

# Software Engineering

## Undergraduate Study

For the undergraduate curriculum in Software Engineering (<http://www.se.iastate.edu>) leading to the degree Bachelor of Science

This curriculum is jointly administered by the Department of Computer Science and the Department of Electrical and Computer Engineering at Iowa State University. The Software Engineering program provides undergraduate students with the opportunity to learn software engineering fundamentals, to study applications of state-of-the-art software technologies and to prepare for the practice of software engineering. The student-faculty interaction necessary to realize this opportunity occurs within an environment motivated by the principle that excellence in undergraduate education is enhanced by an integrated commitment to successful, long-term research and outreach programs.

The software engineering curriculum offers emphasis areas in software engineering principles, process and practice. Students may also take elective courses in computer engineering and computer science.

## Program Educational Objectives

Within five years of graduation, the graduates should:

1. attain a **productive career** in Software Engineering or related fields;
2. attain **leadership** roles and become **effective collaborators** to advance professional and organizational goals;
3. engage in **continuous learning** and professional development.

We expect that these objectives will be manifested in our graduates through the following five key attributes: (a) *peer-recognized expertise*, (b) *engagement in professional practice*, (c) *sustained learning*, (d) *leadership* and (e) *teamwork*.

Demonstration of expertise involves applying state-of-the-art practices for solving problems in the design, development, validation, evolution and sustainment of (software) products. Demonstration of professional engagement involves contributing locally and globally to the use of ethical, competent, and creative practices in industry, academia or the public sector. Demonstration of sustained learning involves the ability to adapt to rapid technological, environmental, and organizational changes through self-study and group study and through opportunities of professional development or graduate study. Demonstration of leadership involves the ability to take initiative, and to facilitate the advancements of individuals and the community by influencing others and by having a widespread, positive impact on critical issues and projects. Finally, demonstration of teamwork involves the ability to work with collaborators who have varied expertise, and with diverse cultural and interdisciplinary backgrounds.

As a complement to the instructional activity, the Department of Computer Science and the Department of Electrical and Computer Engineering provide opportunities for each student to have experience with broadening activities. Students have the opportunity to gain practical industry experience in the cooperative education and internship program. Students have the opportunity to participate in advanced research activities. Through international exchange programs, students learn about engineering practices in other parts of the world.

## Curriculum in Software Engineering

Administered by the Department of Electrical and Computer Engineering in the College of Engineering and the Department of Computer Science in the College of Liberal Arts and Sciences.

Leading to the degree bachelor of science.

**Total credits required: 125 cr. See also Basic Program and Special Programs.**

**International Perspectives: 3 cr. <sup>1</sup>**

**U.S. Diversity: 3 cr. <sup>1</sup>**

**Communication Proficiency/Library requirement (minimum grade of C):**

ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
LIB 160	Information Literacy	1

ENGL 314	Technical Communication	3
Total Credits		10

**General Education Electives: 15 cr. <sup>2</sup>**

Choose 1 course from the following:		3
ECON 101	Principles of Microeconomics	
ECON 102	Principles of Macroeconomics	
I E 305	Engineering Economic Analysis	
Arts and Humanities		6
Social Sciences		3
Additional Arts and Humanities or Social Sciences course		3
Total Credits		15

**Basic Program: 27 cr.**

Complete with 2.00 GPA including transfer courses:

CHEM 167	General Chemistry for Engineering Students	4
or CHEM 177	General Chemistry I	
ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition (see above for grade requirements)	3
ENGR 101	Engineering Orientation	R
or S E 101	Software Engineering Orientation	
S E 185	Problem Solving in Software Engineering	3
LIB 160	Information Literacy	1
MATH 165	Calculus I	4
MATH 166	Calculus II	4
PHYS 221	Introduction to Classical Physics I (See Basic Program rule)	5
Total Credits		27

**Math and Physical Science: 11 cr.**

COM S 227	Introduction to Object-oriented Programming	4
COM S 228	Introduction to Data Structures	3
MATH 267	Elementary Differential Equations and Laplace Transforms	4
Total Credits		11

**Software Engineering Core: 34 cr.**

CPR E 281	Digital Logic	4
Choose one of the following:		3
COM S 229	Advanced Programming Techniques	
CPR E 288	Embedded Systems I: Introduction	
Choose one of the following:		3
COM S 321	Introduction to Computer Architecture and Machine-Level Programming	
CPR E 381	Computer Organization and Assembly Level Programming	
Choose one of the following:		3
COM S 352	Introduction to Operating Systems	
CPR E 308	Operating Systems: Principles and Practice	
Choose one of the following:		3
COM S 330	Discrete Computational Structures	
CPR E 310	Theoretical Foundations of Computer Engineering	
COM S 311	Design and Analysis of Algorithms	3
COM S 363	Introduction to Database Management Systems	3
COM S 309	Software Development Practices	3
S E 319	Software Construction and User Interfaces	3
S E 329	Software Project Management	3
S E 339	Software Architecture and Design	3

Note: CPR E 288, CPR E 381 and CPR E 308 are 4-credit courses. The core credit requirement (34 credits) is given in terms of 3-credit courses. If the 4-credit courses are taken instead, then the extra credits will be used as credits for Supplementary Electives.

