engineering tools and techniques. Topics covered include Design Patterns, the Unified Modeling Language (UML), Component-based Software Development, Advanced OO Design and Analysis, Refactoring, and other techniques such as Extreme Programming. An extensive software development project will allow for practical application of the discussed techniques.

*Prerequisite:* CS 271 and CS 341, each with a grade of C or better. (Not currently offered)

### **CS 344 Mobile Application Development (3 units)**

An introduction to the tools and techniques for developing mobile applications. Topics covered include: history of mobile development, app creation using a modern IDE, deployment to an emulator and/or physical device, building a responsive user interface, understanding the application lifecycle, asynchronous programming, interfacing with databases and web services, and deploying a completed app. Over the course of the semester students will design and implement a substantive mobile application.

*Prerequisite:* CS 262 with a grade of C or better.

### **CS 346 Web Software Development (3 units)**

An introduction to the tools and techniques for doing full-stack web development. Topics covered include: web history and protocols, client-side development using HTML, CSS and a scripting language; and server-side development with database integration.

*Prerequisite:* CS 262 with a grade of C or better.

### **CS 361 Database Systems (3 units)**

An introduction to database processing with emphasis on database techniques, design, and modeling. Programming projects include implementation of selected database processing methods and the use of database software.

*Prerequisite:* A grade of C or better in Computer Science 271.

### **CS 371 Computer Graphics (3 units)**

An introduction to the mathematics, data structures, and algorithms used to create graphical output in the programmable pipeline. Topics include graphics hardware, shaders, transformations in two-



and three-dimensions, three-dimensional viewing, modeling three-dimensional shapes with polygon meshes, hierarchical modeling of three-dimensional objects, lighting and shading techniques, raster algorithms.

*Prerequisite:* CS 262 and Math-171 or Math 206 each with a grade of C or better.

### **CS 381 Theory of Computing (3 units)**

An introduction to the basic concepts in the theory of computing. Topics covered will include automata theory, formal languages, Turing machines, the Chomsky Hierarchy, and undecidability.

*Prerequisite:* A grade of C or better in CS 271 AND (CS 212 OR Math 222).

### **CS 391 Computer Networks (3 units)**

A course which covers the basic concepts in computer networks. Topics covered will include the nature of data communication, characteristics of computer networks, the ISO-OSI network protocol layers, and network performance considerations.

*Prerequisite:* A grade of C or better in CS 251 and CS 271.

### **CS 421 Operating Systems (3 units)**

An introduction to operating systems concepts. Topics covered include: interrupts, memory allocation, virtual memory techniques, process scheduling and synchronization, deadlocks, resource allocation, and file systems. A major programming project will be assigned to provide experience with operating system design.

*Prerequisite:* A grade of C or better in CS 251 and CS 271.

### **CS 431 Compilers (3 units)**

An introduction to compiler writing techniques for translating a higher level programming source language into a lower level target language. Topics to be covered include: definition of programming languages, lexical and syntactic analysis, low level code generation and optimization, run time systems, and error detection, reporting, and recovery. A major programming project will be assigned to provide experience with compiler design.

*Prerequisite:* A grade of C or better, or concurrent registration, in CS 331.

### **CS 474 Honors: Thesis (1-6 units)**

Honors thesis projects include any advanced independent endeavor in the student's major field of study e.g., a written thesis, scientific experiment or research project, or creative arts exhibit or production. Proposals (attached to Independent Study contract) must show clear promise of honors level work and be approved by a faculty sponsor. Course title for transcript will be 'Honors Thesis.' Completed projects will be announced and presented to interested students and faculty.

*Prerequisite:* University Honors program and junior standing. Maximum of 6 units (crs.). A maximum of 3 units (crs.) can count as electives toward the Computer Science major (in all emphases) as long as at least one Computer Science faculty member is sponsoring the project.

### **CS 480 Topics in CS (3 units)**

A topic of current interest in computer science will be investigated by faculty and qualified students. In addition to lectures by faculty, the students will be responsible for research and presentation of selected aspects of the topic. The course may be repeated for credit if the topic is different, and the student has the consent of department.

*Prerequisite:* Junior-level standing and consent of the instructor.

### **Practicum and Internship**

The courses CS 399 Internship in Computer Science and CS 490 Practicum in Computer Science are designed to be the capstone courses for the major or minor. Either course satisfies the Writing Emphasis requirement in the Computer Science Department. Each semester a faculty member in the Computer Science department is assigned the duties of being the "Practicum & Internship Coordinator." The name of and the times to see the coordinator are posted in the departmental office each semester.

