

# COMPUTER SCIENCE

## Degrees Offered

Bachelor of Science

## Majors Offered

Computer Science

## Concentrations Offered

Software Development

Networking and Computer Security

Graphics and Simulation

## Computer Science Program (BS) Objectives

Through their careers in computing or a related profession, Pacific graduates are expected to demonstrate the following within a few years of earning their Bachelor of Science degree with a major in Computer Science:

- Graduates employ design skills and technical knowledge that contributes to building or utilizing computing systems in a variety of professional careers.
- Graduates work effectively in team environments, utilize communication skills, and grow and adapt to a world of evolving technology.

## Transfer Students

Community college students can transfer to the School of Engineering and Computer Science at any point in their academic program. It is important that each student contact the appropriate Department at Pacific as early as possible and arrange for faculty assistance in planning his or her transfer.

The School of Engineering and Computer Science makes every effort to accommodate the needs of transfer students. Faculty offer advice on programs of study prior to coming to the University and then match student backgrounds with program requirements. Students are encouraged to complete introductory math and science courses prior to entering the program. An introductory object-oriented programming course (C++ or Java) is beneficial for students planning to major in computer science. Check with your program in advance.

## Co-op/Internship

No more than four units of Cooperative Education (ENGR 181) or Internship (COMP 187) may be applied towards the bachelor of science with a major in computer science.

## Bachelor of Science Major in Computer Science

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the bachelor of science with a major in computer science.

### I. General Education Requirements

PACS 001	What is a Good Society	4
PACS 002	Topical Seminar on a Good Society	4

PACS 003	What is an Ethical Life?	3
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**Note: 1)** Pacific Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer units complete 2 additional General Education elective courses from below in place of taking PACS 001 and PACS 002.

One course from each subdivision below:

#### Social and Behavioral Sciences

Two courses from the following:

IA. Individual and Interpersonal Behavior

IB. U.S. Studies

IC. Global Studies

#### Arts and Humanities

IIB. ENGR 030

One course from the following categories:

IIA. Language and Literature

IIC. Visual and Performing Arts

**Note: 1)** Only one course can come from each subcategory (A, B, or C) within each category. **2)** No more than 2 courses from a single department may be applied to meet the breadth program requirements, with the exception of certain 1-unit GE IIC courses.

### II. Diversity Requirement

Students must complete one diversity course (3-4 units)

ENGR 030	Engineering Ethics and Society	3
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**Note: 1)** Transfer students with 28 units or more transfer units prior to fall 2011 are encouraged but not required to complete a designated diversity course prior to graduation. **2)** Diversity course may also be used to meet general education and/or major/minor requirements.

### III. Fundamental Skills

Students must demonstrate competence in:

Writing

Quantitative analysis

**Note: 1)** Fundamental skills must be satisfied prior to enrolling in upper division courses.

### IV. Major Requirements

#### Mathematics and Science

Minimum 30 units that must include a minimum of 15 units in mathematics. COMP 047, COMP 147 and ECPE 127 count as mathematics units.

COMP 047	Discrete Math for Computer Science	4
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COMP 147	Computing Theory	4
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Select one of the following: 3-4

ECPE 127 Random Signals

MATH 037 Introduction to Statistics and Probability

MATH 039 Probability with Applications to Statistics

Select one of the following: 4

MATH 045	Introduction to Finite Mathematics and Calculus	
MATH 051	Calculus I	
Two laboratory science courses which can be any General Education Category IIIA course or BENG 55		8
Additional mathematics and science courses. Mathematics courses must be MATH 049 or MATH 053 or above. Science courses may be any General Education Category IIIA course, BENG 53, or BENG 55. Other science courses may be used with approval of academic advisor.		4-6
<b>Computer Science Core (minimum 27 units)</b>		
COMP 051	Introduction to Computer Science	4
COMP 053	Data Structures	4
COMP 055	Application Development	4
COMP 141	Programming Languages	4
COMP 157	Design and Analysis of Algorithms	4
COMP 173	Operating Systems	4
COMP 188	Senior Project I	2
COMP 189	Senior Project II	2
ECPE 071	Digital Design	3
ECPE 170	Computer Systems and Networks	4
ENGR 010	Dean's Seminar	1
ENGR 025	Professional Practice Seminar	1