Total Credits		34
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**Other Remaining Courses: 38 cr.**

S E 491	Senior Design Project I and Professionalism	3
S E 492	Senior Design Project II	2
S E 494	Software Engineering Portfolio Development	R
SP CM 212	Fundamentals of Public Speaking	3
STAT 330	Probability and Statistics for Computer Science	3
One of the following ENGL courses (with a minimum grade of C)		3
ENGL 309	Report and Proposal Writing	
ENGL 314	Technical Communication	
Math Elective: Choose one from the following list		3
MATH 207	Matrices and Linear Algebra	
MATH 304	Introductory Combinatorics	
MATH 314	Graphs and Networks	
MATH 317	Theory of Linear Algebra	
Software Engineering Electives <sup>2</sup>		6
Technical Elective <sup>2</sup>		3
Supplementary Elective <sup>2</sup>		9
Open Elective		3
<b>Total Credits</b>		<b>38</b>

**Seminar/Co-op/Internships**

S E 166	Careers in Software Engineering	R
Co-op or internship (S E 396, S E 397, S E 398) is optional		

**Transfer Credit Requirements**

The degree program must include a minimum of 30 credits at the 300-level or above in professional and technical courses earned at ISU in order to receive a B.S. in software engineering. These 30 credits must include S E 491 Senior Design Project I and Professionalism, S E 492 Senior Design Project II, and credits in the core professional curriculum and/or in technical electives. The software engineering degree program requires a grade of C or better for any transfer credit course that is applied to the degree program.

1. These university requirements will add to the minimum credits of the program unless the university-approved courses are also approved by the department to meet other course requirements within the degree program. U.S. diversity and international perspectives courses may not be taken Pass/Not Pass.
2. Choose from department approved lists.

Note: International perspectives and U.S. diversity courses are used to meet the general education electives.

**Courses primarily for undergraduates:****S E 101. Software Engineering Orientation.**

Cr. R.  
Introduction to the procedures, policies, and resources of Iowa State University and the department of Computer Science and Electrical and Computer Engineering. Information on engineering and computer-based professions.

**S E 166. Careers in Software Engineering.**

Cr. R.  
Overview of the nature and scope of the software engineering profession. Relationship of coursework to careers. Departmental rules, student services operations, degree requirements, program of study planning, career options, and student organizations.

**S E 185. Problem Solving in Software Engineering.**

(3-1) Cr. 3. *Prereq: Credit or enrollment in MATH 142*  
Introduction to software engineering and computer programming. Systematic thinking process for problem solving in the context of software engineering. Group problem solving. Solving software engineering problems and presenting solutions through computer programs, written documents and oral presentations. Introduction to principles of programming, software design, and extensive practice in design, writing, running, debugging, and reasoning about programs.

**S E 298. Cooperative Education.**

Cr. R. F.S.SS. *Prereq: Permission of department and Career Services*  
First professional work period in the cooperative education program. Students must register for this course before commencing work.

**S E 319. Software Construction and User Interfaces.**

(Cross-listed with COM S). (3-0) Cr. 3. F. *Prereq: COM S 228*  
Basic theory of grammars, parsing. Language paradigms. State transition and table-based software design. Review of principles of object orientation, object oriented analysis using UML. Frameworks and APIs. User interface architecture, evaluation of user interface. Design of windows, menus, and commands. Introduction to formal specification and model-based software design. Introduction to domain-specific software engineering. Nonmajor graduate credit.

**S E 329. Software Project Management.**

(Cross-listed with CPR E). (3-0) Cr. 3. *Prereq: COM S 309*  
Process-based software development. Capability Maturity Model (CMM). Project planning, cost estimation, and scheduling. Project management tools. Factors influencing productivity and success. Productivity metrics. Analysis of options and risks. Version control and configuration management. Inspections and reviews. Managing the testing process. Software quality metrics. Modern software engineering techniques and practices. Nonmajor graduate credit.

