COLLEGE OF
ENGINEERING
AND COMPUTER
SCIENCE

Computer Science

STUDENT HANDBOOK

PORTLAND STATE
UNIVERSITY

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Message from the Chair

As this message is written in late summer of 2001, our department is continuing to experience rapid growth in many areas. Our enrollments, which have undergone double-digit increases for the last four years, are on track to increase again this coming year. Our Ph.D. program is now under way and has several students admitted, and we hope to have our first graduate soon.

We move into our new space in the Fourth Avenue Building in fall of 2001. The space includes new laboratories for high performance computing, power-aware (wireless) computing, networking, and testing research. The glass-walled high-performance computing laboratory, which holds our Beowulf cluster and several machines donated by IBM, is particularly dramatic. In addition, we have new instructional laboratories, including our main laboratory equipped with Unix platforms, a laboratory equipped with Linux machines, and a laboratory for our Capstone courses. The Intel laboratory already in the building provides Windows platforms, and a generous grant from Intel has allowed us to upgrade the computers in that laboratory and equip the Linux lab.

Research areas in the department include network performance and security, operating systems performance, wireless computing, databases, software engineering, programming languages, and theory. Bryant York, who is joining our faculty this year, brings expertise in high-performance and scientific computing. We offer courses in most other sub-areas of computer science, including artificial intelligence and graphics, and our graduate students can take advantage of courses offered by other institutions in the area, including the Oregon Master of Software Engineering Program, the OGI School of Science and Engineering, and the Oregon Health and Science University, which is offering a series of courses in bioinformatics starting this fall.

We are continuing to update our ABET-accredited undergraduate curriculum to prepare students for careers in industry and for graduate school. We have had several students admitted to top graduate programs around the country, and a June 2000 graduate received a prestigious National Science Foundation Graduate Fellowship award.

Our location in Oregon's "Silicon Forest" gives us many advantages. Adjunct faculty from nearby companies teach our students about cutting-edge developments, such as spoken language computer interfaces, and part-time students working in industry bring a real-world perspective to class discussions. There are many internship and employment opportunities for students, including the chance to participate in the industry-sponsored MECOP internship program.

We offer an up-to-date curriculum, state-of-the-art laboratories, a highly qualified faculty, and a vibrant environment. We welcome inquiries and invite interested students to visit our Web site at *http://www.cs.pdx.edu*, or call our office at 503-725-4036.

Cynthia Brown
Department Chair

Careers in Computing

A wide variety of career opportunities are available in computing. The following is a brief description of some typical careers.

Computer User
Most professionals use computers to improve their productivity through the use of software and/or programming. For non-majors, PSU's Computer Science Department offers the course sequence CS 105, 106, 107, Computing Fundamentals. These courses provide a broad-based introduction to computer literacy, software packages, and introductory programming. Other courses are offered through:

PSU School of Business Administration, 503-725-3712

PSU Professional Development Center, 503-725-4820

Mount Hood Community College, 503-491-6422

Portland Community College, 503-244-6111

Clackamas Community College, 503-657-6958

One way to decide if your career plans go beyond the category of computer user is to ask whether you want to participate in some part of the development of computer programs. If so, you should consider one of the following careers:

Computer Programmer
Computer programmers take directions from systems analysts or computer scientists and translate those directions into programs. Many graduates of two-year community college programs are computer programmers. Information about such programs is available locally from:

Portland Community College campuses, 503-244-6111

Mount Hood Community College, 503-491-6422 or 503-491-7407

Clackamas Community College, 503-657-6958

Clark College Computer Science Department, 360-992-2106

Graduates of four-year programs such as PSU's Computer Science program may begin their careers as computer programmers.

Students work in the main computer science laboratory.

Computer Scientist/ Systems Analyst
These careers involve analysis of the needs for computer hardware and software along with the design of systems to meet those needs. Such needs may be met by purchasing packages, writing programs, and/or manual systems. Training for these careers typically requires at least a four-year program, such as the bachelor's degree offered by PSU's Department of Computer Science.

Software Engineer
A software engineer specializes in the analysis of problem requirements, specification of computer systems, and the design of those systems for programming. The field is professional, concerned with the application of computer science knowledge to practical problems. Graduates of a four-year computer science program may learn software engineering on the job, or they may take a specialized engineering degree, often at the graduate level, like that offered by the Oregon Master of Software Engineering (OMSE). For information telephone OMSE at 503-725-2900, or visit their web site at *http://www.omse.org*

Job Opportunities in Computer Science
Job opportunities for computer scientists are plentiful and salaries are high for graduates with at least two of the following qualifications:

- high grades (typically a GPA higher than 3.00)
- good recommendations from teachers
- work experience
- graduate degree

Portland State University offers an excellent placement service. All senior computer science students who are seeking employment should register with the Career Center, 402 University Services Building (USB), 503-725-4613, and should interview with prospective employers as they recruit on campus. The Career Center also offers assistance in preparing résumés and interviewing.

Computer Science Programs

Programs Offered

Portland State University offers a full range of courses and degree programs in Computer Science (CS). Students may take an occasional course without officially entering any degree program. They may pursue a conventional bachelor's, master's, or doctoral degree, or they may move more quickly through a program using credits from another academic program or work experience.

Non-admitted Students

Anyone may take up to 6 credit hours of graduate coursework or 8 credit hours of undergraduate coursework per term at PSU without being formally admitted to a degree program. (Most graduate courses carry 3 credits; most undergraduate courses carry 4 credits.)

First-time registrants must provide a completed Quick Entry Form (in the *Schedule of Classes*) to the Office of Admissions and Records to register by telephone. Also see *http://www.pdx.edu* for information on electronic registration. Note that non-admitted students register after all other students, which can be a disadvantage for courses in high demand.

Post-baccalaureate Students

PSU has a post-baccalaureate (post-bac) program for students who already hold a bachelor's degree but wish to take further courses for credit. This program is primarily intended for students who wish to earn a second bachelor's degree in a new field. The requirements to graduate with a second bachelor's degree are the same as the departmental requirements for the bachelor's degree; the "general" University requirements are waived, so the post-bac degree takes less time to complete. (It can be completed in about two and a half years of full-time work by a student with a technical background.) The post-bac program is also useful to prospective graduate students who wish to take undergraduate and/or graduate classes to prepare for application to the graduate program. (See the discussion on choosing a degree program below.)

There are advantages to obtaining post-bac status rather than just taking courses as a non-admitted student: you can register for more credits per quarter, and you register for courses before non-admitted students.

Post-bac students taking only undergraduate courses pay undergraduate fees. If you take one or more graduate classes in a given quarter, then you pay graduate fees for all classes during that quarter.