## V. Area of Concentration and Computer Science Electives

17 units

Students complete their degree with 17 additional units of upper division computer science courses, beyond the core courses. These courses must include the specified courses in a selected concentration and other courses approved by the advisor. Areas of concentration are selected by students to allow them to specialize in an area appropriate for their post-graduation plans.

### Networking and Computer Security Concentration

Career options: Systems administrator, security specialist, network administrator, network appliance developer

COMP 127	Web Applications	4
COMP 175	System Administration and Security	3
COMP 177	Computer Networking	4
COMP 178	Computer Network Security	3
Electives selected with advisor		3

### Software Development Concentration

Career options: Application developer, software engineer, software architect, quality assurance

COMP 129	Software Engineering	4
COMP 135	Human-Computer Interface Design	3
COMP 137	Parallel Computing	3
COMP 163	Database Management Systems	4
Electives selected with advisor		3

### Graphics and Simulation Concentration

Career options: Game engine developer, simulation developer, training system developer, scientific application developer, games/animation tools developer, graphics/multimedia application developer

COMP 151	Artificial Intelligence	3
COMP 153	Computer Graphics	3
COMP 155	Computer Simulation	4
COMP 159	Computer Game Technologies	4
Electives selected with advisor		3

## Computer Science Faculty

Michael Doherty, Associate Professor and Chair of Computer Science, 1998, BS Electrical Engineering, University of Florida, 1983; MS Computer Science, University of Rhode Island, 1992; PhD Computer Science, University of Colorado at Boulder, 1998. Computer animation, simulation, video game technology, database management systems, programming languages, computer science education.

Michael L. Canniff, Lecturer, 2003, BS Computer Science, University of Minnesota, 1985; MS Computer Science, Syracuse University, 1990.

Cathy Carlson, Visiting Assistant Professor of Computer Science, 2008, BS, University of the Pacific, 2004; MBA, University of the Pacific, 2005. Business application training and implementation; lead tracking, generation and analytic software; website design.

Daniel Cliburn, Professor of Computer Science, 2006, BS Computer Science and Mathematics, Illinois College, 1997; MS Computer Science, University of Kansas, 1999; PhD Computer Science, University of Kansas, 2001. Computer graphics, video game design, virtual reality, computer science education.

Zengdi Cui, Assistant Professor of Computer Science, 2008, BS in Hydrogeology & Engineering Geology, Geology at China University of Mining & Technology, 1990; BS in Computer Science, University of Windsor, 2000; MBA, Shandong University of Science & Technology, 1995; MS in Computer Science, Wayne State University, 2002; PhD in Circulation Economy & Sustainable Development at Shandong University of Science & Technology, 2010; Project-based software engineering, database management systems, cyclic economy and sustainable development, technology transfer and marketing strategy.

Jinzhao Gao, Associate Professor of Computer Science, 2008, BS Computer Science and Engineering, Huazhong University of Science and Technology, 1995; MS Mechanical Engineering, Huazhong University of Science and Technology, 1998; PhD Computer and Information Science, Ohio State University, 2004. Scientific visualization, computer graphics, large scale data management, data analysis and visualization, data-intensive computing, remote visualization, Web-based applications.

Emma Hayes, Associate Professor of Computer Science, 2007, BS Computer Science, University of Southern California, 2003; PhD Computer Science, University of Southern California, 2007. Artificial Intelligence, multi-agent systems, machine learning, agent-based simulation, computer science education.

