## Welcome to the OGI School of Science & Engineering

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The OGI School of Science & Engineering’s roots go back to the early 1960s when Oregon Governor Mark Hatfield and an advisory committee of industrial and educational leaders recommended creating an independent institution for graduate education and research in the Portland metropolitan area. In 1963 they established the Oregon Graduate Center for Study and Research, which changed its name to Oregon Graduate Institute of Science and Technology in 1989.

By the 1990s OGI had emerged as a mature institution, and over the course of the decade it awarded more than 1,000 graduate degrees, offered hundreds of continuing education classes and workshops, and pursued more than $100 million in largely federally funded research. Then, in July 2001, laying the groundwork for the next phase of the institution’s growth, OGI merged with Oregon Health & Science University, becoming OHSU’s fourth school alongside the Schools of Dentistry, Medicine and Nursing.

The merger was particularly timely because of the growing need for collaboration between the health sciences, the information sciences and the environmental sciences. The resulting benefits will include the design of new medical instrumentation, the development of bioinformatics databases, a better understanding of the relationship between the environment and human health, and the cross-fertilization that takes place whenever interdisciplinary investigations occur. The merger is also helping OGI expand its programs in computer science, computer engineering and environmental science.
LETTER FROM THE DEAN

The OGI School of Science & Engineering at Oregon Health & Science University is one of the most innovative, exciting and productive schools of its size anywhere in the world.

Indeed the school's modest size has long been one of its attractions. Students have close access, for instance, to top-notch faculty in both the classroom and the research lab, plus we pride ourselves on our flexibility in meeting students' academic needs. And our recent merger with OHSU further raises our stature as one component of a highly regarded institution that shares our dedication to education and research.

We have long been extremely successful in competing for limited research funding. A wide variety of public- and private-sector funding organizations believe in us so firmly, in fact, that they support nearly $20 million in research annually at OGI. Students can thus be assured that OGI faculty are providing instruction grounded on leading-edge research in their discipline. Such research-informed education has always been the cornerstone of our approach to graduate education in disciplines such as computer science, environmental science, electrical engineering and molecular biology. And our merger with OHSU will bring added growth in those disciplines as well as more interdisciplinary activities, including a major new initiative in biomedical engineering.

OGI's close relationship with the high-tech industry is also very important. Many of our part-time students, for instance, are full-time employees of companies both large and small. As a result, these students acquire pragmatic knowledge and skills that will enhance their careers, plus our full-time students establish valuable contacts within industry. And classroom interactions benefit from a healthy measure of real-world experience.

Classroom and research interactions are further enhanced by the diverse backgrounds of our faculty and students, who represent a cross section of cultures and sub-disciplines.

All of which taken together helps explain why our alumni find great success in a variety of career paths — whether their inclinations lead them toward academia, entrepreneurship or advancement with established companies. We pride ourselves on their achievements.

Ed Thompson
OVERVIEW

ACADEMIC DEPARTMENTS

The OGI School of Science & Engineering has five academic departments: Biochemistry and Molecular Biology (BMB), Computer Science and Engineering (CSE), Electrical and Computer Engineering (ECE), Environmental Science and Engineering (ESE), and Management in Science and Technology (MST). Research and educational interaction among these departments is ensured in part by research programs that utilize faculty members from multiple departments. This encourages the exchange of ideas between persons working in related research areas and enables the fullest use of the wide range of instrumentation available at the School.

DEGREE PROGRAMS

The OGI School of Science & Engineering offers Master of Science degrees and Ph.D. degrees in Biochemistry and Molecular Biology, Computer Science and Engineering, Electrical Engineering, and Environmental Science and Engineering. The school offers Master of Science degrees in Management in Science and Technology and in Computational Finance. OGI also offers a professional degree, the Oregon Master of Software Engineering.

CERTIFICATE PROGRAMS

Three certificate programs are offered in Applied Computing, Computational Finance, and Management in Science and Technology.

STUDENTS NOT SEEKING DEGREES

Any qualified student may take courses at OGI in a part-time capacity without enrolling in a degree program. Students may take a full-time course load for only one quarter while waiting for a decision regarding admission to a degree program. Up to 21 credits taken at OGI prior to matriculation (enrollment in a degree program) may be accepted toward degree requirements. Individual departments’ regulations may be more restrictive.

COLLABORATIVE/JOINT PROGRAMS

Full-time students in the school’s Computer Science and Engineering (CSE) and Electrical and Computer Engineering (ECE) departments may take certain courses at Portland State University at no additional cost. Similar arrangements are being explored for other OGI departments.

Contact the Department of Graduate Education for details.

The OGI School also participates in the Oregon Master of Software Engineering (OMSE) program, a joint program with Portland State University, Oregon State University and the University of Oregon. Students apply for this master’s degree through one of the participating schools. Please direct inquiries to (503) 725-2900 or ltyler@omse.org.

ACCREDITATION

Oregon Health & Science University is accredited by the Commission on Colleges of the Northwest Association of Schools and Colleges, an institutional accrediting body recognized by the Council for Higher Education Accreditation and the U.S. Department of Education. The commission’s address is 11130 NE 33rd Place, Suite 120, Bellevue, WA 98004.

ADMISSIONS PROCEDURES

Printed application forms are available from the school’s Department of Graduate Education. Completed applications, transcripts and other application materials should be sent to:

Department of Graduate Education
OGI School of Science & Engineering
20000 NW Walker Road
Beaverton, OR 97006-8921
Phone: (503) 748-1027
Toll-free: (800) 685-2423
Fax: (503) 748-1285
E-mail: admissions@admin.ogi.edu

You may also apply for admission on-line at www.ogi.edu/forms/application.html

Students may become matriculated (enrolled in a degree program) only after completing the requirements for a bachelor’s degree or its equivalent, although students may be provisionally admitted prior to that time.

DEGREE PROGRAMS

The following items must be submitted:

• Complete OGI School of Science & Engineering application form or Oregon Master of Software Engineering (OMSE) degree program application form, if applicable.
• $50 nonrefundable application fee, which is valid for one year and cannot be waived or deferred.
• Official transcripts from each college or university attended.
• Three letters of recommendation.
• Official GRE scores.

The GRE general test is required for M.S. applicants in Computational Finance (GMAT could be substituted); Computer Science and Engineering; Environmental Science and Engineering; Environmental Systems Management, and the Oregon Master of Software Engineering.

The GRE general test is required for PhD applicants in Biochemistry and Molecular Biology (subject test is also required); Computer Science and Engineering; Electrical and Computer Engineering, and Environmental Science and Engineering.

Applications may be submitted as early as one year before the proposed date of enrollment.

Applications received by March 1 (Feb. 15 for the Environmental Science and Engineering Department) will receive priority review for admission and financial support.

CERTIFICATE PROGRAMS

The following items must be submitted:

• Completed OGI certificate program application form.

• $20 nonrefundable application fee, which is valid for one year and cannot be waived or deferred.

ADDITIONAL REQUIREMENTS FOR INTERNATIONAL STUDENTS

To be considered for admission to OGI for a full course of study, international students must also provide documents to show that they meet the requirements described below.

• Evidence of adequate financial resources to pay for their OGI education and their cost of living.

• Written TOEFL scores are required of all M.S. and Ph.D. applicants whose native language is not English. Students who have earned a degree in the United States are exempt from this requirement. Minimum required TOEFL scores vary by department: BMB 550; CSE 600; ECE 575; ESE 600; MST 625. The minimum desired TOEFL score for admission is 575, but a lower score may be offset by excellent GRE scores.

Please note: the minimum TOEFL scores above are for the paper-based test only. The computer-based TOEFL uses a different score scale. For more information on the computer-based score scale, please visit www.toefl.org.
TUITION AND FINANCES

TUITION
For the 2001-2002 academic year, tuition for full-time matriculated students (defined as 9 or more credit hours per quarter) is $4,905 per quarter. Part-time tuition for regular OGI School of Science & Engineering courses is $545 per credit hour or audit unit. Please note that there is no full-time tuition rate for non-matriculated students, except when an admission decision is pending. There are no student fees.

- Tuition for Computational Finance core courses is $695 per credit hour or audit unit. Students matriculated in the Computational Finance degree pay only for credits required to fulfill degree requirements. Credits taken during the 12-month program beyond the 45 required to fulfill degree requirements will not incur charges (up to a limit of 54 credits). Full-time quarterly tuition for students not matriculated in the Computational Finance program who take one Computational Finance course is $5,355; with two Computational Finance courses it is $5,805. Full-time Ph.D. students do not incur additional cost for registering for Computational Finance courses.
- ESE students pay tuition on an annual basis. That tuition may be paid in full at the beginning of the year or in quarterly installments.
- Courses in the Oregon Master of Software Engineering program are $495 per credit hour. Full-time matriculated students may register for OMSE courses when paying full-time tuition.

Note: Payment or arrangement for deferred payment for all courses must be made before your place in a class is confirmed. The school offers students the option of deferring most of the payment through no-interest promissory notes. Students who are reimbursed for their courses must make payment arrangements with their employer, but those students still incur financial responsibility for courses. Courses sponsored by the Oregon Center for Advanced Technological Education (OCATE), whether taken for credit or audit, must be paid in full at the time of registration.

FINANCIAL AID
Entering full-time Ph.D. students can obtain financial support though a combination of tuition scholarships, OGI fellowships, named fellowships, graduate research assistantships and (for U.S. citizens only) low-interest student loans. Part-time Ph.D. students may be eligible for some of the above. Partial-tuition scholarships may be awarded to entering full-time M.S. students, and full- and part-time M.S. students who are U.S. citizens may apply for low-interest student loans.

Fellowships, scholarships and assistantships are awarded by individual departments.

Title IV Federal Student Loan programs are administered through the OHSU Financial Aid office. These loans are available to U.S. citizens and eligible non-citizens. For application materials and additional information, contact Cherie Honecell, Director of Financial Aid & Registrar, at (503) 494-5117 or honnellc@ohsu.edu. Applications for federal student loans (FAFSA) are available from OGI’s Department of Graduate Education, or www.ogi.edu/students/fin.html.

ACADEMIC POLICIES
The following is a summary of select OGI School of Science & Engineering academic policies. A more comprehensive listing can be found in the school’s Student Handbook at www.ogi.edu/students/studenthandbook.pdf.

ON SITE (RESIDENCY) REQUIREMENTS
The school has a two-year Ph.D. residency requirement. For full-time students, this requirement is normally met by an on-site dissertation project. In exceptional circumstances (e.g., dissertation topics requiring access to special facilities only available elsewhere), other arrangements may be proposed to the Educational Policy Committee (EPC). In such cases, a written plan of the research, with a schedule and description of the special circumstances and understandings between the student, thesis advisor and Student Program Committee (SPC), must be included. Approval of this plan by the EPC is required before a student is granted candidacy status for Ph.D. work under such an arrangement. For part-time Ph.D. students, the first year of the residency requirement can be satisfied by attendance in classes on the OGI campus. The second year of residency, however, must be spent full-time on campus under the advisement of an OGI faculty member.

There is no residency requirement for M.S. or certificate programs at OGI.

TIME LIMITS TO COMPLETE THE DEGREE
Ph.D.: Six years of full-time study or eight years of part-time study.

M.S.: Three years of full-time study or four years of part-time study.

Petitions for extensions must be approved by the department and submitted to the Educational Policy Committee for approval.

CONTINUOUS ENROLLMENT
A Ph.D. or Master’s student who has begun work on the dissertation or thesis must register and pay for at least one credit hour of research per quarter in order to maintain matriculated status. If all requirements have not been satisfied at the end of four consecutive academic quarters of registering for only one credit per quarter, or if an alternate plan of completion has not been approved by the department and the Educational Policy Committee, matriculated status will be terminated. If the student wishes to return to his or her program at a later date, it will be necessary to reapply for admission. Continuous enrollment is not required of Master’s students not pursuing a thesis, nor of Master’s or Ph.D. students who have not yet begun working on the thesis or dissertation. However, all matriculated students are required to register for classes OR to indicate temporary inactive status by filing a Temporary Inactive Status form with the Department of Graduate Education.

LEAVE OF ABSENCE
In special circumstances, leaves of absence from a graduate program may be allowed. A student considering a leave should first discuss the issue with his or her advisor or another faculty member. If the department supports the leave of absence, the student then submits a petition to the school’s Educational Policy Committee for approval.