To obtain post-bac status you must formally apply to the University by completing the post-bac application, which is available from the Admissions Office. The deadlines are the same as for ordinary graduate admission, but applications will be considered after the deadline has passed if possible (it usually is). Admission to the post-bac program is not competitive; it is normally given if you hold a four-year undergraduate degree from an accredited institution. You must also have a cumulative GPA of 2.00 (2.25 for nonresidents) for any work taken after your bachelor's degree.

There is no departmental admission process for post-bac students, but if you decide to work toward a second bachelor's degree, you will have to declare formally as a CS major. In any case, you should consult with a faculty adviser before entering the CS undergraduate program; call the CS Department Office at 503-725-4036 to arrange an appointment.

Bachelor of Science

The Bachelor of Science in CS is the first university degree in the field and usually takes at least four years of full-time work to complete. Students may enter the program directly from high school, after preliminary coursework in a two-year community college program, or after they have work experience in the field without a college degree. Those who have a bachelor's degree in another field can complete the degree more quickly under the post-bac program described above. Full information about the Bachelor of Science degree is presented beginning on page 10.

Master of Science

The Master of Science (M.S.) in CS is the first graduate degree in the field, and usually takes one-and-a-half years of full-time study to complete. Students entering the program must have a bachelor's degree and adequate background in computer science, such as is obtained in an undergraduate computer science program. The master's degree may be a good alternative to the post-bac program for those wishing to retrain in computer science from a different technical background. For them it can be completed in a little more than three years of full-time work, including background courses.

Doctor of Philosophy

The Doctor of Philosophy (Ph.D.) is the highest degree offered in any discipline. It is intended for those who will pursue research in the field. The degree is usually required to teach computer science at the university level, and for employment in prestigious industrial research laboratories. Students may enter the doctoral program with a bachelor's degree or with a master's degree, and must have adequate background in computer science. Since completion of the degree requires presentation of a dissertation comprising original research, the time required is not cut and dried. Four to six years of full-time work are typical, less if the student enters with a master's degree in CS. Full information about the M.S. and Ph.D. programs is presented beginning on page 13.

Courses

Complete course descriptions are available in the *PSU Bulletin* and through the Departmental web site at *http://www.cs.pdx.edu*.

Choosing a Degree Program

CS programs, like those in any engineering or science field, are tough. Don't become an undergraduate CS major or plan to enter a graduate pro-

gram in the field unless you think you will enjoy it and do well. If you are not sure of your ability, the first course sequence for CS majors can help you to find out. Take CS 161 (Introduction to CS I). If you get an A or high B easily and have a great time in the course, then this field may be for you. If you get a low B or a C, think carefully about another major. If you are unable to maintain a better than B average in the introductory sequence, CS 161, 162, 163, you should not consider a CS major.

Accelerating Your Undergraduate Program

Students with significant experience in computer science gained on the job or through self-study can reduce the time required to gain a bachelor's degree by waiving requirements and by taking courses "by examination."

Any 100- or 200-level computer science course may be taken by examination during a term in which it is offered. In order to qualify to take a course by examination, you must be admitted to PSU and must present evidence to your adviser, and to the instructor of the class, that you have mastered the content of the course. Taking a course by examination may involve writing programs, doing specific exercises, or taking exams, as required by the course's instructor, plus taking the final exam along with regular students in the course. You will be able to consult with the instructor only to clarify requirements. Your grade will appear on your transcript as it does for any other course for which you paid full tuition. You must finish all work required by the instructor two weeks before the beginning of finals week in order to be able to take the final exam. There is a nominal fee for each course taken in this way which must be paid at the beginning of the term when you submit an "Application for Credit by Examination" form.

In exceptional circumstances a required CS course may be waived if there is sufficient evidence that the course material has been learned. For example, a student might present evidence that the material for a CS course is equal to parts of several courses taken at another school. The completion of a CS course does not imply that a prerequisite course may be waived. No credit is given for a waived course, so a waiver does not change the credit requirements for a degree. For undergraduates, if an upper-division CS course is waived, then another upper-division CS course must be taken in its place so that the total number of required CS upper-division credits remains the same. In addition, in the event that the CS Capstone is waived, then the capstone requirement must be met through University Studies. Your adviser has the authority to waive course requirements.

CS Degrees for Non-CS Degree Holders

Students who have a bachelor's degree in another discipline and wish to get a computer science degree have two options. Which one is best for you depends on your goals and your experience. You may enter the post-bac program and get a second bachelor's degree. Or, you may make up necessary background and enter the graduate program. The first option is the fastest way to a computer science degree, but the program is not very flexible, since its requirements are prescribed by the accreditation rules of the undergraduate program. You will have to take low-level courses in sequence and earn formal credit for them all. (However, see the section above on accelerating your program.)

The second option has less rigid rules for the undergraduate work, but may take longer. In making up background to enter the master's program, you do not necessarily need to earn formal credits in the background subjects. You must just convince the graduate admissions committee that you have the needed knowledge. You must demonstrate knowledge of the core curriculum of an undergraduate CS degree in order to be admitted to the graduate program. The core curriculum includes basic background in high-level language programming, algorithms, and data structures, computer hardware organization and architecture, operating systems, discrete mathematics, and logic, plus a year of calculus. The purpose of this requirement is to ensure that you can succeed in graduate coursework.

You may already know some of this material from previous coursework or from work experience. You might find that the best way to remedy deficiencies is to take formal courses. Or, you might want to study from textbooks on your own. The core curriculum corresponds approximately to these PSU courses:

- Programming and data structures: CS 161, 162, 163
- Machine organization and architecture: CS 200, 201
- Programming systems: CS 202
- Discrete math and logic: CS 250, 251, 311

In addition, several 300-level courses, especially CS 321 (Programming Languages and Compiler Design I), 333 (Operating Systems), and 350 (Algorithms) are usually required. Department faculty can advise you on the best level at which to begin preparatory coursework. Contact the CS Department Office (503-725-4036) to make an appointment with an adviser.

You can demonstrate adequate knowledge of an area of the core curriculum by passing the relevant 100- and 200-level course(s) with a grade of B or better. It will also establish your background if you take and do well in an advanced course, for which the core course is prerequisite. For example, a grade of A in CS 202 would establish that you probably do not need to take CS 161, 162. An application for admission to the graduate program will normally not be approved without formal coursework on the record to establish adequate knowledge of upper-division courses in programming languages, operating systems, and algorithms. This normally means passing CS 321, 333, 350 with a grade of B or better. Students having exceptional ability or background may demonstrate their readiness

to enter the graduate program by passing several 500-level courses, including at least one of the required graduate courses (CS 533, 558, and 581) with a grade of B or better.

CS courses may be taken at PSU either on a non-admitted basis or on a post-bac basis while you prepare for admission to the graduate program. These mechanisms are described above. You can also take core background courses at other schools such as Portland Community College (PCC). Courses at community colleges may be numbered differently than at PSU, but there are equivalent courses for most of the first two years of undergraduate study.