Leili Javadpour, Lecturer, 2015, BS Industrial Engineering, Isfahan University of Technology, 2007; MS Product Design and Management, University of Liverpool, 2009; PhD Engineering Science, Louisiana State University, 2013. Numerical Methods, Data Analytics, Natural Language Processing, Database Management Systems.

Oswaldo Jimenez, Assistant Professor of Computer Science, 2013, BS Computer Science, Stanford University, 2002; MA Learning, Design, & Technology, Stanford University, 2003; PhD Learning Sciences &

Technology Design, Stanford University, 2013. Educational games, video game development, software engineering, human-computer interaction, computer science education.

Chadi El Kari, Assistant Professor of Computer Science, 2014, BS Computer Engineering, Université Saint Joseph 2002; MS Computer Science and Engineering, University of Connecticut, 2005; PhD Computer Science and Engineering, University of Connecticut, 2011. Distributed Systems, Cloud Computing, Cryptography, Combinatorial Optimization.

## Computer Science Courses

### **COMP 023. Computer Concepts and Applications. 3 Units.**

This general introduction course to computers focuses on applications in word processing and spreadsheets. The students also study the basic concepts of computer architecture, the internet, and network communications. Students explore graphical design concepts with Web pages and PowerPoint presentations. The course may not be taken by students who have completed COMP 025. Prerequisite: Fundamental Math Skills requirement.

### **COMP 025. Computers and Information Processing. 4 Units.**

This introductory information technology course focuses on computer architecture, networking, internet technologies and the integration of productivity software. Lectures, readings, hands-on projects and lab assignments give a variety of learning experiences. Specific topics include computer architecture, digital data, networking, file management, spreadsheets, database systems and presentation applications. Students are exposed to JavaScript and Visual Basic scripting. Particular emphasis is placed on HTML programming and creating an interactive student website for homework and lab linking throughout the semester. Prerequisite: Fundamental Math Skills requirement. **(GE3B)**

### **COMP 041. Great Ideas in Computing. 4 Units.**

This course is a broad introduction to the field of computing. The concepts that are the foundation of computing are presented and placed in historical context. Discussion topics include the ways of thinking and working that make computing effective, and the future of the field. Example topics include number representation, architecture of computing systems, intelligent computing systems, and the use of computing in art and games. Prerequisite: Fundamental Math Skills requirement. **(GE3C)**

### **COMP 047. Discrete Math for Computer Science. 4 Units.**

This course is designed to develop skills in deductive reasoning and to apply concepts of discrete mathematics to computer science. Topics include logic, deductive reasoning, mathematical induction, set theory, functions, recurrence relations, combinatorics and probability, graphs, trees, and Boolean Algebra. Prerequisite: Fundamental Math Skills requirement. (Spring, every year). **(GE3B)**

### **COMP 051. Introduction to Computer Science. 4 Units.**

The course emphasizes program design and problem solving techniques that use a high-level programming language. The course introduces basic concepts such as assignment, control flow, iteration, and basic data structures in addition to a supervised lab. Prerequisite: Fundamental Math Skills requirement. **(GE3B)**

### **COMP 053. Data Structures. 4 Units.**

The course continues the development of program design and problem solving techniques. Topics include development of fundamental data structures and their associated algorithms as well as array-based algorithms, recursion, lists, generics, dynamic memory, binary trees, and associative structures. Prerequisite: COMP 051 with a "C-" or better.

### **COMP 055. Application Development. 4 Units.**

This course develops the skills and techniques required for the creation of contemporary software applications. Contemporary software applications are complex systems that involve the interaction of multiple subsystems that require teams of developers working together for extended periods of time. Topics include teamwork and communication skills, current development methodologies, analysis and design documentation and the use of libraries. This course is intended to prepare students to transition to upper division courses. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, every year).

### **COMP 093. Special Topics. 3 or 4 Units.**

### **COMP 127. Web Applications. 4 Units.**

The World-Wide Web consists of client-server applications operating over the Internet. This course introduces the skills and techniques for designing and developing web applications. Topics include: client-server architectures, web servers and web browsers, server-side programming, client-side programming, form processing, state management and multimedia. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better or permission of instructor. (Fall, even years).