STUDENT STATUS
A matriculated student is one enrolled in a degree program. A non-matriculated student is not working toward completing a degree. Full-time matriculated students carry a minimum of nine credits per quarter. (Audit units do not count toward this minimum except in special circumstances.) Academic departments may require students to carry more than nine credits per quarter as a condition of eligibility for a stipend and/or tuition scholarship. Part-time matriculated students are admitted to a degree program, carry fewer than nine credits per quarter and pay tuition at the appropriate per credit rate.
Non-matriculated students have not been admitted into a degree program, typically carry fewer than nine credits per quarter, and pay tuition at the appropriate hourly rate.

AUDITING A COURSE
OGI courses are offered for graded graduate credit hours or ungraded audit units. Students may register to audit an OGI course on a space-available basis. Students taking a course for credit have priority over students taking a course for audit. Audits are recorded on the student's transcript at the discretion of the instructor, based upon a reasonable expectation of attendance and minimal participation. Audits are charged at the standard tuition rate. Audit units do not count toward a student's full-time status. Instructors have final discretion over allowing audits of their classes and defining the academic expectations of audits.

CREDIT LOAD PER QUARTER
Twelve credits per quarter is considered a normal course load for full-time students, although nine or more is also considered full-time. Up to 18 credits/audits may be taken with the approval of the department. Registering for more than 18 credits requires Educational Policy Committee permission; 18 credits plus up to 4 audit units does not require EPC permission and does not incur additional cost. Students in the Electrical and Computer Engineering Department are limited to 12 credits per quarter, but may take up to 16 with their advisor's and home department's written approval.

TRANSFER CREDIT
OGI accepts transfer credit from accredited institutions provided that such prior academic work has not been previously applied toward another degree. A maximum of 21 credits earned prior to matriculation at OGI may be applied. This may include up to 12 credits transferred from another institution (up to 18 from Portland State University, University of Oregon and Oregon State University) and/or up to 21 credits taken at OGI prior to matriculation. Contact each academic department for specific policies and procedures. Transfer credit grades, other than those from OGI, are not calculated in the OGI grade-point average (GPA).

GRADING/SATISFACTORY ACADEMIC PROGRESS
All OGI courses are graded with a letter grade; an exception is that Ph.D. students may receive P/NP for work in a seminar. In addition, faculty may assign P/NP or letter grades to research work, but grades for research cannot be counted in a student's GPA.

The following scale is employed at the school:

- A = 4.0
- B+ = 3.33
- B = 3.0
- A- = 3.67
- B- = 2.67
- C+ = 2.33
- C = 2.0
- C- = 1.67
- F = 0.0

The grading system is defined as:

- A = Excellent
- B = Satisfactory
- C = Below graduate standard
- F = Failure

The following marks are also used:

- AU = Audit, no credit
- P = Satisfactory completion
- NP = No credit, unsatisfactory
- I = Incomplete
- PI = Permanent Incomplete
- W = Withdrawn (after the add/drop period)
- AU = Audit, no credit

Matriculated students must maintain a cumulative GPA of 3.0 on all work taken at OGI. Failure to do so may result in probation or dismissal.

INCOMPLETES
The school's policy is that an Incomplete must be completed by the end of the quarter following that in which the Incomplete was awarded. In cases where the Incomplete is not completed, the instructor has the choice of assigning a grade or converting the Incomplete into a Permanent Incomplete. The grade may be an F if the course work was not completed, but instructors have the option of assigning another grade if they feel quality and quantity of work that was accomplished warrants it. If an extension of this one-quarter deadline is desired, the student may petition the Educational Policy Committee, showing the instructor's support of the extension (a separate letter or signature on the petition will suffice). Normally an extension will be granted, as long as the plan is specific, includes a date by which the grade will be assigned, and is submitted to the Graduate Education manager in writing.

400-LEVEL COURSES
Courses offered and designated by 400-series numbers within academic departments at the school are not considered to satisfy any degree requirements. These courses do not carry graduate credit at the school, but are entered on the transcript.

CONFIDENTIALITY OF STUDENT RECORDS
With the passage of the Federal Family Educational Rights and Privacy Act (FERPA) of 1974, OGI adopted rules to govern the collection, use and disclosure of student records with the goal of ensuring their privacy. Students have the right to inspect their educational records that are maintained by OGI; the right to a hearing to challenge the contents of those records when they allege the records contain misleading or inaccurate information; and the right to give their written consent prior to the release of their records to any person, agency or organization other than OGI officials and certain authorized federal and state authorities.

DIRECTORY INFORMATION
Certain public domain information, known as directory information, can be released by the school unless a student files a written request in the Graduate Education Department. The school limits this information to the student's name, home address, e-mail address, dates of attendance, degrees and awards received, number of credits earned and the fact of enrollment, including whether the student is enrolled full- or part-time. The school does not make this information available to vendors.

TRANSCRIPTS
Your transcript is a formal, written record of your educational experience at the OGI School of Science & Engineering. All courses you take at the school are recorded on it, as are all grades and degrees you earn while at OGI. If you have transferred credits from another institution, they will be recorded on your transcript as well. By law, requests for transcripts must be in writing and submitted by fax, mail or in person to the Department of Graduate Education. Official transcripts
are on special paper and have the official school seal; unofficial transcripts are printed on regular paper without the seal. There is no charge for unofficial transcripts; official transcripts cost $4 per copy. Requests are usually processed immediately, but we ask that you allow three days. Your request must have your name, signature and social security number (if applicable); indicate whether you will pick up the transcript(s) or include the address(es) to which the transcript(s) should be mailed; and include payment information, if relevant. You can send a check, submit a credit card number or pay cash. Sending cash through the mail is not recommended.

THE CAMPUS

GEOGRAPHIC SETTING
The greater-Portland metropolitan area has a population of about 1.5 million, nearly half the population of Oregon. It provides diverse cultural activities, including art, music, entertainment and sports. Portland has an extensive park system, including the largest wilderness park within the limits of any city in the United States. The OGI School of Science & Engineering is located 10 miles west of downtown. We are the newest school within Oregon Health & Science University (OHSU), joining the Schools of Medicine, Dentistry and Nursing, which are located on the main campus on Marquam Hill overlooking downtown Portland. OGI is now part of OHSU’s newly named West Campus, which also includes the Neurological Sciences Institute, the Oregon Regional Primate Research Center, and the Vaccine and Gene Therapy Institute. OGI’s campus consists of modern, attractive buildings, providing spacious laboratories, offices and a research library.

LIBRARY
The Samuel L. Diack Memorial Library’s collection includes more than 18,000 monographic titles and 400 print journal subscriptions. These support the teaching and research efforts at OGI by providing texts, conference proceedings, reference materials, journals and research monographs in the subject areas of computer science, electrical engineering, environmental sciences, biochemistry, molecular biology, and management as related to science and technology. In addition, the OHSU Library holds more than 74,000 monographs and 1,200 journal subscriptions. These print collections are available for use when visiting the libraries. Materials unavailable at OGI are obtained on interlibrary loan for faculty, staff and students. An on-line catalog, acquisitions and circulation system is in place. Access to other college and university collections is provided by access to databases, library catalogs and grants circulation privileges to OGI students at 13 other area institutions, including Portland State University and Reed College.

OGI library workstations not only enable students and faculty to search the catalog and the library’s databases but also provide entry to Web resources, telnetting and ftp options for faculty, staff and students. The OGI librarians will perform searches on the systems and databases that are not directly available to students. Library orientation is part of the introduction to OGI for new students, and classes on library research methods are offered throughout the year.

Most of OGI’s electronic library resources will be integrated with those of the other OHSU schools and institutes by 2003.

COMPUTER FACILITIES
The OGI School of Science and Engineering’s computing environment gives members of the community access to a rich array of technologies and information resources. Many of these resources, including networks and telecommunications, are the responsibility of OHSU’s central Information Technology Group (ITG). In addition, many school departments and laboratories maintain their own computing facilities. Most of OGI’s computers connect to a school-wide local-area network and to the Internet, providing convenient access to the World Wide Web. The local-area network is connected to the Internet through two high-speed data paths. In addition, it is also connected to Internet 2 (Internet2.edu) resources. The Internet 2 connection was made possible through an alliance of local academic institutions.

HOUSING
While OGI has no on-campus housing, it is located in the midst of a very large residential area. There are numerous apartment complexes, rental houses, bus and light rail lines, and shopping areas near the school. The Office of Student Services in the Graduate Education Department maintains a list of local apartment buildings for students to reference. In addition, the Student Council has a Web site for current, new and prospective OGI students who are looking for housing information, roommates, etc. This service is found at cslu.cse.ogi.edu/council/st_forum.html.

STUDENT COUNCIL
The Student Council serves as the liaison between the student body and the faculty and administration, and it strives to improve OGI students’ quality of life. Student representatives make themselves available to students in their department in order to forward their comments, ideas and concerns to the Student Council and to promote their involvement in student body activities. Representatives also serve to disseminate all pertinent information to the students in their departments. As liaisons, members of the Student Council represent the student body and student interests on a wide variety of OGI task forces and committees, including the Faculty Senate, the Educational Policy Committee and the Safety Committee. Each quarter the Student Council also sponsors and coordinates at least one major social event, which is open to everyone at OGI. These events have included a coffeehouse with live music performed by people from throughout the school, an annual international food and cultural fair, and an educational forum. There are also monthly and weekly events, including movie nights and bagel breakfasts in the student lounge. More information on the Student Council is available on its Web site at cslu.cse.ogi.edu/council/ or by e-mail at scouncil@admin.ogi.edu.
THE DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY offers graduate study leading to M.S. and Ph.D. degrees. Participation in research begins immediately upon entering our program. This early exposure to research allows each student to become familiar with the variety of activities represented in the department and aids the student in thesis research selection.

RESEARCH AREAS INCLUDE:

- Metallobiochemistry (with an emphasis on the structure and function of metal ions in proteins and the mechanisms of metal trafficking in cells)
- Fungal and yeast biochemistry and molecular biology (with an emphasis on gene regulation and enzyme characterization)
- Ion transport across biological membranes (with an emphasis on molecular biology and reconstitution of cation or anion carriers)

The research experience at OGI is extensive. Much of the research is interdisciplinary, covering basic and applied aspects. Students are involved in all aspects of the departmental research program and have ready access to modern research instrumentation. As a result, our graduates are well qualified for research careers in academia, government and industry.

ADMISSION REQUIREMENTS

Admission requirements are the same as the general requirements of the institution. In addition, Ph.D. applicants must submit general GRE scores and a GRE subject score for one of the following tests: (a) biology, (b) chemistry or (c) biochemistry, cell and molecular biology. M.S. applicants are not required to submit GRE scores. Prospective students should carefully examine the faculty research interests and departmental research programs to determine whether their specific professional needs can be fulfilled at OGI. Communication with individual faculty members is encouraged prior to applying or enrolling.

DEGREE REQUIREMENTS

M.S. PROGRAMS

Two options are offered for the M.S. in biochemistry and molecular biology.

NON-THESIS OPTION

The non-thesis M.S. requires satisfactory completion of 44 credits, 28 of which are in graded courses and 16 of which are derived from an experimental research project (BMB610); and a written report on the research. Graded courses include 12 credits in BMB527-528-529, and 16 or more credits in advanced courses (BMB532-542), student seminars (BMB594 or 596) and Special Topics (BMB580). The research for the non-thesis degree is typically a specific contribution to a larger project, providing the student with extensive hands-on experience in biochemical and molecular biological techniques. The non-thesis M.S. degree can be completed in one year of full-time study.

THESIS OPTION

The thesis M.S. is a research degree that requires satisfactory completion of 44 credits, 20 of which are in graded courses (12 credits in BMB 527-528-529 and eight or more credits in advanced courses), and a written thesis based on independent research (BMB700). The thesis M.S. degree can be completed in 18 months of full-time study.

PH.D. PROGRAM

The department offers a Ph.D. in biochemistry and molecular biology. Ph.D. candidates are required to take the BMB 527-528-529 biochemistry sequence and three of the following core courses:

- BMB532  Bioenergetics and Membrane Transport, 4 credits
- BMB533  Enzyme Structure, Function and Mechanisms, 4 credits
- BMB534  Instrumental Methods in Biophysics I, 4 credits
- BMB540  Advanced Molecular Biology, 4 credits
- BMB542  Molecular Cell Biology, 4 credits

Students must register for 12 credits per quarter. These credits typically include student seminars (BMB594 or BMB596), Department Seminar (BMB 591) and Research (BMB600 or BMB800).