In general you can apply graduate credits taken as a non-admitted or post-bac student toward a graduate degree if you are subsequently admitted, but such credits must be formally transferred just like any others, require the approval of your adviser, and are subject to a limit of 15 to 18 credits. You typically cannot transfer courses taken while your GPA is too low to permit ordinary graduate admission. Once you decide to work toward a graduate degree, you should apply for formal admission as soon as possible. Contact the CS Department office to arrange a meeting with a faculty adviser to resolve any questions you may have.

Accreditation

The Portland State undergraduate CS program is fully accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, phone 410-347-7700.

Accreditation has two advantages for students. First, accreditation is a form of quality control. CSAC sets minimum standards for every aspect of a degree program. They periodically send an evaluation team to examine everything from the degree requirements (which are stiffer than average, at their insistence) to the way classes are conducted and graded. They interview students, staff, and faculty. They examine facilities. A program is accredited only if everything is up to par.

The second advantage of accreditation is that it increases the real market value of the B.S. in CS. Some companies (particularly those accustomed to hiring engineers) pay better starting salaries if the employee comes from an accredited degree program. They may give better job titles as well.

Internships

PSU is fortunate to be surrounded by high-tech industries. Therefore, our CS majors are in demand as part-time employees at local companies. The department maintains a file of job opportunities and advertises these on an electronic bulletin board. Often, companies are looking for student "interns." An intern position is often used to look over a potential full-time employee. Upon graduation, if the intern and the company hit it off, permanent employment can result.

The CS Department also participates in a formal internship program, the Multiple Engineering Cooperative Program (MECOP), which works closely with Northwest industry to offer students paid, high-quality industrial experience. The undergraduate program is a five-year program that includes two six-month internships.

Sarah Mocas, Assistant Professor

Computer Science Department

Faculty

The department faculty are listed in Table 1.

Office Staff

Beth Phelps, Hiring and Scheduling, *beth@cs.pdx.edu*

Teddie Seeley, Secretary/Receptionist, *seeleyt@cs.pdx.edu*

René Remillard-Marx, Grants and Budget, *rene@cs.pdx.edu*

Faith Gorsuch, Graduate Secretary, *faith@cs.pdx.edu*

The department office (120 FAB) is open Mondays through Fridays from 8 a.m. to 5 p.m.

Tutors and Computer Support

The department hires student tutors to staff our laboratories and to help students with coursework. This help is

Table 1: Computer Science Department Faculty

FACULTY	EXPERTISE	E-MAIL (@cs.pdx.edu)
PROFESSORS		
Sergio Antoy, Ph.D. University of Maryland	Formal aspects in software engineering, programming languages	antoy
Cynthia Brown, Ph.D. University of Michigan	Algorithms	cbrown
Laszlo Csanky, Ph.D. University of California-Berkeley	Numerical methods, theory of algorithms, parallel computation	
Richard Hamlet, Ph.D. University of Washington	Software engineering, theory of computing	hamlet
Warren Harrison, Ph.D. Oregon State University	Software metrics, testing, and project management; reverse engineering	warren
James L. Hein, Ph.D. Northwestern University	Theory and logic programming	jhein
Leonard Shapiro, Ph.D. Yale University	Database management	len
Bryant York, Ph.D. University of Massachusetts	Scientific computing	york
ASSOCIATE PROFESSORS		
Jingke Li, Ph.D. Yale University	Parallel computation, compiling techniques for parallel machines	li
Suresh Singh, Ph.D. University of Massachusetts	Wireless networks, performance evaluation, protocol design	singh
Andrew Tolmach, Ph.D. Princeton University	Programming languages	apt
ASSISTANT PROFESSORS		
Joseph Albert, Ph.D. University of Wisconsin	Database systems	albert
Karen L. Karavanic, Ph.D. University of Wisconsin	Parallel and distributed performance tools, operating systems	karavan
Bart Massey, Ph.D. University of Oregon	Artificial intelligence, software engineering	bart
Sarah Mocas, Ph.D. Northeastern University	Theory, cryptography	sarah

INSTRUCTORS		
Karla Fant, M.A. Portland State University	Computer graphics, computer education	karlaf
Robert Rosenoff, M.S. University of Portland	Computer education	brosenof
Mark Morrissey, M.S. Oregon Graduate Institute	Network protocols, operating systems	markem
NETWORK SCIENTIST		
James Binkley, M. S. Washington State University	Computer networks	jrb
EMERITUS PROFESSOR		
Maria Balogh, Ph.D. Oregon State University	Natural language interfaces to database systems	maria

available for 12 hours each weekday and eight hours each weekend day in the department laboratory. Tutors can be contacted on duty in the laboratory, or by e-mail at *tutors@cs.pdx.edu*. As you progress in the major you may be eligible to be a tutor.

The departmental computing systems are maintained by an organization called the Computer Action Team (CAT). The CAT is made up of volunteers, hourly paid staff, and salaried staff, under the direction of Janaka Jayawardena, who is director of computing services for the College of Engineering and Computer Science. Students can join the CAT as volunteers and learn UNIX systems administration. The CAT has a computer-implemented system of logging and responding to requests, which should be sent to *support@cs.pdx.edu*.

Computing Equipment

PSU is fortunate to have the support of local companies such as Tektronix, Intel, and Sequent, which have donated significant, state-of-the-art equipment to the department. Most of our equipment is connected in a local area network and to the worldwide Internet. PSU is a member of a local consortium of universities which sponsors a high-speed network called PREN (Portland Research and Education Network), which provides a connection to Internet2.

The department maintains a network of computer servers running the UNIX operating system. Students on campus access this network largely through X-Windows graphics terminals, provided in offices and an open laboratory. The network also interfaces to other campus computers (other departments, the library, etc.) and to central University servers; other self-contained computers (Macintoshes, PCs, Sparcs, etc.) are also connected. Students have access to a color laser printer.

Specialized software packages that support teaching and research are available on the network. From off campus, high-speed modems allow access to the network, including a SLIP/PPP service to connect to the Internet through phone lines.

The department has several specialized labs supporting various research projects. These include a cluster computer, a networking lab, and a lab for experimenting with power consumption in wireless networks.

Information Online

The text of this brochure and the complete text of the current *PSU Bulletin* are available online, linked into the department's web site at *http://www.cs.pdx.edu*. The web site contains links to up-to-date information about schedules, instructors, courses, research programs, student activities, etc. It is also the starting point for finding the personal web pages of faculty, students, and staff.