#### **CS 399 Internship in Computer Science (3 units)**

An internship experience with a cooperating organization or corporation to provide on-the-job learning. The student must be involved in a large software development effort.

The internship guidelines and application form are online.

*Prerequisites: 75 credits toward graduation, at least six credits of 300-400 level CS courses, and completion of IS 208 (Professional Career Skills in Math and Natural Science, 1 credit) with a passing grade.*

#### **CS 490 Practicum in Computer Science (3 units)**

A course in which students use and go beyond the material learned in previous Computer Science courses in order to complete a research project or develop new software under the supervision of a Computer Science faculty member.

The practicum guidelines and application form are online.

*Prerequisites: 75 credits toward graduation, at least six credits of 300-400 level CS courses, and completion of IS 208 (Professional Career Skills in Math and Natural Science, 1 credit) with a passing grade.*

**Progress Checklist**  
**Computer Science Major (52-53 cr.)**

<b>Computer Science Major</b>	
<p>Computer Science Required (29 cr.):</p> <ol style="list-style-type: none"> <li>1. CS 212 _____</li> <li>2. CS 221 _____</li> <li>3. CS 251 _____</li> <li>4. CS 262 _____</li> <li>5. CS 271 _____</li> <li>6. CS 321 _____</li> <li>7. CS 331 _____</li> <li>8. CS 341 _____</li> <li>9. One of:               <ol style="list-style-type: none"> <li>1. CS 399 _____</li> <li>2. CS 490 _____</li> </ol> </li> </ol>	<p>Computer Science Electives (12 cr.):</p> <ol style="list-style-type: none"> <li>1. _____</li> <li>2. _____</li> <li>3. _____</li> <li>4. _____</li> </ol> <p>Mathematics Required (7-8 cr.):</p> <ol style="list-style-type: none"> <li>1. Calculus _____</li> <li>2. Statistics _____</li> </ol> <p>Philosophy Required (3 cr.):</p> <p>Phil 350 _____</p> <p>Interdisciplinary Studies Required:</p> <p>INTRDSCP 208 _____</p>

**Progress Checklist**  
**Computer Science Major - Systems and Theory Emphasis**

<b>Systems and Theory Emphasis</b>	
<p>Computer Science Required (44 cr.):</p> <ol style="list-style-type: none"> <li>1. CS 212 _____</li> <li>2. CS 221 _____</li> <li>3. CS 251 _____</li> <li>4. CS 262 _____</li> <li>5. CS 271 _____</li> <li>6. CS 310 _____</li> <li>7. CS 321 _____</li> <li>8. CS 326 _____</li> <li>9. CS 331 _____</li> <li>10. CS 341 _____</li> <li>11. CS 381 _____</li> <li>12. CS 391 _____</li> <li>13. CS 421 _____</li> <li>14. CS 499 _____</li> <li>15. One of:               <ol style="list-style-type: none"> <li>1. CS 399 _____</li> <li>2. CS 490 _____</li> </ol> </li> </ol>	<p>Computer Science Elective (3 cr.):</p> <p>_____</p> <p>Mathematics Required (11-12 cr.):</p> <ol style="list-style-type: none"> <li>1. Math-171 _____</li> <li>2. Math-172 or Math-256 _____</li> <li>3. Math-201 or Math-301 _____</li> </ol> <p>Philosophy Required (3 cr.):</p> <p>Phil 350 _____</p> <p>Interdisciplinary Studies Required (1 cr.):</p> <p>INTRDSCP 208 _____</p>

**Progress Checklist**  
**Software Technology Major**

<b>Software Technology Major</b>	
<p>Computer Science Required (26 cr.):</p> <ol style="list-style-type: none"> <li>1. CS 221 _____</li> <li>2. CS 247 _____</li> <li>3. CS 262 _____</li> <li>4. CS 271 _____</li> <li>5. CS 341 _____</li> <li>6. CS 344 _____</li> <li>7. CS 346 _____</li> <li>8. CS 399 _____</li> </ol>	<p>INFO SYS Required (6 cr.):</p> <ol style="list-style-type: none"> <li>1. INFO SYS 315 _____</li> <li>2. INFO SYS 316 _____</li> </ol> <p>One of following INFO SYS Required (3 cr.):</p> <ol style="list-style-type: none"> <li>1. INFO SYS 318 _____</li> <li>2. INFO SYS 432 _____</li> </ol> <p>Philosophy Required (3 cr.):</p> <p>Phil 350 _____</p> <p>Interdisciplinary Studies Required (1 cr.):</p> <p>INTRDSCP 208 _____</p>

## Student Notes