The qualifying examination for the Ph.D. is a comprehensive examination. The qualifying exam must be completed within two years of entering OGI. An oral defense of the Ph.D. dissertation is required.
BMB | BIOCHEMISTRY AND MOLECULAR BIOLOGY

COURSE DESCRIPTIONS

BMB527 Biochemistry I: Proteins and Enzymes
Primary, secondary and tertiary structure of proteins; enzyme mechanisms; enzyme kinetics. 4 credits

BMB528 Biochemistry II: Introduction to Molecular Biology
DNA replication, RNA synthesis and protein synthesis; genetic code; gene regulation. 4 credits

BMB529 Biochemistry III: Metabolism and Bioenergetics
Metabolism of carbohydrates, lipids and amino acids; bioenergetics; photosynthesis; oxidative phosphorylation. 4 credits

BMB532 Bioenergetics and Membrane Transport
Critical evaluation of the chemiosmotic theory with specific reference to oxidative phosphorylation, photophosphorylation and metabolite transport. Biochemical mechanisms of energy transduction common to bacterial and mitochondrial respiration, and bacterial and plant photosynthesis are reviewed. 4 credits

BMB533 Enzyme Structure, Function and Mechanisms
Provides an in-depth analysis of the structural origins of protein interactions and catalysis that are the basis for biological function. The course develops the basic principles of structural biology through an overview of X-ray crystal structures and folding processes, acquainting students with computational resources for protein structure analysis. The structural foundation is expanded into a detailed investigation of enzyme active sites, including the application of kinetic approaches to understanding enzymatic reaction mechanisms. 4 credits

BMB534 Instrumental Methods in Biophysics I
Theory and application of physical techniques to problems in biochemistry. Optical, fluorescence, circular dichroism, infrared and Raman spectroscopy of chromophoric groups. Magnetic susceptibility and nuclear magnetic resonance of metalloproteins. 4 credits

BMB535 Instrumental Methods in Biophysics II
Investigation of physical techniques particularly useful for studying metalloproteins. Electron paramagnetic resonance, electron spin echo, magnetic circular dichroism, and X-ray absorption spectroscopy. The course has significant “hands-on” exposure to instrumentation and computer simulation techniques. 4 credits

BMB537 Metals in Biochemistry
Comprehensive study of the chemistry and biochemistry of metal ions in biological molecules and living systems. Topics include metalloprotein structure, metal ion specificity, biological oxidation mechanisms, metal ion catalysis in enzymes, metal ion transport and gene regulation. 4 credits

BMB538 Coordination Chemistry
Structures and stabilities of transition metal coordination compounds with mono- and multi-dentate ligands; coordination compounds as models for biological metal centers; strategies for synthesis of transition metal complexes. 4 credits

BMB539 Chemical Group Theory
Properties of mathematical groups, symmetry properties of molecules; symmetry groups, representations and character tables. Applications of group theory to the study of structure and spectroscopy of organic and inorganic molecules; Hückel molecular orbital theory; ligand field theory; electronic spectroscopy and vibrational spectroscopy. 4 credits

BMB540 Advanced Molecular Biology
An in-depth study of the molecular mechanisms governing the replication, recombination, transcription and translation of genetic material. Emphasis is placed on experimental approaches that have led to our understanding of these fundamental processes. 4 credits

BMB541 Molecular Genetics of Development
A focused study of selected topics examining the regulation of gene expression during cellular differentiation. Emphasis is placed on the molecular nature of cell-cell interactions and the genetic control of complex cellular responses to developmental and environmental stimuli. 4 credits

BMB542 Molecular Cell Biology
The techniques of molecular biology have created an explosion in knowledge of cell structure and function. This course examines the following topics: cellular organization, cell signaling, cell differentiation, cell evolution. Knowledge of the cell is obtained through combining core readings and lectures with student-led discussions of primary research papers. 4 credits

BMB543 Current Topics in Proteomics
Proteomics is a new area of molecular biology that aims to identify and map the total protein complement of a genome. It expands the scope of biological investigation from studying single proteins to systematically studying all proteins. Proteomics has broad applications in disease diagnosis, drug discovery and agriculture. The key technologies used in proteomics are two-dimensional gel electrophoresis, mass spectrometry (ESI-MS, MALDI-TOF), imaging and database software. This course will use lectures, student seminars and literature readings to focus on electrophoresis, mass spectrometry and applications. 3 credits

BMB544 Introduction to Bioinformatics
Primary literature of computational biology and hands-on experience in data manipulation from local and remote databases. 3 credits

BMB580 Special Topics in Biotechnology
Examination of current and past research papers in a specific area of biotechnology that is of mutual interest to the student and the faculty member. Requires a written review paper or seminar presentation in one of the Student Seminar series. Variable and repetitive credit

BMB591 Department Seminar: Biochemistry/Molecular Biology
1 credit, repetitive

BMB594 Metallobiochemistry Student Seminar
Presentations and discussions of selected topics from the recent literature and of ongoing research projects in the department. 2 credits, repetitive

BMB596 Molecular Biology/Biochemistry Student Seminar
Presentation and discussion of journal articles from the recent literature in molecular biology, genetics and biochemistry. 2 credits, repetitive

RESEARCH PROGRAMS

Translational Control in Fungal Amino Acid Biosynthesis
A greater understanding of many human health issues relies on increased knowledge of how cells express genetic information. Gene expression can be controlled by regulating the synthesis and stability of functional RNA and protein. The goal of our research is to obtain a greater understanding of how these mechanisms work using the Neurospora crassa arg-2 and Saccharomyces cerevisiae CPA1 genes as models. These homologous genes encode the first enzyme in arginine biosynthesis, and they are negatively regulated at transcriptional and translational levels in response to the availability of arginine. An evolutionarily conserved upstream open reading frame (uORF) present in the 5’-leader regions of these transcripts is responsible for translational control. Synthesis of the uORF-encoded peptide causes ribosomes to stall when the level of arginine is high, blocking access of ribosomes to the translation initiation site for the polypeptide encoding the arginine biosynthetic enzyme. Our current work is focused on developing a molecular understanding of how synthesis of this uORF-encoded peptide causes ribosomes to stall, since this will provide important insights into the fundamental cellular process of protein synthesis. Sachs

Translational Control of Human Proto-Oncogenes
The transcripts specified by many genes involved in human cancers contain uORFs; these include the bcl-2 and bcl-2 proto-oncogenes. Using methods similar to those developed for understanding the roles of the uORFs of N. crassa arg-2 and S. cerevisiae CPA1 gene expression, we are examining...
the functions of these mammalian uORFs, to better understand their role in controlling the expression of these critically important genes. Sachs

The Neurospora Genome
We are part of a team that is sequencing and annotating the genome of Neurospora crassa (see www.genome.wi.mit.edu/annotation/fungi/neurospora/), and are gearing up to apply this information to large-scale community-wide efforts in functional genomics. This is the first genome of a filamentous fungus that has been sequenced with public funds; the annotation of this sequence is proving invaluable for understanding fungal genome evolution; many fungi important for agriculture and medicine are closely related to N. crassa. We recently began experiments aimed at cloning and analyzing the telomeric regions of N. crassa and the closely related pathogenic rice blast fungus Magnaporthe grisea because mounting evidence indicates that genes near telomeres evolve more quickly and are frequently involved in pathogenic interactions with hosts. Sachs

Mechanisms of Mammalian Chemical Communication and Vomeronasal Olfaction
Chemical communication plays a significant role in life strategies for many mammals. Our research focuses on chemical identification of pheromones functioning during reproductive events in the Asian elephant, Elephas maximus. A female-to-male preovulatory urinary sex pheromone, (Z)-7-dodecen-1-yl acetate, has been identified and demonstrated to be robust in its synthetic form. This compound is also bioactive in many Lepidoptera, making it a good example of convergent evolution of structure and function. Biochemical studies have established the presence of the pheromone in the serum, and future studies will investigate its biosynthetic pathways. Considerable progress has been made on establishing the proteins functioning as pheromone transporters prior to signal transduction in the neuroreceptive cells of the vomeronasal organ. Radiolabeled analogs, competition experiments and molecular biological studies have established unusual roles for elephant albumin and olfactory binding protein. A second pheromonal system is actively being investigated. The facial temporal gland, breath and urine exude unusual chemical compounds during musth in Asian male elephants. These signals have a role in mate choice by female conspecifics. Utilizing spectroscopic and computational approaches to explore the structure and dynamics of Mn active sites. For MnSD, we find an unexpected temperature dependence for the structures of anion complexes, which change coordination as the temperature is raised. This thermal transition implies that the stability of the active site structure is determined by dynamical features of the complex and that dynamical excitation may play an important role in controlling the energetics of ligand binding and redox. A wide range of projects relating to the chemistry and biology of Mn are in progress. Whittaker

Electronic Spectroscopy of Biological Metal Complexes
Electronic spectroscopy extends structural studies of biomolecules beyond the atomic resolution of X-ray crystallography to a level of structural detail that directly relates to chemistry. The techniques used in these studies span five decades of the electromagnetic spectrum, from microwaves to the ultraviolet and beyond. At the lowest energy, electron paramagnetic resonance (EPR) spectroscopy gives information on the electronic ground state, defining the molecular orbital that contains the unpaired electron in a paramagnetic complex. At higher energy, UV-visible absorption spectroscopy excites orbital transitions between electronic states, giving information on characteristic metal-ligand interaction energies that can be understood in terms of a ligand field or molecular orbital analysis. Polarization spectroscopy (linear dichroism, circular dichroism and magnetic circular dichroism) can give more detailed information on ground and excited state electronic wave functions using geometric features of light to probe the active site. These experimental approaches can be complemented by spectroscopic modeling and computational biology methods to provide a detailed description of a metalloprotein complex and its interactions. Whittaker

Vibrational Spectroscopy of Metalloprotein Active Sites
Many spectroscopic methods are available for the investigation of structural and functional properties of metal ions in enzymes and proteins. We use electronic, vibrational (especially resonance Raman) and EPR spectroscopy to characterize metal-ion active sites. Our laboratory has a sensitive, state-of-the-art Raman instrument, a fast spectrograph with a liquid N₂-cooled CCD detector. We also use a combined FT-IR/FT-Raman instrument for protein and model compound studies. Our research focuses on the description of the molecular and electronic structures of heme (iron porphyrin), nonheme-iron and copper enzymes to gain an understanding of the role of the metal ion in enzymatic catalysis. Of particular interest is the biochemistry of O₂. Metalloproteins are involved in O₂ binding (hemoglobin or hemocyanin) and in oxidative chemistry where O₂ is reduced and substrates are oxygenated or oxidized. Trapped reaction intermediates and model
compounds help us unravel these complex processes and define reaction mechanisms. In all projects, modern molecular biology techniques provide site-directed mutants that permit alterations in structures and reactivities. Loehr & Moënne-Loccoz

**Heme Oxygenase**

Heme oxygenase is a fascinating system that uses the O₂-binding affinity of its heme substrate in the cellular degradation of heme to open-chain biliverdin. These studies are carried out with Paul R. Ortiz de Montellano's group at U.C. San Francisco. The resting heme-heme oxygenase enzyme substrate complex is much like myoglobin: the heme is linked to the enzyme by an iron-histidine bond, and the iron exists mainly in a six-coordinate, high-spin state with an additional water ligand. The Fe-N(His) bond was identified from its resonance Raman vibration at 216 cm⁻¹ in the Fe(II)-heme complex. The absence of this fingerprint frequency in the H25A mutant clearly identified His25 as the axial ligand. Remarkably, when imidazole was added to the inactive H25A preparation, activity was fully restored. Our current efforts, in collaboration with Angela Wilks at the University of Maryland, examine the structure and activity of several bacterial heme oxygenases. Loehr and Moënne-Loccoz