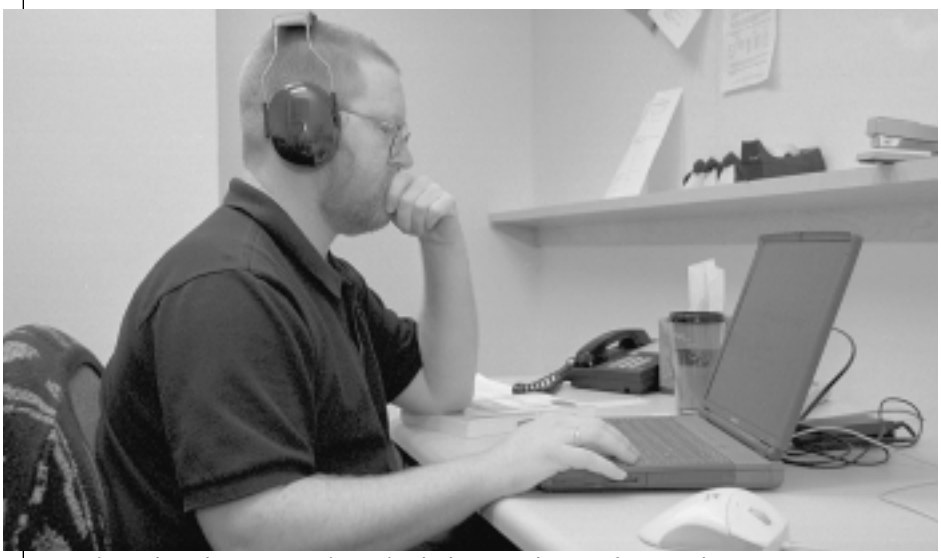
Seminars and Colloquia

Colloquium speakers provide expert, up-to-date information in the rapidly changing field of CS. Speakers come from universities, industry, and government. The PSU CS Department hosts speakers on campus, for which notices are posted in PCAT and electronically. OCATE sponsors colloquia in Beaverton, often in a series with a theme that changes each term. The Oregon Graduate Institute has a regular computer science colloquium series. Students are encouraged to attend these free lectures, to become acquainted with the latest research, and to meet the speakers.

Undergraduate Program

Admission to the Computer Science Program

Upon achieving junior standing at PSU (90 credits or more) and completing all lower-division CS requirements, students should file an Application for Admission to the CS program at the Computer Science Office. Admitted CS students are assigned an adviser and may register for upper-division CS courses. No more than eight credits of upper-division CS courses may be taken before admission to major status.



Mark Morrissey, instructor, works on developing an assignment for Operating Systems.

Advising

Freshmen and sophomores (defined as students with fewer than 90 credits of coursework) should call the College of Engineering and Computer Science at 503-725-4631, where they will be advised by a freshman/sophomore adviser.

Juniors, seniors, and post-bac students who are accepted for admission to the CS program will be assigned a faculty adviser the fourth week of their first term. Students who will be inactive (i.e., not taking any classes at PSU) for a term must file a leave request with the CS Office in order to retain their adviser. Students may file a maximum of one leave request per year.

As a CS major, you should feel free to consult your faculty adviser about your overall program of study, your career plans, or any problems you encounter in CS at PSU. You should make a point of seeing your adviser your first term as an admitted CS major for an initial consultation.

Your CS adviser is particularly useful in helping you interpret the CS requirements for your degree. However, if you are depending on this interpretation, make sure that you get it in writing (usually in the form of a "Substitution/ Waiver of CS Requirements") and that it is added to your file in the Computer Science Office.

It is also important to know when not to consult your faculty adviser because someone else is more appropriate.

1. For information about a specific course, see the course's instructor.
2. For information about University degree requirements, rules, exceptions to rules, forms, etc., consult the *PSU Bulletin*. If the *Bulletin* is not clear, you may check with the Information and Academic Support Center (IASC) at 503-725-4005.

The *PSU Bulletin* is the absolute authority for all regulations.

Students are responsible for knowing the rules, regulations, and requirements in the *PSU Bulletin*. Ultimately, the responsibility of ensuring that you have completed all requirements for your degree is yours. Your CS adviser and the advisers at the Information and Academic Support Center will help you interpret the requirements that are in the *PSU Bulletin*. Their role is not to "approve" or otherwise construct a program of study for you. An approved program of study can be found in the *PSU Bulletin* under the section on CS. A graphical description of the program year by year is given in Table 2.

Prerequisites

Prerequisites for each CS course are listed in the course descriptions. Each prerequisite implicitly includes instructor's permission as an alternative. Students should not attempt to take courses for which they do not have the prerequisite background. The prerequisite structure of the required courses in CS is given in the graph in Table 3. The graph also includes an indication of the terms in which each course is offered.

Graduation Requirements

In order to obtain a bachelor's degree in CS at Portland State University, you must satisfy the University-wide requirements given in the *PSU Bulletin*, summarized in Table 4, and Department of Computer Science requirements.

Computer Science Requirements

Department requirements are interpreted by the Department of Computer Science. Variances from these requirements are permitted only when a "Substitution/Waiver of CS Requirements" form (copies are in the CS office) is on file with the department.

A synopsis of the requirements follows:

Computer Science Courses .....Credits
CS 161, 162 Introduction to Computer Science I, II 8
CS 163 Data Structures 4

Table 2: Computer Science Possible 4-Year Course Plan

FRESHMAN			SOPHOMORE			JUNIOR			SENIOR		
FALL	WINTER	SPRING	FALL	WINTER	SPRING	FALL	WINTER	SPRING	FALL	WINTER	SPRING
Math / Science Requirements											
MTH 251	CALCULUS MTH 252	MTH 253	D				D	STATS 460			
PH 221	PHYSICS PH 222	PH 223								A	A
PH 214	PH 215	PH 216									
Computer Science / Engineering Requirements											
INTRO TO CS I CS 161	INTRO TO CS II CS 162	DATA STRUC CS 163	COMP ARCH AND ASS LANG CS 200	COMP ARCH AND ASS LANG CS 201	PROG SYS CS 202	SOFT ENGR CS 300	LANG AND COMP DESIGN CS 321	LANG AND COMP DESIGN CS 322	B	B	B
			DISC STRUC CS 250	LOGIC STRUC CS 251	COMP STRUC CS 311	B	ALGOR COMP CS 350	OP SYS CON PR CS 333	SOFT CAP CS 487	SOFT CAP CS 488	B
									ETHICS 407		
General Education Requirements (see Table 4)											
				SP PB SPK SP 220							
FRESHMAN INQUIRY UNST 101	FRESHMAN INQUIRY UNST 102	FRESHMAN INQUIRY UNST 103	SOPHOMORE INQUIRY UNST 299	SOPHOMORE INQUIRY UNST 299	SOPHOMORE INQUIRY UNST 299	TECH WR WR 227	UNST UP DIV CLUST	UNST UP DIV CLUST	UNST UP DIV CLUST	C	C