### **COMP 129. Software Engineering. 4 Units.**

Students gain practical experience in dealing with medium to large scale software systems. Students learn how current analysis and design methodologies are used to develop the abstractions necessary to understand large systems. Students also learn how such methodologies and abstractions are used to communicate with coworkers and clients about the analysis and design. Because communication is an essential skill in large system development, students are expected to produce documents and presentations of professional quality and depth. Prerequisites: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Spring, odd years).

### **COMP 135. Human-Computer Interface Design. 3 Units.**

Human-Computer Interface (HCI) Design focuses on the relationship between humans and computers or other physical devices. This course helps students develop an understanding of the common problems in designing these interfaces and presents a set of design techniques to ensure that designs are both useful and useable. Prerequisite: Completion of all Fundamental Skills. Junior standing. (Spring, odd years).

### **COMP 137. Parallel Computing. 3 Units.**

Parallel computing is a science which solves a large problem by giving small parts of the problem to many computers to solve and then combining the solutions for the parts into a solution for the problem. This course introduces architectures and implementation techniques to support parallel computation. Students are expected to design and implement an original parallel application as a term project. Prerequisite: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Spring, even years).

### **COMP 141. Programming Languages. 4 Units.**

Topics in evaluation, design, and development of programming languages. Topics include type systems, variables and scope, functions, parameter passing, data hiding and abstractions, recursion, memory allocation, grammars and parsing, compilers architecture, programming paradigms, and comparison of programming languages and environments. Prerequisites: Completion of Fundamental Skills and COMP 053 with a "C-" or better. (Spring, every year).

**COMP 147. Computing Theory. 4 Units.**

Students study automata, formal languages and computability. Topics include finite state automata, regular languages, pushdown automata, context-free languages, Turing machines; decidability, reducibility, and time complexity that includes NP-completeness, intractability. Prerequisites: Completion of all Fundamental Skills; COMP 047 or ECPE 071 or MATH 074 with a "C-" or better. (Fall, every year).

**COMP 151. Artificial Intelligence. 3 Units.**

Students study fundamental concepts, techniques and tools used in Artificial Intelligence. Topics include knowledge representation, search techniques, machine learning and problem solving strategies. Also listed as ECPE 151. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, odd years).

**COMP 153. Computer Graphics. 3 Units.**

An introduction to two and three dimensional computer graphics. Basic representations and mathematical concepts, object modeling, viewing, lighting and shading. Programming using OpenGL and other computer graphics applications. Also listed as ECPE 153. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, every year).

**COMP 155. Computer Simulation. 4 Units.**

This course explores digital simulation, in which a model of a system is executed on a computer. The course focuses on modeling methodologies, mathematical techniques for implementing models, and statistical techniques for analyzing the results of simulations. Students develop simulations use both simulation development toolkits and general-purpose programming languages. Also listed as EMGT 155. Prerequisites: Completion of all Fundamental Skills; MATH 037 or MATH 039; MATH 045 or MATH 051, COMP 051 or ENGR 019 with a "C-" or better. (Fall, even years).

**COMP 157. Design and Analysis of Algorithms. 4 Units.**

Topics for this course include complexity analysis, algorithms for searching, sorting, pattern matching, combinatorial problems, optimization problems, backtracking, algorithms related to number theory, graph algorithms, and the limitations of algorithm power. Prerequisites: Completion of all Fundamental Skills; COMP 047 or MATH 074; COMP 053; MATH 045 or MATH 051 with a "C-" or better. (Fall, every year).

**COMP 159. Computer Game Technologies. 4 Units.**

This course surveys the technologies and processes used for modern video game development. Course topics include software engineering, media creation and management, hardware interfaces, user interaction, 3D mathematics and common algorithms and data structures to support graphics, physics and artificial intelligence. Prerequisite: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Fall, odd years).