**Oxygen Activation by Iron Proteins**

Several iron enzymes react with molecular oxygen to form powerful oxidizing agents important in biology. Examples include (i) ribonucleotide reductase protein R2, which oxidizes its tyrosine 122 to its catalytically important neutral radical form, (ii) methane monooxygenase, whose hydroxylase component oxidizes hydrocarbons to alcohols; (iii) plant desaturases, which oxidize fatty acids to olefins, e.g., stearyl to oleyl; and (iv) ferrodoxidase reactions, in which Fe⁺ is oxidized to Fe³⁺. A common feature of these enzymes appears to be the formation of an initial peroxo intermediate from the reduced enzyme. However, in the respiratory protein, hemerythrin, binding of dioxygen is accomplished by reduction to peroxide in a reaction that is readily reversible. In ribonucleotide reductase, peroxide is similarly formed but decomposes irreversibly to a ferryl intermediate that is capable of carrying out oxidative chemistry. This dichotomy of behavior is reminiscent of the respiratory vs. peroxidase functions of different heme-containing proteins. We are interested in determining common principles that influence the pathways of oxygen utilization. This problem is being approached by structural elucidation of the heme sites in the proteins themselves and in model complexes, as well as by studying mechanisms of their reactions with oxygen-containing substrates. Loehr and Moënne-Loccoz

**Interaction of Nicotin Oxide with Metalloproteins**

Nitric oxide (NO) is of intense interest due to its role in a diverse range of biological processes. The importance of NO in mammalian physiology is indicated by the award of the 1998 Nobel Prize for Medicine for the discovery of its role as a signaling molecule in the cardiovascular system. In bacteria, NO is produced as an intermediate during denitrification — the process by which certain organisms convert nitrate to N₂ or N₂O. The production of NO is the first opportunity for fixed nitrogen to be lost from the soil to the atmosphere, with implications ranging from fertilizer loss to atmospheric pollution. Throughout biological NO chemistry, proteins with Fe- or Cu-containing active sites play a central role in generating and releasing NO as well as in sensing and initiating chemistry in response to changes in NO levels. Our research is aimed at investigating the structures and mechanisms of these metalloproteins through the use of a variety of spectroscopic, biochemical, and kinetic techniques. Andrew

**Regulation of Long Chain Fatty Acid Transport and Oxidation in Mammalian Heart and Liver**

The rate-limiting step in β-oxidation is the conversion of long-chain acyl-CoA to acylcarbimine, a reaction catalyzed by the outer mitochondrial membrane enzyme carnitine palmitoyltransferase I (CPTI) and inhibited by malonyl-CoA. The acylcarbimine is then translocated across the inner mitochondrial membrane by the carnitine/acylcarnitine translocase and converted back to acyl-CoA by CPTII. This reaction in intact mitochondria is inhibited by malonyl-CoA, the first intermediate in fatty acid synthesis, suggesting coordinated regulation of fatty acid oxidation and synthesis. Although CPTII has been examined in detail, studies on CPTII have been hampered by an inability to purify CPTII in an active form from CPTI. In particular, it has not been conclusively demonstrated that CPTII is even catalytically active, or whether sensitivity of CPTII to malonyl-CoA is an intrinsic property of the enzyme or is contained in a separate regulatory subunit that interacts with CPTI. To address these questions, the genes for human heart muscle M-CPTI and rat liver L-CPTI and CPTII were separately expressed in Pichia pastoris, a yeast with no endogenous CPT activity. High levels of CPT activity were present in purified mitochondrial preparations from both CPTI- and CPTII-expressing strains. Furthermore, CPT activity was highly sensitive to inhibition by malonyl-CoA while CPTII was not. Thus, CPTI catalytic activity and malonyl-CoA sensitivity are contained within a single CPTI-polyepitope in mammalian mitochondrial membranes. My laboratory is the first to describe the kinetic characteristics for the yeast-expressed CPTIs; the first such report for a CPTI enzyme in the absence of CPTII. Both yeast-expressed M-CPTI and L-CPTI are inactivated by detergent solubilization. However, removal of the detergent in the presence of phospholipids resulted in the recovery of malonyl-CoA-sensitive CPTI activity, suggesting that CPTI requires a membrainous environment. CPTI is thus reversibly inactivated by detergents. We have isolated and sequenced the promoter region of the gene for the human heart M-CPTI. We have mapped the malonyl-CoA and substrate binding sites in human heart M-CPTI and liver L-CPTI by deletion, site-directed mutagenesis and chemical modification studies using residue-specific reagents. Our deletion and point mutation analyses have demonstrated that glutamate-3 and histidine-5 are necessary for malonyl-CoA inhibition and binding of CPTI but not for catalysis. We will determine the structural basis for the high malonyl-CoA sensitivity of M-CPTI by constructing chimeras between M-CPTI and L-CPTI and by site-directed mutagenesis. We will prepare milligram quantities of the expressed highly purified human heart M-CPTI and liver L-CPTI for structural characterization studies. Finally, we plan to study the regulation of human heart M-CPTI gene expression by hormonal, developmental and dietary factors. Our goal is to elucidate the molecular mechanism of the regulation of fatty acid transport and oxidation in mammalian cells. Woldegiorgis

**The Mitochondrial ATP-sensitive K⁺ Channel (mitoKATP)**

MitoKATP resides in the inner membrane of mitochondria, where it serves to regulate the volume of mitochondrial compartments and also to trigger cell signaling leading to cardioprotection and gene transcription. We showed that mitoKATP mediates the actions of potassium channel openers and ischemic preconditioning to protect the heart against ischemia-reperfusion injury. We are now working to understand the mechanisms of this effect and the normal physiological role of mitoKATP in heart and brain. We introduced techniques for purification and reconstitution of mitoKATP in lipid vesicles and use this preparation to study the transport kinetics of the channel. We have purified the mitoKATP subunits to homogeneity and will use these to obtain the molecular structure of mitoKATP. Garlid

**Mitochondrial Uncoupling Proteins**

Our laboratory was the first to demonstrate reconstitutive activity of the new uncoupling proteins, UCP2 and UCP3, and we have long been active in the study of UCP1. Flux studies in proteoliposomes containing UCP have led to a new mechanism of UCP-mediated uncoupling in which the fatty acid anion is transported by UCP and the protonated fatty acid cycles spontaneously back across the bilayer to deliver protons. Garlid

**Mitochondrial Bioenergetics**

Progress in understanding mitochondrial bioenergetics has not kept pace with the enormous progress in structure-function of the enzymes of oxidative phosphorylation. This occurs at a time when understanding bioenergetics at the physiological level is most needed, in view of the increased recognition of the roles played by mitochondria in cell physiology and pathophysiology. A number of unresolved questions relating to the mechanism of energy conservation in mitochondria are being addressed by theoretical and experimental approaches. Subjects being investigated include the question of redox slip, volume activation of electron transport, and the role of the intermembrane space in regulating energy transfers between matrix and cytosol. Garlid

**Anaerobiosis of Bacillus subtilis**

A gram-positive soil bacterium, *B. subtilis*, is highly amenable to genetic analysis and has been used as a model system to study fundamental microbiological research. In addition, *B. subtilis* is medically and industrially important since it produces a variety of antibiotics and extracellular...
enzymes. Although the organism has been widely used, it has been mistakenly referred to as a strict aerobe until recently. Our studies, together with others, have shown that *B. subtilis* is able to grow under anaerobic conditions by utilizing nitrate or nitrite as an alternative electron acceptor. In the absence of terminal electron acceptors, it undergoes fermentative growth. Our research aims to elucidate the regulatory mechanisms through which the cells adapt to oxygen limitation. Molecular genetic and biochemical approaches are applied. Nakano

**Two Physiological Roles of Nitrate and Nitrite Reductases**

Nitrate and nitrite reductases have two roles in metabolism of *B. subtilis*: assimilation of nitrate/nitrite and anaerobic respiration. Two genetically and biochemically distinct nitrate reductases are present to fulfill the dual roles; in contrast, a single nitrate reductase functions in both assimilation and respiration. The functional differences of the enzymes correspond to the difference in gene regulation. We have studied how these nitrate and nitrite reductase genes are regulated in response to nitrogen and oxygen limitation by promoter analysis of these genes and identification of trans-acting factors. The mechanisms of transcriptional activation of the nitrate/nitrite reductases are being investigated. Nakano

**ResD-ResE Two-Component Signal Transduction System**

Bacteria often encounter sudden environmental changes. Cells cope with such changes by an elaborate network of adaptive responses. The two-component signal transduction system senses and then processes information derived from environmental changes so that the cell can choose the appropriate adaptive response. This simple signal transduction system is widespread in bacteria and also found in plants and lower eukaryotes. ResE is a histidine kinase and ResD is a response regulator of this large protein family. We have shown that ResD and ResE are indispensable for anaerobic respiration in *B. subtilis*. A specific signal derived by oxygen limitation is recognized by the N-terminal input domain of the ResE kinase leading to autophosphorylation of a conserved histidine residue in the C-terminal transmitter domain. This phosphoryl group is then transferred to aspartate in the conserved N-terminal domain of ResD, altering the activity of its C-terminal domain as a transcriptional activator. The ResD-ResE signal transduction system is activated by oxygen limitation or by addition of nitric oxide generators. The objectives of our studies are to determine how ResE senses oxygen limitation or nitric oxide and how anaerobically induced genes are activated by ResD. Nakano

**Flavohemoglobin (Hmp)**

Flavohemoglobin is a ubiquitous protein present in organisms ranging from *Escherichia coli* to *Saccharomyces cerevisiae*. The N-terminal part of the protein has similarity to hemoglobin, and the C-terminus is homologous to reductase with a flavin-binding domain. Recent studies showed that flavohemoglobin is involved in detoxification of nitric oxide. *B. subtilis* *hmp* was identified among genes, expression of which is induced by oxygen limitation. The anaerobic induction of *hmp* requires the ResD-ResE signal transduction pairs and nitrite. The expression is also induced by exogenous nitric oxide through ResDE-dependent and -independent mechanisms. The detailed regulatory mechanism of *hmp* expression and its functional role in anaerobiosis are under investigation. Nakano

**Peptide Antibiotic Biosynthesis**

Our research is aimed at understanding the mechanism of antimicrobial peptide biosynthesis. Peptide antibiotics are synthesized either by the non-ribosomal thiopeptide mechanism or are bacteriocins that are gene-encoded and synthesized on ribosomes. Both classes are used as bio-control agents in medicine, agriculture, and the food industry. Non-ribosomally synthesized peptides also include iron-scavenging siderophores which are required for virulence by some bacterial pathogens and toxins produced by a variety of bacterial and fungal species that infect plants. A knowledge of how peptide and bacteriocin biosyntheses are carried out at the molecular level may provide information that ultimately be used to design ways to control the virulence of pathogenic microorganisms and to synthesize peptides with a defined structure and bioactivity. The spore-forming bacterium *Bacillus subtilis* will produce an abundance of peptide antibiotics and bacteriocins under conditions of nutritional stress and oxygen limitation. The genes encoding the enzymes that catalyze peptide biosynthesis have been cloned, and we are engaged in genetic engineering of the enzymes to understand the mechanism of antimicrobial peptide biosynthesis. Zuber

**Prokaryotic Signal Transduction/Gene Regulation**

Bacteria can respond in a variety of ways to a growth-restricting environment. Prolonged exposure to a nutritionally poor environment results in the induction of antibiotic biosynthesis, functions required for cell motility and processes of cellular differentiation that give rise to highly resistant cell types. How cells respond to nutritional stress is profoundly influenced by cell density. Extracellular signal molecules accumulate in the local environment of densely populated cell cultures and trigger antibiotic production and developmental processes such as sporulation and genetic competence. The objective of our research is to understand, in molecular terms, the regulatory networks that cells utilize to choose the most appropriate response to harsh conditions. In the spore-forming bacterium *Bacillus subtilis*, establishment of genetic competence is co-regulated with peptide antibiotic biosynthesis by a complex network of signal transduction pathways that utilize protein components common to all prokaryotic and most eukaryotic organisms. Zuber