Explanation

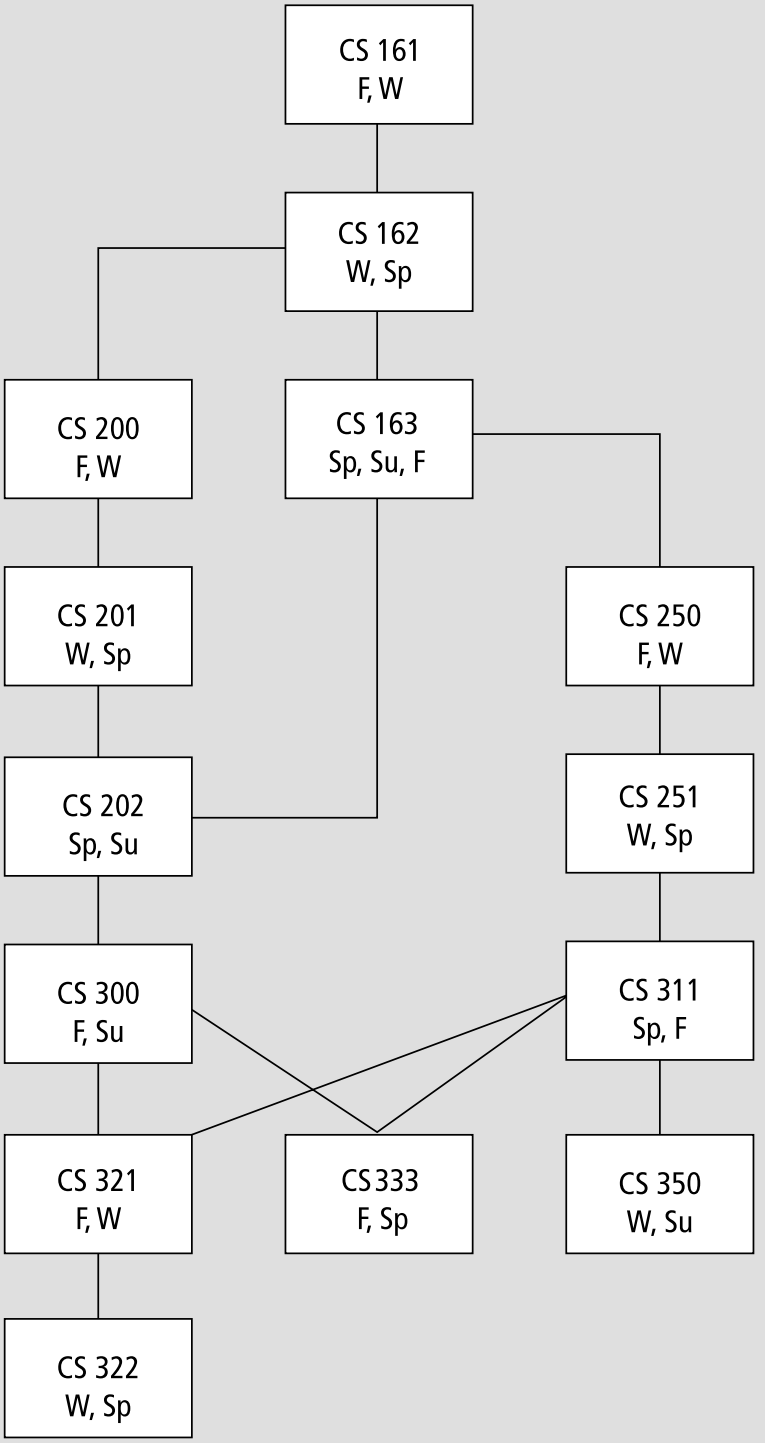
CREDIT HOURS

- 1
- 2
- 3
- 4

- A = Non-major science elective
- B = CS elective
- C = Free elective
- D = Math elective

- CS 487 and 488 fulfill UnSt capstone
- Includes 72 credits of upper-division courses
- Transfer students may substitute Physics 211-213 for Physics 221-223
- Sp 220 waived for students who take Freshman Inquiry

Table 3: Prerequisite Structure of Required Courses



CS 200 Computer Organization and Assembly Language 4
CS 201 Computer Architecture 4
CS 202 Programming Systems.....4
CS 250 Discrete Structures 4
CS 251 Logical Structures 4
CS 311 Computational Structures 4
CS 300 Elements of Software Engineering 4
CS 321, 322 Languages and Compiler Design 8
CS 333 Operating Systems and Concurrent Programming 4
CS 350 Algorithms and Complexity.....4
CS 407 Ethical and Legal Issues 2
CS 487, 488 Software Engineering Capstone 6
Approved upper-division computer science electives.....20

Total in computer science 84

Other Courses .....Credits
Mth 251, 252, 253 Calculus I, II, III 16
Approved math electives.....8
Stat 451 Applied Statistics for Engineers and Scientists 3
Ph 221, 222, 223 General Physics (with Calculus) 9
Ph 214, 215, 216 Physics Laboratory.....3
Sp 220 Public Speaking* 4
Wr 227 Technical Writing.....4
Approved science electives 8

Total in other fields 51

*Waived for students who take Freshman Inquiry

Approved Science Electives

The student is required to complete 8 credits of approved science electives. These must be chosen from Bi 251, 252, 253; G 201, 202, 203; Ch 221, 222, 223; or any 300- or 400-level course from these departments or the department of physics. Laboratories taken with these courses also count toward the 8 credits.

Approved Upper-division Computer Science Electives

Students must complete 20 credits of upper-division computer science electives. The total may include any regular upper-division computer science course and any of the courses ECE 455, 456, 485, 486, except that no more than 4 credits may be taken from CS 399, 401, 405, 406, 407, 409, and CS 404 may not be used.

Approved Math Electives

Students must complete eight credits of approved mathematics electives, which must include at least one upper-division course in mathematics. The current list of approved courses includes: Mth 254 or 256, Mth 343, Mth 344, Mth 346, and Stat 452 (new second course in statistics). Other

upper-division mathematics courses may be used to satisfy the requirement with prior written adviser approval.

Post-baccalaureate Requirements
Post-bac students working toward a second bachelor's degree must satisfy all the departmental requirements, including calculus, physics, math, and science electives, but are not required to take free electives or to satisfy the general University requirements.

Table 4: General Education Requirements Portland State University

The General Education requirements for engineering students can be met in one of the following ways:

1. Students who complete their entire program at Portland State University meet the requirement by taking 39 credits of University Studies (15 credits Freshmen Inquiry, 12 credits Sophomore Inquiry, and 12 credits upper-division cluster), plus the computer science capstone.

2. Transfer students meet the requirement by having WR 121, Sp 220, and 33 credits as a combination of University Studies courses and Liberal Arts/Social Science transfer credits. (At a minimum the 12-credit junior/senior cluster must be taken at PSU.)