**COMP 163. Database Management Systems. 4 Units.**

A database management system (DBMS) is a computer application designed for the efficient and effective storage, access and update of large volumes of data. This course look at such systems from two perspectives. The user-center perspective focuses on how a DBMS is used to build support for a data intensive application. This perspective includes examination of common data models, query languages and design techniques. The system implementation perspective focuses on the policies, algorithms and data structures used to design and implement a DBMS. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. Corequisite: COMP 047 or MATH 074. (Spring, even years).

**COMP 173. Operating Systems. 4 Units.**

Students are introduced to the fundamental concepts of modern operating systems. Topics include an overview of the computer hardware that supports the operating system, process management, threads, and CPU scheduling. Students also study process synchronization that uses primitive and high-level languages, virtual memory management, file systems, system protection, and distributed systems. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better or permission of instructor. (Fall, every year).

**COMP 175. System Administration and Security. 3 Units.**

Students are introduced to an operating system from an administrator's standpoint. Topics include installation is considered with the proper allocation of disk resources, maintaining the operating system and various subsystems, security issues that include server hardening, host firewalls and network security issues. Students also study account administration in a networked environment, change management and intrusion detection. Prerequisites: Completion of all fundamental skills and familiarity with console-based operating systems commands. Junior standing. (Fall, every year).

**COMP 177. Computer Networking. 4 Units.**

Topics examined in this course include computer networks and the internet, LAN and WAN architectures, and packet switched networks and routing. Students learn about the 7-layer OSI model and internet protocol stack, socket programming and client/server systems, wireless and security. The course includes a laboratory. Also listed as ECPE 177. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better. Junior or Senior standing. (Fall, every year).

**COMP 178. Computer Network Security. 3 Units.**

This course is an examination of the pervasive security threats related to the Internet, data communications and networking. Topics include TCP/IP protocols, authentication, encryption, malware, cybercrime, and social engineering. Emphasis is on computer and network attack methods, their detection, prevention and analysis, and the integration of the tools and techniques employed in this effort. Includes lab. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a "C-" or better. (Spring, every year).

**COMP 187. Internship in Computer Science. 1-4 Units.**

This internship course offers cooperative employment in a professional computer science environment. The internship requires satisfactory completion of the work assignment and written reports. Prerequisites: Completion of all Fundamental Skills; COMP 055 and ENGR 025 with a "C-" or better. Grading is Pass/No Credit only.

**COMP 188. Senior Project I. 2 Units.**

Students establish design objectives and criteria, analyze solution alternatives and evaluate design performance for a medium scale software application. Results include analysis and design documents and a presentation of the system design. Prerequisite: Completion of all Fundamental Skills. Senior standing.

**COMP 189. Senior Project II. 2 Units.**

This course is a continuation of Senior Project I. Students implement, test, and evaluate their software application. Results include final design documents, test reports and a presentation and demonstration of the project. Prerequisite: Completion of all Fundamental Skills and COMP 188 with a "C-" or better.

**COMP 191. Independent Study. 1-4 Units.**

Students create student-initiated projects that cover topics not available in regularly scheduled courses. A written proposal that outlines the project and norms for evaluation must be approved by the department chairperson.

**COMP 195. CS Senior Project. 4 Units.**

In this course, students synthesize their cumulative computer science knowledge through the development of a computer application. Students will establish design objectives and criteria, analyze solution alternatives and evaluate design performance. Students will then implement, test and evaluate the system. Results will include analysis and design documents, the implemented system, test reports and a presentation and demonstration of the project. Prerequisites: Completion of all Fundamental Skills, Senior Standing, COMP 055 with a "C-" or better.

**COMP 197. Undergraduate Research. 1-4 Units.**

Students conduct supervised research that contributes to current active topics in Computer Science. Topics may be selected by the student, related to faculty research, or provided by industrial sponsors. Permission of Undergraduate Research Coordinator.