**Biochemistry of Lignin Degradation**

Lignin is the most abundant renewable aromatic polymer, constituting approximately 25 percent of woody plant cell walls. Our multidisciplinary
The research program aims to understand and exploit the fungal degradation of this underutilized resource. The metabolic pathways and enzymatic components of the lignin degradative system are examined using biochemical, enzymological and molecular biological methods. Two novel extracellular heme peroxidases (lignin peroxidase and manganese peroxidase) involved in the degradation of lignin were discovered in our laboratory. Lignin peroxidase oxidizes a variety of nonphenolic lignin model compounds and priority pollutants. Manganese peroxidase oxidizes Mn$^2+$ to Mn$^3+$, which in turn oxidizes phenolic and nonphenolic substrates. The structures, active sites, mechanisms, catalytic cycles and regulation of these enzymes are being characterized in our laboratory and via collaborations using spectroscopy, stopped-flow kinetics, protein chemistry, enzymology, X-ray crystallography and bio-organic and molecular genetic methods. Recently, we developed a homologous expression system for these peroxidases. This system allows structure/function studies by site-directed mutagenesis. Applications for lignin-degrading systems include the more efficient utilization of biomass, nonpolluting forest products technologies and toxic waste cleanup. We also are studying several intracellular enzymes such as quinone reductases, ring-cleaving dioxygenases and reductive dehalogenases that are involved in lignin and pollutant degradation. Gold

**Molecular Biology and Genetics of Phanerochaete chrysosporium and Its Lignin-Degrading System**

We are isolating and sequencing the genes encoding components of the P. chrysosporium lignin-degrading system. These include genes encoding lignin and manganese peroxidases, a novel quinone reductase and several other genes. We are analyzing the coding and promoter regions of these genes and studying the regulation of their transcription. We have discovered that Mn peroxidase is regulated by Mn ion, the substrate for the enzyme, as well as by nutrient nitrogen, heat shock and oxidative stress. Using reporter genes and RT-PCR, we are elucidating the molecular mechanisms involved in Mn peroxidase gene regulation. Recently we developed a transcriptional reporter system based on the gene encoding green fluorescent protein from jellyfish. We also are undertaking molecular biology studies on the manganese peroxidase gene of Dichomitus squalens and on its heterologous expression in P. chrysosporium. Gold

**Biodegradation of Aromatic Pollutants**

The nonspecific and oxidative nature of the lignin degradation system of the fungus Phanerochaete chrysosporium enables this organism to degrade a variety of toxic aromatic pollutants, including polychlorinated phenols, polychlorinated dioxins, chlorophenoxyacetic acid and nitroaromatics. We are examining the biochemical pathways, enzymes and regulatory mechanisms involved in the total degradation of these compounds. We have shown that the fungus utilizes extracellular peroxidases as well as intracellular quinone reductases, reductive dehalogenases and dioxygenases to carry out these processes. We are attempting to characterize these enzymes and their encoding genes to more fully understand the mechanisms involved in the degradation of these pollutants. Recently we discovered a novel reductive dechlorination system in white-rot fungi that removes chlorines from chlorinated hydroquinones. This system is being examined by biochemical and molecular biological methods. Gold

**Oxidative Enzymes Involved in Fungal Cellulose Degradation**

Cellulose constitutes 40 percent to 60 percent of plant cell wall material; its biotechnological conversion, initially to glucose and then to ethanol, can provide an alternative source of energy. This application requires a complete understanding of the various enzymes involved in fungal cellulose degradation. The cellulose-degrading cultures of Phanerochaete chrysosporium produce a unique hemoflavoenzyme, cellobiose dehydrogenase (CDH), which oxidizes cellobiose to cellubionolactone. We have purified CDH to homogeneity in high yields. Cellulases bind to crystalline cellulose using a specific cellulose-binding domain. CDH appears to have a similar domain for cellulose binding. The amino acid sequence responsible for cellulose binding and the binding mechanism are under investigation. Our recent research suggests that a possible physiological role of CDH is to enhance crystalline cellulose degradation by cellulases, the rate-limiting step in the bioconversion of cellulose to glucose. A detailed study of the structure, function and mechanism of CDH using spectroscopic, biochemical and molecular biological methods is in progress. Gold
REPRESENTATIVE PUBLICATIONS
N.J. Blackburn, M. Ralle, R. Hassett and D.J. Kosman, "Spectroscopic Analysis of the Trinuclear Cluster in the Fe3S Protein from Yeast, a Multinuclear Copper Oxidase." Biochemistry 2000, 39, 2316-2324.

RESEARCH INTERESTS
Structure and function of oxidation and oxygenases metalloenzymes, spectroscopy of metal sites in proteins with emphasis on EPR, EXAFS, absorption edge, and FTIR spectroscopies; coordination chemistry and biochemistry of copper. Biochemistry of metal trafficking in cells.

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RESEARCH INTERESTS
The structure-function of the mitochondrial ATP-sensitive K+ channel (mitoKATP) and its role in cardioprotection and cardiac physiology; the structure-function of uncoupling proteins; mitochondrial and cellular bioenergetics.

REPRESENTATIVE PUBLICATIONS
RESEARCH INTERESTS
Metallobiochemistry; biological role of transition metals; molecular and electronic structures of metalloenzyme active sites; chemistry of O2, metabolism; metal-oxo intermediates; reaction and FT Raman, FT-IR, and EPR spectroscopy.

REPRESENTATIVE PUBLICATIONS


Michiko Nakano Research Associate Professor Ph.D., Cell Biology University of Tokyo, 1976

RESEARCH INTERESTS
Anaerobiosis of Bacillus subtilis; oxygen-controlled gene regulation, two-component signal transduction system; transcriptional activation; nitrate/nitrite reduction; flavohemoglobin; anaerobic electron transport; nitric oxide signaling.

REPRESENTATIVE PUBLICATIONS


REPRESENTATIVE PUBLICATIONS

Mammalian chemocommunication: the transport, olfactory and vomeronasal organ reception of (Z)-7-dodecenyl acetate; the sex pheromone of the Asian elephant; the origin and synthesis of (Z)-7-dodecenyl acetate; identification and function of pheromones and chemical signals of the elephant-unique temporal gland.

RESEARCH INTERESTS

Mammalian chemocommunication; structure-function analysis of metalloenzymes. Spectroscopic characterization of copper transporters such as Wilson’s and Menkes disease protein, using extended X-ray absorption fine structure spectroscopy (EXAFS). Cloning, overexpression and characterization of proteins involved in copper transport in the mammalian cell.

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RESEARCH INTERESTS

Metallobiochemistry; structure-spectroscopy (EXAFS). Extended X-ray absorption fine structure spectroscopy for copper transporters such as Wilson’s and Menkes disease proteins. Characterization of copper transporters using extended X-ray absorption fine structure spectroscopy (EXAFS). Cloning, overexpression and characterization of proteins involved in copper transport in the mammalian cell.

REPRESENTATIVE PUBLICATIONS


N.J. Blackburn, M. Kalle, R. Hassett and D.J. Kosman, “Spectroscopic Analysis of the Trimetallic Cluster in the Fe3 Protein from Yeast, a Multimetallic Copper Oxidase.” Biochemistry 2000, 39, 2316-2324.


MATTHEW S. SACHS

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RESEARCH INTERESTS

Mechanisms of translational and transcriptional control that regulate the expression of the Neurospora crassa arg-2 and Saccharomyces cerevisiae CPM1 genes; translational control of human proto-oncogenes; fungal genomes.

REPRESENTATIVE PUBLICATIONS


JAMES W. WHITTAKER

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RESEARCH INTERESTS

Electronic structures and dynamics of metalloenzyme active sites; spectroscopic and computational approaches to biomolecular structure; metalloenzyme mechanisms; enzyme engineering; biology of metal ions.

REPRESENTATIVE PUBLICATIONS


RESEARCH INTERESTS
Regulation of carnitine palmitoyltransferase I; regulation of long-chain fatty acid transport and oxidation in mammalian cells; regulation of cell metabolism and signalling by long-chain acyl CoA esters; mitochondrial ion transport and bioenergetics.

REPRESENTATIVE PUBLICATIONS

RESEARCH INTERESTS
Regulation of prokaryotic gene expression and development in response to stress, signal transduction, regulation and mechanism of peptide antibiotic biosynthesis; regulation of genetic competence in Bacillus subtilis.

REPRESENTATIVE PUBLICATIONS

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Ph.D., Biochemistry University of Maryland, Baltimore 1996
JORDANN L. LLOYD
Ph.D., Biochemistry University of Maryland, Baltimore 1996

RESEARCH INTERESTS
Regulation of carnitine palmitoyltransferase I; regulation of long-chain fatty acid transport and oxidation in mammalian cells; regulation of cell metabolism and signalling by long-chain acyl CoA esters; mitochondrial ion transport and bioenergetics.

REPRESENTATIVE PUBLICATIONS
THE DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING has an internationally acclaimed research program. The breadth and depth of the research program is evidenced by the research projects and research centers listed below, and by the educational program.

Four degrees are offered: Master of Science in Computer Science and Engineering, Master of Science in Computational Finance, Oregon Master of Software Engineering, and Doctor of Philosophy in Computer Science and Engineering. In addition to these degrees, we offer a Certificate in Computational Finance, Applied Computing, and Oregon Master of Software Engineering.

ADMISSION REQUIREMENTS

Admission requirements are the same as the general requirements of the institution. General aptitude GRE scores are required, except in cases of advanced placement admission for M.S. students (see below). A candidate must hold a bachelor’s degree in computer science, mathematics, engineering, one of the biological or physical sciences, or one of the quantitative social sciences. Candidates with a degree in a field other than computer science must have completed courses in the following subject areas:

- An introduction to programming in a high-level language
- Data structures*
- Discrete mathematics*
- Logic design and computer organization
- Calculus or other college-level mathematics

*APC515 Data Structures and Discrete Mathematics may be taken to meet the prerequisite.

ADVANCED PLACEMENT ADMISSIONS FOR MS STUDENTS

Students who are currently studying at OGI and have earned 12 credits in computer science classes are exempt from the GRE and TOEFL requirements. Only two letters of recommendation are required; all other admissions requirements remain the same. The CSE courses must include at least two, preferably three, courses from the MS Core (list follows). Students must earn an overall Grade Point Average of 3.0 and a B or better in each MS Core class to be eligible to apply through Advanced Placement:

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<td>CSE513</td>
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<tr>
<td>CSE533</td>
<td>Automata and Formal Languages</td>
<td>3</td>
</tr>
</tbody>
</table>

If a student applies to the Computational Finance program through advanced placement, the 12 credits earned may be from CSE, ECE APC or FIN courses.

DEGREE REQUIREMENTS

A Student Program Committee (SPC) that provides academic advising is assigned for each matriculating student. The student’s SPC also approves the application of courses toward the degree requirements.

A maximum of 21 credits earned prior to matriculation at OGI may be applied toward the master’s degree. This may include up to 12 credits transferred from other institutions (up to 18 from Portland State University, the University of Oregon or Oregon State University) and credits taken at OGI prior to matriculation.

The program of study for each master’s student may be tailored to meet individual needs by the SPC. Students are particularly encouraged to include special-topic courses (CSE 58X) relevant to their interests.

CSE MS PROFESSIONAL INTERNSHIP OPTION

Participation is limited by available industrial internships. Students declaring this option must complete 45 credits of course work and up to an additional 3 credits of a professional internship. (CSE620)

MASTER OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING

All M.S. students must complete the M.S. core of 21 credits.

M.S. CSE CORE

The following courses are required of all M.S. CSE students:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE500</td>
<td>Introduction to Software Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CSE511</td>
<td>Principles of Compiler Design</td>
<td>3</td>
</tr>
<tr>
<td>CSE513</td>
<td>Introduction to Operating Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSE514</td>
<td>Introduction to Database Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSE521</td>
<td>Introduction to Computer Architecture</td>
<td>3</td>
</tr>
</tbody>
</table>

Doctoral student Francis Chang (left) and faculty member Wu-chang Feng are working on network support for streaming digital media.
COMPUTER SCIENCE AND ENGINEERING

1. M.S. THESIS OPTION

Students choosing the thesis option must submit and defend a master's thesis and may apply up to 12 credits of thesis research (CSE 700) toward the 45 credit requirement.

1. M.S. CSE CORE (listed above)
2. CSE 700 M.S. THESIS (maximum 12 credits)
3. ELECTIVES (12 credits), as directed by the thesis advisor or SPC

Please note: Students may not receive credit for both CSE504 and OMSE533.