3. Students transferring from community colleges having co-admission agreements with PSU (currently Clackamas Community College, Mount Hood Community College, and Portland Community College) may be able to complete Freshman and Sophomore Inquiry at their community college before transferring to PSU. If so, they may follow No. 1.

NOTE: Additional information regarding general University requirements may be obtained from the *PSU Bulletin*.

Graduate Program

Admission
Admission to the graduate program is competitive. To be considered for admission, you must have a four-year baccalaureate degree (normally in computer science) from an accredited institution, with a GPA of at least 3.00 in your undergraduate upper-division course work. If your bachelor's degree is not in computer science, you must make up the background needed for graduate study before applying for admission, as described above.

The department also requires that you submit scores from the general portion of the Graduate Record Examination (GRE) and two letters of reference.

There is no specific minimum standard for admission. Our admission decisions are based on all the information you provide to us. You are welcome to contact the CS Department Office (503-725-4036) to make an appointment with an adviser.

Students may apply to the master's program, and then later transfer to the doctoral program. This procedure is recommended if you are not sure which degree you will seek. Students who are sure that they wish to enter the doctoral program (those who already have a master's in CS, for example) may apply directly for the higher degree. Doctoral applicants are screened more carefully than master's applicants. A student who is not well prepared or who does not have a clear motivation and a likely choice of research area will probably not be admitted to the doctoral program. These issues should be addressed in the student's statement accompanying the application.

Application Procedure
Applications to the CS graduate program are handled jointly by the University's Office of Admissions and Records and the CS Department office; you must send materials to both, as described below. The admission process is slow, so you should apply early, especially if you are an international student. Forms are available from the CS office, or a request for forms may be sent to *gc@cs.pdx.edu*. Forms are not available online, so include a postal address in your request. The deadlines for application are set up to guarantee there will be time to process your application in advance of the term in which you plan to enter. You may submit your application after the deadline; if it is too late for the desired term, you will normally be considered for the following term instead.

Submit to the University Office of Admissions:
1. University application form.
2. Non-refundable application fee ($50).
3. Measles vaccination form.
4. Official transcripts from every post-secondary institution you have attended.
5. (International students) Official report of TOEFL score. PSU requires a minimum score of 550.

Submit (or arrange to have submitted) to the CS Department:
1. Departmental application form.
2. Official reports of your Graduate Record Examination (GRE) scores. The general examination is required.
3. Two letters of reference, preferably from people who know your academic performance and potential. Letters from work supervisors are less useful but also acceptable. Letters should be on the sender's letterhead if possible.

4. Unofficial transcript from each post-secondary institution you have attended. (Not required for international students.)
5. A short personal statement describing your plans, interests, and qualifications. Give your background in CS, including any relevant work experience, your primary interests in CS, and your reasons for seeking a graduate degree. Please indicate whether you plan to work toward the degree part-time or full-time; if part-time, describe your other employment or major activities. If you are applying for immediate admission to the doctoral program, include a description of your potential research area, the faculty members with whom you hope to do your research, and your reasons for not entering the master's program.
6. If you will require financial assistance to attend PSU, include a departmental application form for financial assistance with your other application papers. The form may be obtained from the CS Office.

The official deadlines for submission of all materials (to both offices) are as follows:

Term	Standard Deadline / International Student Deadline
Fall	April 1 / March 1
Winter	September 1 / July 1
Spring	November 1 / September 1
Summer	February 1

Financial Assistance

Teaching Assistantships

The department normally has a number of teaching assistantships available to our best-qualified graduate students. Normally, these assistantships are granted for one year at a time and are renewable based on the student's performance in coursework and TA responsibilities. A typical assistantship pays approximately $3,000 per quarter, plus a tuition remission. The student might teach a course under the supervision of a faculty member or grade papers for approximately 14 hours per week.

Criteria for choosing TAs are similar to those used for admission—grades, references, GRE scores—plus evidence of teaching experience or ability.

Assistantships are usually awarded for the academic year beginning in the fall term. Application forms may be obtained from the CS Office. If you are a new applicant, include the form with the rest of your application. If you are already admitted to the CS graduate program, file the assistantship form by itself according to the deadlines for application.

Additional assistantships may be advertised to graduate students shortly prior to the term for which they become available.

Research Assistantships

Faculty in the department have research grants that support research assistantships. Faculty members choose RAs on an individual basis, but the most important criterion is usually the student's ability to contribute to the professor's research program. Ordinarily students are given a research assistantship only after they have been in the graduate program for at least one term and have taken at least one class from the professor.

After advancing to candidacy (see Doctoral Requirements on page 16) doctoral students are normally supported by a research assistantship with their dissertation adviser and may be able to use the work as a part of their own research.

Other University Sources of Financial Aid

Some additional sources of financial assistance are administered by other PSU offices (not by the CS Department); contact the Office of Financial Aid for information. Some of these sources have early deadlines; see "Financial Assistance" in the *PSU Bulletin* for more details.

The Oregon Laurels Graduate Tuition Remission Program provides tuition remission to academically qualified Oregon residents on a competitive basis; contact the Office of Graduate Studies for further information.

A limited number of scholarships are available for graduate students; contact the Information and Academic Support Center for information.

Some other departments hire CS graduate students as TAs to assist in computer-related activities.

A list of on-campus job opportunities is posted outside the Human Resources Office, 322 University Services Building.

Loans and work-study programs are administered by the Office of Financial Aid.

Off-Campus Jobs

Information about computer job opportunities in the Portland area is posted regularly in the newsgroup *psu.jobs* and on the bulletin board outside the CS Department Office (120 FAB).

General Graduate Requirements

Planning Your Course of Study

Initially upon being accepted as a graduate student, you will be assigned a faculty adviser. Doctoral students are also assigned additional faculty members to make up a preliminary Ph.D. committee.

When you begin research work on a Ph.D. dissertation, or if you choose to do a master's project or thesis, you should change your adviser to the person who will supervise this process. Your adviser must be a full-time faculty member.

Your current adviser is defined to be the faculty member who has signed your most recent Quarterly Graduate Program Approval form. You may change advisers, but since the new adviser must agree to the change, and there are PSU regulations about advising duties (particularly for doctoral degrees), you must make sure that any change has been properly recorded and processed by the CS Office. When you apply for graduation, your current adviser must approve your program, and is not necessarily bound by the decisions of a different, earlier adviser. For this reason it is recommended that students

discuss their study plans with advisers regularly.

Transfer Credits

Any courses taken before you are admitted to the PSU graduate program in CS are normally not part of your graduate program, even if you take them at PSU. To have such credits counted, you must have the approval of your adviser. You can only transfer credits for courses in which you obtained a grade of B or better. Normally 15 quarter credits, at most, may be transferred in this way. If all your transfer credits are from PSU, Oregon State University, University of Oregon, or Oregon Graduate Institute, you may transfer an additional 3 quarter credits, for a total of 18. (Note: This additional transfer possibility is specific to the CS Department and is not described in the *PSU Bulletin*.)