**S E 339. Software Architecture and Design.**

(Cross-listed with CPR E). (3-0) Cr. 3. *Prereq: S E 319*  
Modeling and design of software at the architectural level. Architectural styles. Basics of model-driven architecture. Object-oriented design and analysis. Iterative development and unified process. Design patterns. Design by contract. Component based design. Product families. Measurement theory and appropriate use of metrics in design. Designing for qualities such as performance, safety, security, reliability, reusability, etc. Analysis and evaluation of software architectures. Introduction to architecture definition languages. Basics of software evolution, reengineering, and reverse engineering. Case studies. Introduction to distributed system software. Nonmajor graduate credit.

**S E 342. Principles of Programming Languages.**

(Cross-listed with COM S). (3-1) Cr. 3. F.S. *Prereq: COM S 321; COM S 330 or CPR 310; either COM S 309, COM S 362 or COM S 363; ENGL 250*  
Study of concepts in programming languages and major programming paradigms, especially functional programming. Special emphasis on design tradeoffs that enable students to make sound choices of programming languages for a given software development task. Programming projects. Nonmajor graduate credit.

**S E 396. Summer Internship.**

Cr. R. Repeatable. SS. *Prereq: Permission of department and Career Services*  
Summer professional work period.

**S E 397. Software Engineering Internship.**

Cr. R. Repeatable. F.S. *Prereq: Permission of department and Career Services*  
One semester maximum per academic year professional work period.

**S E 398. Cooperative Education.**

Cr. R. F.S.SS. *Prereq: S E 298, permission of department and Career Services*  
Second professional work period in the cooperative education program. Students must register for this course before commencing work.

**S E 409. Software Requirements Engineering.**

(Dual-listed with S E 509). (Cross-listed with COM S). (3-0) Cr. 3. F. *Prereq: COM S 309, ENGL 250, SP CM 212*  
The requirements engineering process, including identification of stakeholders, requirements elicitation techniques such as interviews and prototyping, analysis fundamentals, requirements specification, and validation. Use of Models: State-oriented, Function-oriented, and Object-oriented. Documentation for Software Requirements. Informal, semi-formal, and formal representations. Structural, informational, and behavioral requirements. Non-functional requirements. Use of requirements repositories to manage and track requirements through the life cycle. Case studies, software projects, written reports, and oral presentations will be required. Nonmajor graduate credit.

**S E 412. Formal Aspects of Specification and Verification.**

(Cross-listed with COM S, CPR E). (3-0) Cr. 3. *Prereq: S E 319, COM S 309*  
Introduction to propositional/predicate/temporal logic, program verification using theorem proving, model-based verification using model checking, and tools for verification. Nonmajor graduate credit.

**S E 416. Software Evolution and Maintenance.**

(Cross-listed with CPR E). (3-0) Cr. 3. *Prereq: COM S 309*  
Practical importance of software evolution and maintenance, systematic defect analysis and debugging techniques, tracing and understanding large software, impact analysis, program migration and transformation, refactoring, tools for software evolution and maintenance, experimental studies and quantitative measurements of software evolution. Written reports and oral presentation. Nonmajor graduate credit.

**S E 417. Software Testing.**

(Cross-listed with COM S). (3-0) Cr. 3. S. *Prereq:* COM S 309, COM S 319, ENGL 250, SP CM 212

Comprehensive study of software testing, principles, methodologies, management strategies and techniques. Test models, test design techniques (black box and white box testing techniques), integration, regression, system testing methods, and software testing tools. Nonmajor graduate credit.

**S E 490. Independent Study.**

Cr. arr. Repeatable. *Prereq:* Senior classification in software engineering  
Investigation of an approved topic.

**S E 491. Senior Design Project I and Professionalism.**

(2-3) Cr. 3. *Prereq:* S E 329, completion of 29 credits in the S E core professional program, ENGL 314

Preparing for entry to the workplace. Selected professional topics. Use of technical writing skills in developing project plan and design report; project poster. First of two-semester team-oriented, project design and implementation experience.

**S E 492. Senior Design Project II.**

(1-3) Cr. 2. *Prereq:* S E 491

Second semester of a team design project experience. Emphasis on the successful implementation and demonstration of the design completed in S E 491 and the evaluation of project results. Technical writing of final project report; oral presentation of project achievements.

**S E 494. Software Engineering Portfolio Development.**

Cr. R. F.S. *Prereq:* Credit or enrollment in S E 491

Portfolio assessment for Software Engineers. Guidelines and Advice to improve software engineering portfolios and to better use portfolios as a tool to enhance career opportunities.

**S E 498. Cooperative Education.**

Cr. R. Repeatable. F.S.SS. *Prereq:* S E 398, permission of department and Career Services

Third and subsequent professional work periods in the cooperative education program. Students must register for this course before commencing work.