2. NONTHESIS OPTIONS

Students choosing the nonthesis M.S. option must complete 15 courses and a minimum of 45 credits; up to six credits of nonthesis research (CSE 610) may be included, with the approval of the student's SPC. Students matriculated prior to Winter Quarter 2002 are exempt from the 15 course requirement. Students pursuing the non-thesis option may choose one of the nine areas of emphasis defined below or consult their SPC to define a custom program.

ADAPTIVE SYSTEMS AREA OF EMPHASIS
NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. ADAPTIVE SYSTEMS CORE (12 credits):
   Required:
   CSE547 Statistical Pattern Recognition 3 credits
   CSE560 Artificial Intelligence 3 credits
   Choose two of:
   CSE540 Neural Network Algorithms & Architecture 3 credits
   CSE545 Advanced Neural and Adaptive Algorithms 3 credits
   CSE546 Data and Signal Compression 3 credits
   CSE548 Statistical Computing 3 credits
   CSE550 Spoken Language Systems 3 credits
   CSE562 Natural Language Processing 3 credits
   CSE564 Human-Computer Interaction 3 credits
   CSE568 Empirical Research Methods 3 credits
   CSE569 Scholarship Skills 3 credits
   CSE58X appropriate special topics course (or) any CSE class not already taken

Please note: Students may not receive credit for both CSE504 and OMSE533.

COMPUTATIONAL FINANCE AREA OF EMPHASIS
NONTHESIS M.S. CSE DEGREE

1. M.S. CSE Core (listed above)
2. COMPUTATIONAL FINANCE CORE (18 credits):
   Required: (Choose 6 of the following):
   FIN541 Principles of Modern Finance 3 credits
   FIN544 Investment and Portfolio Management 3 credits
   FIN547 Global Markets and Foreign Exchange 3 credits
   FIN551 Options and Futures 3 credits
   FIN552 Options and Futures II 3 credits
   FIN558 Advanced Numerical Computing in Finance 3 credits
   FIN561 Risk Management 3 credits
   FIN573 Financial Time-Series Analysis 3 credits
   FIN576 Financial Markets and Trading 3 credits
   FIN585 Topics in Computational Finance 3 credits
   3. SUGGESTED ELECTIVES (6 credits)
   CSE509 Object-Oriented Programming 3 credits
   CSE540 Neural Network Algorithms & Architecture 3 credits
   CSE544 Introduction to Probability and Statistical Inference 3 credits
   CSE545 Advanced Neural and Adaptive Algorithms 3 credits
   CSE546 Data and Signal Compression 3 credits
   CSE547 Statistical Pattern Recognition 3 credits
   CSE548 Statistical Computing 3 credits
   CSE549 Applied Business Forecasting 3 credits
   CSE555 Mathematical Methods for Engineering & Finance 3 credits
   CSE564 Human-Computer Interaction 3 credits
   CSE568 Empirical Research Methods 3 credits
   CSE58X Special Topics
   ECE525 Analytical Techniques in Process & Communication 4 credits
   ECE555 Engineering Optimization (or) any CSE class not already taken

Please note: Students may not receive credit for both CSE504 and OMSE533.

DATA-INTENSIVE SYSTEMS AREA OF EMPHASIS
NONTHESIS M.S. CSE DEGREE

1. M.S. CSE Core (listed above)
2. DATA-INTENSIVE SYSTEMS CORE (12 credits)
   Four of:
   CSE515 Distributed Computing Systems 3 credits
   CSE526 Modern Operating System Design 3 credits
   CSE541 Database Implementation 3 credits
   CSE542 Object Data Management 3 credits
   CSE58X Information Retrieval and the Internet 3 credits
   CSE58X Any special topics course in the database area
   One course from the System Software Core
   One course from the Software Engineering Core or the Software Engineering for Industry Professionals Core
   3. SUGGESTED ELECTIVES (12 credits)
   Any CSE class not already taken.

Please note: Students may not receive credit for both CSE504 and OMSE533.

SOFTWARE ENGINEERING AREA OF EMPHASIS
NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SOFTWARE ENGINEERING CORE (15 credits)
   Required:
   CSE503 Software Engineering Processes 3 credits
   CSE524 TCP/IP Internetworking Protocols 3 credits
   CSE527 Principles and Practices of System Security 3 credits
   CSE533 Automata and Formal Languages 3 credits
   CSE532 Analysis and Design of Algorithms 3 credits
   CSE541 Structure of Spoken Language 3 credits
   CSE58X Cryptography 3 credits
   CSE569 Scholarship Skills 3 credits
   CSE58X Any special topics course appropriate to this area
   3. SUGGESTED ELECTIVES (6 credits)
   One course from the Software Engineering Core or the Software Engineering for Industry Professionals Core
   One course from the System Software Core
   Four of:
   CSE540 Neural Network Algorithms & Architecture 3 credits
   CSE544 Introduction to Probability and Statistical Inference 3 credits
   CSE545 Advanced Neural and Adaptive Algorithms 3 credits
   CSE546 Data and Signal Compression 3 credits
   CSE547 Statistical Pattern Recognition 3 credits
   CSE548 Statistical Computing 3 credits
   CSE549 Applied Business Forecasting 3 credits
   CSE555 Mathematical Methods for Engineering & Finance 3 credits
   CSE564 Human-Computer Interaction 3 credits
   CSE568 Empirical Research Methods 3 credits
   CSE58X Special Topics
   ECE525 Analytical Techniques in Process & Communication 4 credits
   ECE555 Engineering Optimization (or) any CSE class not already taken

Please note: Students may not receive credit for both CSE504 and OMSE533.
SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS

1. M.S. CSE CORE (listed above)
2. SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS

Required:

Choose one of:

- OMSE531: Software Requirements Engineering 3 credits
- OMSE533: Software Design Techniques 3 credits

Choose one of:

- CSE564: Human-Computer Interaction 3 credits
- CSE567: Developing User-Oriented Systems 3 credits

3. SUGGESTED ELECTIVES (9 credits)

Any CSE class not already taken.

Please note: Students may not receive credit for both CSE504 and OMSE533.

SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SOFTWARE ENGINEERING FOR INDUSTRY PROFESSIONALS CORE (15 credits)

Choose four of:

- CSE515: Distributed Computing Systems 3 credits
- CSE524: TCP/IP Internetworking Protocols 3 credits
- CSE526: Modern Operating System Design 3 credits
- CSE527: Principles and Practices of System Security 3 credits
- CSE541: Database Implementation 3 credits
- CSE58X: Internet Technology 3 credits
- CSE58X: Multi-Media Networking 3 credits
- CSE58X: plus any special topics courses appropriate to this area

3. SUGGESTED ELECTIVES (12 credits)

Any course in the Systems Software area core or any CSE class not already taken.

Please note: Students may not receive credit for both CSE 504 and OMSE 533.

SPOKEN LANGUAGE SYSTEMS AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SPOKEN LANGUAGE SYSTEMS CORE (12-16 credits)

Three of:

- CSE550: Spoken Language Systems 3 credits
- CSE551: Structure of Spoken Language 3 credits
- CSE552: Hidden Markov Models for Speech Recognition 3 credits

CSE561: Dialogue 3 credits
CSE562: Natural Language Processing 3 credits
ECE541: Speech Processing 3 credits
ECE545: Speech Systems 4 credits
ECE58X: Speech Synthesis 4 credits

Choose one of the following or one more from the above list:

- CSE540: Neural Network Algorithms & Architectures ($) 3 credits
- CSE545: Advanced Neural & Adaptive Algorithms 3 credits
- CSE547: Statistical Pattern Recognition 3 credits
- CSE560: Artificial Intelligence 3 credits
- CSE564: Human Computer Interaction 3 credits
- CSE568: Empirical Research Methods 3 credits
- ECE540: Auditory & Visual Proc. by Human & Machine 4 credits
- ECE544: Intro to Signals, Systems and Info. Processing 4 credits

Any course in the Spoken Language Systems core, or any CSE class not already taken.

Please note: Students may not receive credit for both CSE 504 and OMSE 533.

SYSTEKS SOFTWARE AREA OF EMPHASIS NONTHESIS M.S. CSE DEGREE

1. M.S. CSE CORE (listed above)
2. SYSTEMS SOFTWARE CORE (12 credits)

Choose four of:

- CSE515: Distributed Computing Systems 3 credits
- CSE524: TCP/IP Internetworking Protocols 3 credits
- CSE526: Modern Operating System Design 3 credits
- CSE527: Principles and Practices of System Security 3 credits
- CSE541: Database Implementation 3 credits
- CSE58X: Internet Technology 3 credits
- CSE58X: Multi-Media Networking 3 credits
- CSE58X: plus any special topics courses appropriate to this area

3. SUGGESTED ELECTIVES (12 credits)

Any course in the Systems Software area core or any CSE class not already taken.

Please note: Students may not receive credit for both CSE 504 and OMSE 533.

The Master of Science in Computational Finance is an interdisciplinary program offering students the flexibility to learn technical skills directly relevant to quantitative or computational work in the financial securities industry. A professional internship track is also available. (see below)

1. M.S. IN COMPUTATIONAL FINANCE CORE (24 credits)

Choose eight of:

- ECE551: Introduction to Digital Signal Processing 4 credits
- ECE552: Digital Signal Processing I 4 credits
- ECE554: Adaptive Signal processing 4 credits
- ECE555: Mathematical Methods for Science and Engineering 3 credits
- ECE556: Scientific Computing 3 credits
- ECE558: Advanced Numerical Computing in Finance 3 credits
- ECE561: Risk Management 3 credits
- ECE573: Financial Time Series Analysis 3 credits
- ECE576: Financial Markets and Trading 3 credits
- ECE585: Topics in Computational Finance 4 credits

2. BREADTH REQUIREMENT (21 credits)

Breadth requirement courses must come from at least two of the following tracks. The course lists for each track are representative, not exhaustive. Students with strong backgrounds or special interests may request approval to substitute other OGI courses in place of those listed below:

A. APPLIED COMPUTING

- APC500: Development with Visual Basic for Applications 3 credits
- APC501: Accelerated Development with Visual Basic 3 credits
- APC503: Web Development with Perl 5 3 credits
- APC505: Applications Programming in C++ 3 credits
- APC506: Advanced Applications Programming in C++ 3 credits
- APC508: Web Development with Java 2 3 credits
- APC511: Computational Tools for Engineering and Finance 3 credits
- APC515: Data Structures and Discrete Math 3 credits

B. COMPUTER SCIENCE

- CSE500: Principles of Software Engineering 3 credits
- CSE503: Software Engineering Processes 3 credits
- CSE504: Object-Oriented Analysis and Design 3 credits
- CSE509: Object-Oriented Programming 3 credits
- CSE510: Introduction to Database Systems 3 credits
- CSE532: Analysis and Design of Algorithms 3 credits

C. APPLIED MATHEMATICS, STATISTICS, AND MACHINE LEARNING

- CSE540: Neural Network Algorithms and Architectures 3 credits
- CSE544: Introduction to Probability and Statistical Inference 3 credits
- CSE545: Advanced Neural and Adaptive Algorithms 3 credits
- CSE547: Statistical Pattern Recognition 3 credits
- CSE548: Modern Applied Statistics 3 credits
- CSE549: Applied Business Forecasting 3 credits
- CSE555: Mathematical Methods for Science and Engineering 3 credits
- CSE556: Simulation and Optimization 3 credits

D. ENGINEERING

- ECE525: Analytical Techniques in Statistical Signal Processing 4 credits
- ECE544: Introduction to Signals, Systems and Information Processing 4 credits
- ECE550: Linear Systems 4 credits
- ECE551: Introduction to Digital Signal Processing 4 credits
- ECE554: Adaptive Signal Processing 4 credits
- ECE555: Engineering Optimization 3 credits

E. MANAGEMENT SCIENCE

- MST501: Managerial & Financial Accounting 4 credits
- MST502: Financial Management 4 credits
- MST512: Project Management 3 credits
- MST520: Managing in Science and Technology 4 credits
- MST540: International Management in Science & Technology 3 credits
The courses on software development in context provide instruction in the basic areas of software development: requirements, architecture, design, implementation, and testing. The course material in each of these areas provides instruction in underlying principles, development methods and tools, and analytic methods and tools with a focus on applying principles, techniques and tools. Course material focuses on applying techniques and skills from the foundation courses to realistic examples of the products of each development phase. Course emphasis is on understanding the application and effect of the techniques covered in the context of real software development.