Up to 12 additional graduate credits (separate from the 15 or 18 that may be transferred) may be counted if they are taken at PSU during the last 45 credits before you receive your bachelor's degree at PSU and are not needed for your bachelor's degree; see the *PSU Bulletin* for details.

Course Load

Full-time graduate students typically take 9 to 12 credits per term. If you register for more than 16 credits, you must obtain the approval of your adviser. Part-time students are defined as those taking fewer than 9 credits per term.

Teaching and research assistants are required to complete at least 9 graduate credits each quarter with a grade of B- or better, or a Pass; some of these can be CS 501 (Research) credits that will not count toward the credits required for a degree, and should normally be graded Pass/No-Pass. In addition, all assistants are automatically enrolled in a certain number of credits (3 for 15-percent time TAs; 6 for 30-percent time TAs) of CS 501 or CS 509 (Graduate Assistant Practicum), graded Pass/No-Pass. These automatic credits do not count toward the credits required for a degree.

OCATE and OMSE Courses

The Oregon Center for Advanced Technology Education (OCATE) is a state agency that sponsors graduate courses. OCATE is not a school, although it has registration and classroom facilities in the Capital Center, 18640 NW Walker Road, Beaverton. Its courses are taught by faculty from Oregon universities, such as PSU, and carry the course numbers and credit from the offering department. OCATE chooses courses of interest to part-time students who are employed in the high-tech industry, which may be taken by people who are not in any degree program. OCATE courses can also be an important part of a graduate program in CS at PSU. Information on OCATE courses is available in the CS office; you may also call OCATE at 503-725-2200 and be put on the mailing list to receive their announcements directly. The credits you receive from non-PSU OCATE courses are subject to the 15/18-credit transfer limit.

Courses from the OMSE (Oregon Master of Software Engineering) program are available to PSU graduate students on a limited basis. For more information see the CS office or the information on the CS web site, *http://www.cs.pdx.edu*. OMSE can be contacted at 503-725-2900 or Web site *http://www.omse.org*.

Courses at Other Universities

An agreement exists between PSU, Oregon State University in Corvallis, and Oregon Graduate Institute in Beaverton, which allows full-time PSU students to take courses in CS and electrical engineering at the other schools free of charge. That is, the full-time PSU tuition covers the other school's courses. This option is available for a limited number of students for each course, with preference given to students supported by the department.

You sometimes register at PSU for a cross-listed version of the course, and sometimes at the other school. Most courses can be cross-listed; therefore, the credits are not transferred and not subject to the 15 to 18-credit limit. See the CS Office for help.

Part-time students are not covered by this special agreement. A part-time PSU student may take courses at other universities, but to do so the student must always register at the other school, pay its regular tuition, and then transfer the credits, subject to the 15- to 18-credit limit.

Pass/No-Pass

Usually courses graded Pass/No-Pass cannot be used toward a graduate degree.

Classes taken Pass/No-Pass at PSU (prior to admission) or other institutions may not be transferred for credit.

Leaving the Program

If you are unable to register for any coursework during a given term, it is your responsibility to inform the CS Department and the Office of Graduate Studies. For details, see the sections on Leave of Absence or Cancellation of Admission and Re-enrollment in the *PSU Bulletin*.

Minimum Grade-Point Average

Students in the graduate program must maintain a 3.00 cumulative GPA and a 2.70 term GPA at all times. Any student who has a cumulative GPA below 3.00 at the end of a term (based on at least 9 credits), or a term GPA below 2.70 (based on at least 6 credits) will be put on academic probation. A student who has been placed on probation and subsequently violates these GPA limits will be terminated from the University.

Master of Science Requirements

Graduation Requirements

In order to graduate with a master's degree, you must:

- Complete a program of 45 graduate-level credits. Fifteen of these 45 credits may be outside of CS. Approval of all 45 credits by your adviser is required. This is done on the "Quarterly Graduate Program Approval" form, signed and filed in the CS Office each quarter. The best way to ensure that your adviser will approve of your final program is to

have these quarterly report forms signed and on file.
- Take the following graduate courses, or their equivalents:
  CS 581 Theory of Computation
  CS 558 Programming Languages
  CS 533 Concepts of Operating Systems

These courses must be passed with a grade of B or better. You are urged to take these courses as early as possible in your graduate program.
- Take one of the following sequences of courses:
  Systems: CS 533, CS 594, and one course from the following: CS 595, CS 596, or CS 575.

  Languages: CS 558, CS 577, and one course from the following: CS 515, CS 530, or CS 557.

  Software Engineering: CS 554 and two courses chosen from: CS 555, CS 556, CS 559, CS 510 Software Quality Analysis, CS 510 Modeling and Analysis of Software Systems, CS 510 Software Architecture and Domain Analysis, CS 510 Software Design Techniques.

  Theory: CS 581, either CS 584 or CS 582, and one course from the following: CS 510 Scheduling, Planning and Search, CS 582, CS 584, or CS 585.

  Databases: CS 544, CS 545, and one course from the following: CS 510 Distributed Databases or CS 546.

General Course Restrictions
The following general restrictions apply to the courses that count toward the 45 credits required for graduation:
- All graded courses must be passed with a grade of B- or better. All courses taken P/NP must be passed.
- A maximum of 6 credits of CS 504 Internship, CS 505 Reading and Conference, or CS 506 Special Projects may be counted.
- Note that it is typical to receive only 1 credit for a summer internship, in which case it is expected that the student will have 46 credits, instead of 45 credits, on graduation.
- CS 501 (Research) /CS 509 (Graduate Assistant Practicum) credits may not be counted.
- At least 30 of the 45 credits must be in CS courses.
- All 45 credits, to be included in your approved program, require the approval of your CS adviser.

You must be registered at PSU for at least 1 credit the term you graduate.

Project or Thesis
Students are encouraged to undertake either a project or a thesis. However, students may choose to graduate under the coursework-only program described above.

Project Option. Write an acceptable project paper under the direction of a faculty member. If this option is chosen, at least 3, but no more than 6, of the required 45 credits must be from CS 506 Special Projects.

A project must reflect a mastery of those computer science topics that the project intersects. Issues raised in courses related to your project, such as "what style of specification and testing should you use?" or "what language(s) did you use and why?" should be addressed and answered in the project description. If there is any question about what topics you should address, consult your project adviser. A public presentation of your project work is required at the completion of your project.

Thesis Option. Write and defend a master's thesis. If this option is chosen, at least 6, but no more than 9, of the required 45 credits must be from CS 503 (Thesis).

University requirements for a master's thesis are given in the *PSU Bulletin*. In particular, an oral thesis defense is required. You must be registered for at least 1 credit during every term during which you are working on any aspect of your thesis and during the term in which you plan to defend your thesis.