### PART 3: PROGRAM INTEGRATION AND STRATEGIC DEVELOPMENT SKILLS (9 Credits)

Courses in this area focus on integrating the skills taught in the OMSE program and on the ability to think abstractly about the processes and products of software engineering. Students must have completed Part 1 and Part 2 of the OMSE program before beginning Part 3. (Exception: A student may begin taking courses in Part 3 in the same term as taking any remaining courses in the first two parts.) In OMSE 551, Strategic Software Engineering students learn the skills necessary to understand, model, and adapt their software engineering processes to meet emerging needs. In OMSE 555/556, the Software Development Practicum, students participate in the end-to-end development of a significant software product and apply the personal competencies and development skills learned throughout the program in a development context that includes the essential characteristics of real commercial software development.

### Area Requirements

Students choose three courses within one area and three courses out of that area, as outlined below.

#### FOUNDATION REQUIREMENTS: Students are required to take six foundation courses. Particularly well-prepared students can waive some of these courses by passing an examination on the course material.

#### AREA REQUIREMENTS: Students choose three courses within each area and three courses out of that area.

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**OMSE 531 Software Requirements Engineering** 3 credits

**OMSE 532 Software Architecture and Domain Analysis** 3 credits

**OMSE 533 Software Design Techniques** 3 credits

**OMSE 534 Software Implementation and Testing** 3 credits

**PART 4: ELECTIVES (6 credits)**

Any CSE or OMSE class not already taken.

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**FINANCE PROFESSIONAL INTERNSHIP PROGRAM**

Participation in this program option is limited by available industrial internships. Students declaring this option, the breadth requirement courses must come from at least one of the tracks previously listed, plus FIN 620 Professional Internship in Finance.

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**OREGON MASTER OF SOFTWARE ENGINEERING (OMSE)**

OMSE has established undergraduate/graduate cooperative programs with Lewis & Clark College, Pacific University, Reed College, and Willamette University. These programs allow selected undergraduate students to enter the master’s program in computer science and engineering at the beginning of their senior year. In two years of residence at OGI, the student can simultaneously fulfill requirements for the bachelor’s degree at the undergraduate institution and the master’s degree at OGI.

### PH.D. PROGRAM

The Ph.D. program is strongly oriented toward preparation for research. Each student has the opportunity to work closely with a faculty research advisor throughout his or her residency at OGI. A student must satisfy the institutional requirements for the Ph.D. Candidate is satisfied in three parts:

#### FOUNDATION REQUIREMENTS: Students are required to take six foundation courses. Particularly well-prepared students can waive some of these courses by passing an examination on the course material.

#### AREA REQUIREMENTS: Students choose three courses within each area and three courses out of that area.

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**OMSE 551 Strategic Software Engineering** 3 credits

**OMSE 555 Software Development Practicum I** 3 credits

**OMSE 556 Software Development Practicum II** 3 credits

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**INTERNSHIP PROGRAM**

For information and availability regarding the OGI School’s Department of Computer Science Internships, please contact the department.

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**COOPERATIVE COMPUTER SCIENCE PROGRAMS**

OMSE 550 Principles of Software Engineering 3 credits

OMSE 551 Managing Software Development 3 credits

OMSE 552 Understanding the Software Business 3 credits

OMSE 553 Professional Communication Skills for Software Engineers 3 credits

OMSE 554 Using Metrics and Models to Support Quantitative Decision Making 3 credits

OMSE 555 Software Quality Analysis 3 credits

OMSE 556 Software Requirements Engineering 3 credits

OMSE 557 Software Architecture and Domain Analysis 3 credits

OMSE 558 Software Design Techniques 3 credits

OMSE 559 Software Implementation and Testing 3 credits

OMSE 560 Software Development Practicum I 3 credits

OMSE 561 Software Development Practicum II 3 credits

Any two CSE or OMSE classes not already taken. 6 credits
Committee provides academic advise and is in direct control of each student’s program of study. The SPC will work with the student to set and review goals on a twice-yearly basis. Students must write a progress report for all SPC meetings except the first one.

**FOUNDATION REQUIREMENTS (18 credits)**

Required:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE502</td>
<td>Functional Programming</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE507</td>
<td>Logic Programming</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE509</td>
<td>Object-Oriented Programming</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE531</td>
<td>Foundations of Semantics</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Choose one programming language course:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE540</td>
<td>Neural Network Algorithms and Architectures</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE545</td>
<td>Advanced Neural and Adaptive Algorithms</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE546</td>
<td>Data and Signal Compression</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE547</td>
<td>Statistical Pattern Recognition</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE568</td>
<td>Empirical Research Methods</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

**DISTRIBUTION REQUIREMENTS (18 credits)**

Three courses from one of the following six areas, and three other courses not from that area not already taken:

**Adaptive Systems and Applications**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE540</td>
<td>Neural Network Algorithms and Architectures</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE545</td>
<td>Advanced Neural and Adaptive Algorithms</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE546</td>
<td>Data and Signal Compression</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE547</td>
<td>Statistical Pattern Recognition</td>
<td>3 credits</td>
</tr>
<tr>
<td>CSE568</td>
<td>Empirical Research Methods</td>
<td>3 credits</td>
</tr>
<tr>
<td>FIN573</td>
<td>Financial Time Series Analysis</td>
<td>3 credits</td>
</tr>
<tr>
<td>ECE540</td>
<td>Auditory and Visual Processing by Human and Machine</td>
<td>4 credits</td>
</tr>
</tbody>
</table>

**Research Proficiency Exam**

**COURSE DESCRIPTIONS**

**CSE500 Introduction to Software Engineering**

Software engineering is concerned with the ways in which people conduct their work activities and apply technology to produce and maintain software products and software-intensive systems. Issues of concern include specification, design, implementation, verification, validation, and evolution of software artifacts. Related topics include software metrics, project management, configuration management, quality assurance, peer reviews, risk management, and process improvement. This course presents an integrated view of these topics and related issues. It is an essential course for anyone working in development, maintenance, management, or related areas in a software organization.

**CSE502 Functional Programming**

In functional programming, we shift our focus from data objects and their representations to functions that act on data. Programs are formulated as compositions of functions, rather than as sequences of statements. This leads to a programming methodology that is quite different from that learned in using statement-oriented languages. This course introduces the student to functional notation, recursion, higher-order functions, reasoning about functions, and polymorphic type systems. Functional programming languages are known for their increased productivity and reliability, due in part to the higher levels of abstraction provided by functional languages. Course is taught by lecture with short weekly programming assignments. Experience is gained by programming in the functional language Haskell or one of its close derivatives. Recent advances in functional programming languages allow them to use updatable state in a safe manner and to cause effects on the real world. Students gain experience by writing programs using these features to program interactive window-based programs using an embedded “widget” library.

**CSE503 Software Engineering Processes**

This course is concerned with examining and improving the software development processes, including the technical, managerial, and cultural processes, used by organizations to develop and maintain high quality software systems in a timely and economical manner. Various process models, including the SEI Capability Maturity Models, the ISO SPICE model, the Team Software Process, and the Personal Software Process are studied and contrasted. Tailoring of process models to fit local situations and various approaches to software process improvement are presented. Students select and complete term projects that address topics in software process improvement.

**CSE504 Object-Oriented Analysis and Design**

This course presents an integrated set of techniques for software design and analysis based on object-oriented concepts. The techniques focus on producing the artifacts and work products, expressed in UML, appropriate for the analysis and design phases of the software development lifecycle. We adopt a use case model for requirements and a responsibility-driven approach for the development of object models. Design patterns and frameworks are also emphasized. Note that CSE 509 Object-Oriented Programming is intended as a follow-on course for CSE 504.

**CSE507 Logic Programming**

Logic programming is an attempt to construct computer languages with completely declarative semantics: The programmer only states “what” should be done; the interpreter or compiler must decide “how.” This course examines existing logic programming languages, notably Prolog, provides the foundations in logic and theorem proving for such languages; and covers implementation of logic programming languages. Other topics may include an introduction to modal logic and intuitionistic logic.

**CSE509 Object-Oriented Programming**

This course provides a rigorous introduction to the concepts behind object-oriented programming. It is...
for students who are already familiar with the concept of object-orientation and with object-oriented analysis and design techniques. One way to learn this background material is by taking CSE 504 Object-Oriented Analysis and Design. In CSE 509, students gain a thorough understanding of incremental programming, type-safety, polymorphism, encapsulation, and set-based abstraction, and apply these concepts through a variety of programming projects. We study several programming languages, including Java and Smalltalk, so students are exposed to different realizations of these concepts and gain an appreciation for the programming language design space. We also look at published object-oriented design patterns and see how they can be implemented in different object-oriented programming languages. Students are required to read appropriate research papers, complete several short programming assignments, complete a substantial programming project, and write some short essays. Prerequisite: CSE 504 or equivalent.

CSE514 Introduction to Database Systems

A survey of database fundamentals emphasizing the use of database systems. Topics include database design, data dependencies and normalization, secondary storage structures, query languages, query processing, query optimization, transactions, recovery, and embedded SQL. This course focuses on relational database systems and the SQL query language. Students participate in a project to design, populate, and query a database. Prerequisites: Data structures, discrete mathematics, and mathematical logic.

CSE515 Distributed Computing Systems

This course concentrates on distributed computing from a systems software perspective. Major topics include communications middleware (remote procedure call, remote method invocation and causal broadcast), operating system support, distributed file systems, distributed transaction processing, load balancing, distributed programming languages and systems, fault-tolerance and replication algorithms, distributed timing issues, and distributed algorithms. Prerequisites: CSE513 Introduction to Operating Systems. (Also a basic understanding of compiler design, computer communications problems and protocols.)

CSE518 Software Design and Development

Contemporary, object-oriented software design, using the Java programming language. An introduction to the eXtreme Programming software development methodology, which is based upon the principle that change is inevitable and successful software designs undergo continual evolution. Techniques that will be taught in the course include program refactorizing, automated unit testing, pair programming, participatory design, and managing short product development cycles. These principles and techniques will be illustrated in a term-length project that provides members of the class with design and implementation experience.

CSE520 Introduction to Computer Architecture

This course provides a broad introduction to computer architecture. The course covers a large amount of material in moderate depth, giving the student a good understanding of the basic issues in computer system design. Specifically, the course covers instruction set design, pipelining, the memory hierarchy, I/O systems, networking issues, and multiprocessors. Example systems include the Intel x86, MIPS, and DEC Alpha processors. Prerequisites: Experience writing software, preferably with some C or assembler programming. Note: Computer architecture has become a quantitative science, so there will be considerable algebraic manipulation involved in the performance analysis component of the course.

CSE522 Advanced Computer Architecture

This course covers new architectural trends in designing high-performance clusters with examples. Topics to be covered include I/O & IPC interconnects (routing, switch designs, virtual lanes, etc.); single system image and scheduling; lightweight messaging and use-level networking; suitable I/O architectures; commercial cluster interfaces and systems; and presence of clusters in data centers. Commercial and academic examples will be covered for each of the above topics, such as InfiniBand, Virtual Interface Architecture (VIA), ServerNet, Beowulf, Memory Channel, etc. Prerequisite: CSE 521.

CSE524 TCP/IP Internetworking Protocols

This course provides an overview of the structure and algorithms used in the TCP/IP networking protocols that make up the foundation of the Internet. Protocols and technologies covered will include an introduction to the link layer, ARP, IP, ICMP, UDP, TCP, routing protocols, and application protocols and systems like the DNS, NFS, SMTP, FTP, HTTP, and multicasting protocols and applications. To provide architectural insight into protocol design issues and operating system implementation techniques, typically in terms of the Berkeley UNIX socket programming model. To provide socket programming experience with the client/server model. To provide experience reading Internet RFC's and/or drafts. Prerequisites: familiarity with the functions of a modern multiuser operating system such as is covered in CSE 513 or in PSU's CS 533. Familiarity with C programming on modern UNIX computers.

CSE526 Modern Operating System Design

This course includes an in-depth study of modern operating system design. The course is based on a collection of recent research papers, and includes an emphasis on evaluating the papers in addition to understanding the systems they describe. Topics include micro-kernel operating systems, lightweight interprocess communication, extensible operating systems, file systems, mobile computing, workstation clusters, adaptive resource management, and OS support for multimedia systems. Prerequisites: CSE 513 and CSE 521.