Doctoral Requirements

There is extensive information on doctoral requirements in the *PSU Bulletin*, and students are responsible for familiarizing themselves with that information.

Admission and Advising
The PSU *Bulletin* gives the University criteria for Ph.D. advisory committees.

The student begins with a temporary advisory committee, eventually to be replaced by the dissertation committee chaired by the dissertation adviser. The temporary committee consists of the department graduate committee, with the addition of a representative from the graduate school and a chair chosen from the student's research area. The temporary committee serves until the student is ready to prepare a dissertation proposal.

Two factors, beyond the student's qualifications, influence admission to the Ph.D. program: availability of a Ph.D. adviser and financial aid.

The selection of a Ph.D. research adviser is a process extending over several academic terms whereby the faculty member and student get to know each other and until both are certain that they can work together.

The student will usually take courses from the faculty member, and they will discuss potential research topics. This process can only occur once the student is physically present in the department, for example while pursuing an M.S. or B.S. degree. An applicant who is not at PSU must communicate his/her own interests very well to make a successful Ph.D. application, because admission will be given only to those for whom potential advisers exist in the department. The student can identify potential advisers in his/her personal statement accompanying the application and can communicate directly with faculty about research topics. Ideally, one of the student's recommendation letters would come from a prospective adviser with whom a solid contact has been established.

Some of the departmental teaching assistantships and research assistantships support top Ph.D. students. A newly entered student is most likely to be given a teaching assistantship, while

someone who has been at PSU and established a good connection with a potential adviser is more likely to be given a research assistantship.

Continued support for Ph.D. students depends on their making satisfactory progress in the program. After the student is advanced to Ph.D. candidacy, the dissertation committee is responsible for monitoring progress. Students who can afford to support themselves during their Ph.D. study will be admitted based on their qualifications and on the availability of faculty to direct their research.

Course Requirements

Ph.D. students must complete an approved program of 90 graduate-level credits.

- 15 credits are required core courses:
  CS 581 Theory of Computation
  CS 584 Algorithm Design and Analysis
  CS 558 Programming Languages
  CS 533 Concepts of Operating Systems
  CS 538 Computer Architecture or ECE 585 and 586
- 18 credits are required courses selected from at most three of five focus areas:
  1. Programming languages
  2. Systems and networking
  3. Databases
  4. Software engineering
  5. Theory of computing
- 21 credits are elective courses from the focus areas or other graduate courses.
- The remaining 36 credits are dissertation research.

Course Restrictions

All courses must be graded (that is, not P/NP) and passed with a grade of B or better. For the 21 credits of elective courses:

- These courses should be used to strengthen the program in the student's research area.
- CS 501 (Research) and CS 509 (Graduate Assistant Practicum) may not be counted.
- A maximum of 6 credits of CS 505 (Reading and Conference) and CS 506 (Special Projects) may be counted.

Your CS adviser must approve the courses in your program. If you have any doubts about the appropriateness of courses you will submit for the degree, it is wise to consult your adviser.

Candidacy

To be admitted to Ph.D. candidacy a student must:

- First, pass written comprehensive examinations covering the 33 hours of core and focus courses.
- Second, present a dissertation proposal describing the proposed research, to be approved by the advisory committee.

Qualifying Exam

The qualifying exam consists of two distinct examinations, a core exam and a focus exam, each offered once a year. There is a choice of focus exams, one in each of the five areas listed above for focus courses. The content of all examinations is defined by a reading list, available one term before the examination is given. The required core courses are good preparation for the core exam; courses in each focus area prepare a student for the focus exam in that area. However, the scope of courses may change, and the reading list defines the material each exam will cover.

Students must register for the core exam before the second week of the fall term; the core exam will be given in the second week of the winter term. The core exam may be retried once.

There is a choice of focus exams, one in each of the five focus areas listed on page 17 under "Course Requirements." Students must register for a focus exam before the second week of the winter term; the examinations will be given in the second week of the spring term. A student may take two tries at the focus exam, taking either the same exam twice or two different exams once. Normally, the focus exam will be chosen to be in the area of the student's dissertation research.

No one may take an examination for which he/she has not registered one term in advance. The examination is not open to students not admitted to the Ph.D. program.

Students making adequate progress in their Ph.D. program are expected to pass both parts of the qualifier by the end of the second year.

Dissertation Proposal

After passing the qualifying exam, a student prepares a written proposal describing his or her dissertation research topic, in consultation with the chair of the advisory committee. (It may be appropriate for the student to first find a new advisory committee chair, if the research area has shifted since admission.) The proposal:

- Identifies the general research field (e.g. networks) and presents an annotated bibliography of literature relevant to the particular dissertation topic (e.g. verification of network routing protocols).
- Describes the research problem.
- Describes the proposed approach to solving the problem, including specific methods to be tried.
- Gives a timeline for completing the work.

The proposal is circulated among the advisory committee, and, when they agree that it is satisfactory, the student publically presents the proposal. The presentation begins with a public talk, then the advisory committee questions the student in private.

Students making satisfactory progress are expected to have a dissertation proposal approved by the end of the third year.

Dissertation

Doctoral students must complete a dissertation comprising original research work and defend it at a final oral examination. It is expected that the work will be of a quality to merit publication in refereed journals or conferences.

Contact Information

For More Information
CALL PSU TOLL FREE
1-800-547-8887

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Portland, OR 97207-0751
USA

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Portland State University
Location: 120 Fourth Avenue Building
Phone: 503-725-4036
Fax: 503-725-3211
email: cmps@cs.pdx.edu
http://www.cs.pdx.edu

Office of Admissions and Records
Portland State University
Location: 104 Neuberger Hall
Phone: 503-725-3511
email: askadm@osa.pdx.edu
http://www.ess.pdx.edu

Student Financial Aid Office
Portland State University
Location: 174 Neuberger Hall
Phone: 503-725-3461
email: askfa@osa.pdx.edu
http://www.ess.pdx.edu

Housing
College Housing Northwest, Inc.
2121 SW Broadway, Suite 1119
Portland, OR 97201
Phone: 503-497-1188
email:staff@chnw.org
http://www.chnw.org

Information and Academic Support Center
Portland State University
Location: 118 Smith Memorial Center
Phone: 503-725-4005
email: askiasc@osa.pdx.edu
http://www.ess.pdx.edu

International Student and Faculty Services
Portland State University
Location: 212 East Hall
Phone: 503-725-4094

Student Resource Center
Portland State University
Location: 115 Smith Memorial Center
Phone: 503-725-4402

Career Center
Portland State University
Location: 402 University Services Building
Phone: 503-725-4613
email: askcarc@carc.pdx.edu
http://www.career.pdx.edu

Veterans Affairs
Veterans Coordinator/Counselor
Portland State University
Location: 118 Smith Memorial Center
Phone: 503-725-3876

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