CSE527 Principles and Practices of System Security

In the Internet age, host system security is essential and difficult. This course will educate students in the principles and practices of securing host systems. Students learn the principles of how to build secure systems and how various real systems succeed and fail in living up to these principles. We will study various security enhancing technologies, in each case relating the security enhancement to the principles of secure systems. Prerequisite: CSE 513.

CSE530 Introduction to Mathematical Logic

Provides a theoretical foundation for the logic of computation. Propositional and first-order predicate calculus, soundness and completeness, incompleteness and incomputability, the Church-Turing thesis, term-rewriting systems, and application to program verification. 3 credits

CSE531 Foundations of Semantics

Formal semantics aims to answer two important questions: 1) when are two programs equal? And 2) when does a program faithfully implement a mathematical specification? The course explores denotational semantics, operational semantics, and program logic, studying how they are related and how they can answer the motivating questions.
Programming language concepts, such as imperative programming, functional programming, call-by-name, call-by-value, and continuations, are contrasted and explained in terms of their semantic foundations. Key concepts include full abstraction and the use of least fixed point constructions to solve recursive equations. The course is designed for students interested in the mathematical foundations of programming languages and programming logics. Prerequisite: Discrete mathematics. 3 credits

CSE532 Analysis and Design of Algorithms
An introduction to the design and analysis of algorithms. The course covers design techniques, such as dynamic programming and greedy methods, as well as fundamentals of analyzing algorithms for correctness and time and space bounds. Topics include advanced sorting and searching methods, graph algorithms and geometric algorithms. Other areas vary from year to year, and may include computational geometry, matrix manipulations, string and pattern matching, set algorithms, polynomial computations, and the fast Fourier transform. Prerequisite: Data structures and discrete mathematics. 3 credits

CSE533 Automata and Formal Languages
Automata theory introduces fundamental models that are used over and over again in computer science for programming languages, in compiler construction, and in algorithms. These models are a valuable part of the repertoire of any computer scientist or engineer. This course introduces progressively more powerful models of computation, starting with finite automata and moving through counter, stack, and Turing machines. It also presents the regular, context-free, recursive, and recursively enumerable languages, and shows how they correspond to the various models of computation and to generation mechanisms such as regular expressions and grammars. The emphasis is on understanding the properties of these models, the relationships among them, and how modifications such as nondeterminism and resource bounds affect them. The course includes application of these concepts to problems arising in other parts of computer science. Prerequisite: Discrete mathematics. 3 credits

CSE534 Computability and Intractability
Computability and complexity theory identify classes of languages based on characteristics of machines that recognize them. The course presents elementary results from recursive function theory, including recursive and recursively enumerable sets, and degrees of undecidability. Using recursion theory as a model, it develops the classical results of complexity theory, including time and space complexity classes, hierarchy theorems, and elementary results from parallel complexity. The course concludes by studying classes of problems that are provably intractable, with a particular emphasis on NP-complete problems. Prerequisites: CSE 532 or CSE 533. 3 credits

CSE535 Categories in Computer Science
Category theory provides a powerful and concise notation for abstract properties of functions. Originally developed for algebraic topology, it has found widespread application in computer science. This course introduces the basic notions of category theory, including functors, natural transformations, products, sums, limits, colimits, monads, and adjunctions. These concepts are illustrated with examples from computer science and mathematics, including the relationship between cartesian closed categories and the lambda-calculus. Familiarity with discrete mathematics is an essential prerequisite. 3 credits

CSE540 Neural Network Algorithms and Architectures
This course introduces the fundamentals of connectionist and neural network models. Paradigms for both unsupervised and supervised learning are covered. Topics include introduction to neural processing elements, Hebbian learning, LMS and back propagation algorithms, competitive learning, computational capability, and elements of statistical pattern recognition. Specific architectures covered include Hopfield nets, single and multilayer Perceptrons, and Kohonen maps. Programming projects involve network simulations and application problems. Prerequisites: Some knowledge of linear algebra and calculus is required. Programming experience is necessary. 3 credits

CSE541 Database Implementation
This course provides hands-on experience implementing high-performance database management systems. The goal of the course is to implement database software and to understand techniques used to provide maximum performance and functionality on modern architectures. Typical topics discussed include benchmarking, transaction processing, file and index implementation, buffer management, concurrency control, recovery, query optimization, and a variety of query processing algorithms. The data model to be implemented, and the computer architecture to be used, will change between offerings. Prerequisite: CSE 514. This course is offered at Portland State University as CS 545. 3 credits

CSE542 Object Data Management
A variety of products for managing object data have emerged in the marketplace. Object-oriented database systems and persistent programming languages have been joined by object-relational databases and middleware component technologies, such as Enterprise Java Beans. Other storage engines, such as LDAP and XML servers, have an object flavor. This course begins with the concepts in types, data models, and languages that underlie object data management. It then looks at example prototype and commercial systems, and examines design dimensions such as data model, persistence, encapsulation, hierarchies, query languages, and transactions. It touches on application development and data management issues and concludes with treatment of software architecture and implementation techniques. Students will do a project using a commercial product. 3 credits

CSE544 Introduction to Probability and Statistical Inference
This course provides a comprehensive introduction to probability, statistical inference and stochastic processes. The topics include the elements of exploratory data analysis, sampling distribution theory, confidence intervals, hypothesis testing, linear regression, goodness-of-fit, ANOVA, maximum likelihood estimation, Bayesian inference, cross-validation, nonparametric tests, random walks, martingales, stochastic processes and stochastic differential equations. The goal of the course is to provide a comprehensive review of essential concepts in probability and statistics. The primary analysis tools for this course are S-PLUS and MATLAB. 3 credits

CSE545 Advanced Neural and Adaptive Algorithms
An advanced treatment of architectures and algorithms for pattern recognition, regression, timeseries prediction, and datamining. Typical topics include convergence, effects of noise, optimization methods, probabilistic framework (including Bayesian estimation), generalization ability and regularization and pruning, Hebbian learning, and clustering and density modeling. Prerequisites: CSE 540 or instructor permission. 3 credits

CSE546 Data and Signal Compression
The need for signal and data compression is ubiquitous in image, video, and speech processing, finance, and computational science. Where data stores become very large (e.g. video, finance, earth science), the need is not met by simple lossless file compression schemes, and we must turn to sophisticated coding techniques. This course addresses both the theoretical basis and practical algorithms for data and signal compression. Topics include lossless entropy based coding including Huffman and Lempel-Ziv, and lossy compression techniques including: scalar quantizers, transform coding (Karhunen-Loeve, DCT, and nonlinear transform codes), predictive coding, vector quantization, adaptive codes, and wavelets. The relation between compression schemes and probabilistic data modeling is emphasized in conjunction with each technique. Application to speech, image, and video coding are discussed. Students will have the opportunity to design compression schemes for such diverse applications as earth science data, finance, speech, or video depending on their specific interests. Prerequisites: Undergraduate calculus, introductory probability and statistics, some programming experience. 3 credits

CSE547 Statistical Pattern Recognition
Theory and practice of statistical pattern recognition. Students will learn fundamental theory and practices that are common to a broad range of pattern recognition applications and technologies, and apply principles to real-world examples. The emphasis is on developing tools, both theoretical and practical, that provide grounding in pattern recognition problems and methods; rather than on showcasing particular technologies. The course will benefit those whose work may use any of a variety of recognition technologies in broad-ranging applications such as speech and image processing, data mining, finance. Topics include: random vectors, detection problems (binary decision problems), likelihood ratio tests, ROC curves, parametric and non-parametric density estimation, classification models, theoretical error bounds and practical error
estimation through cross-validation. Maximum likelihood and Bayesian parameter estimation. Feature extraction for dimensionality reduction, and for classification. Prerequisites: The course is designed to be self-contained. Familiarity with undergraduate probability and statistics is useful.

3 credits

CSE548 Statistical Computing
This course provides an introduction to modern applied statistics. The topics include distributions and data summaries, density estimation, generalized linear models, modern nonlinear regression, robust statistics, factor analysis, linear and nonlinear classifiers, Bayesian classifiers, cluster analysis, decision trees, ensemble learning methods, validation techniques and Bootstrap and Monte Carlo methods. The goal of the course is to provide a solid understanding of practical statistical inference methods and proficiency in using modern statistical tools. The primary analysis tool for this course is S-PLUS. Prerequisite: CSE544 Introduction to Probability and Statistical Inference or equivalent.

3 credits

CSE549 Applied Business Forecasting
This course is taught over the World Wide Web using WebCT; enrollment limitations may apply. An applied course in business forecasting, the course emphasizes generating and implementing business forecasts. Designed for those wishing to understand the basics of modern forecasting, the course emphasizes modern statistical methods widely used to generate business forecasts. Specific applications to business include forecasting sales, production, inventory, macroeconomic variables such as interest rates and exchange rates, and other applications related to business planning, both short- and long-term. Topics include data considerations and model selection, applied statistics, moving averages and exponential smoothing, regression analysis, time-series decomposition, Box-Jenkins (ARIMA) models, bootstrapping, optimal forecast combination, and forecast implementation. The course is based upon the FORECASTX integrated econometric and statistical analysis language for Windows 95 and NT, building spoken language systems using the CSLU Toolkit. The course materials are included in http://www.cse.ogi.edu/~CSLI/hlsurvey/hlsurvey.html.

3 credits

CSE551 Structure of Spoken Language
This course provides a foundation for subsequent learning and research in computer speech recognition. We examine the structure of spoken English through selected readings in speech perception and acoustic phonetics and examination of visual displays of speech. The goals are to understand the acoustic cues for each major phonetic category, understand how these cues are affected by context, understand the perceptual strategies that listeners use to understand speech, and evaluate the assumption that speech can be described as an ordered sequence of phonetic segments.

3 credits

CSE552 Hidden Markov Models for Speech Recognition
Hidden Markov Model-based technology is used widely in today’s speech recognition systems. This course is an introduction to speech recognition using HMM technology. Topics include the theory of Hidden Markov Models (discrete, semi-continuous, and continuous) and their applications to speech recognition, along with the basic mathematics (probability theory, statistics, stochastic process, information theory, and signal processing) that are necessary for speech recognition. The course is focused on understanding the theory behind these fundamental technologies, and applying the technology to develop speech recognition systems. Prerequisite: Some knowledge of engineering mathematics (calculus and linear algebra) is required; C programming experience is necessary.

3 credits

CSE555 Mathematical Methods for Engineering and Finance
This course explores the essential mathematical methods required for quantitative analysis in engineering and finance. The course examines a selection of topics from multivariate calculus, differential equations, stochastic calculus and mathematical optimization. Advanced topics include partial differential equations, Ito calculus, martingales, stochastic control and constrained optimization. The focus is on explaining the key Mathematical results and, by means of examples and assignments, showing how they may be applied in engineering and finance. Prerequisites: Knowledge of calculus, linear algebra and basic differential equations.

3 credits

CSE556 Simulation and Optimization
This course introduces modern, advanced numerical techniques for quantitative work in engineering, finance and operations research, focusing on Monte Carlo Simulation and Optimization techniques. In Monte-Carlo simulation we will cover pseudo-random and quasi-random number generators, generation of stochastic processes, variance reduction techniques, bootstrapping and other statistical techniques. In Optimization we will briefly review classical methods, and study in detail new techniques such as genetic algorithms, differential evolution, simulated annealing and ant colony optimization. Students will be introduced to mathematical modeling, and learn the science and art of effectively applying these techniques. Grading will be based on assignments and a group project, and these will involve programming in Matlab. The assignments, project and examples in class will be drawn from practical problems in engineering and finance. Prerequisites: Programming experience, linear algebra, calculus, CSE544 Introduction to Probability and Statistical Inference (or equivalent).

3 credits

CSE560 Artificial Intelligence
This course surveys the foundations and applications of symbolic approaches to artificial intelligence. The approach emphasizes the formal basis of automated reasoning and includes an introduction to programming in Prolog. Fundamentals covered include search, knowledge representation, automated inference, planning, nonmonotonic reasoning, and reasoning about belief. Applications include expert systems, natural language processing and agent architectures.

3 credits

CSE561 Dialogue
This course provides an in-depth treatment of the major theories of dialogue, including finite-state, plan-based, and joint action theories. Dialogue is examined at a level general enough to encompass conversations between humans, between human and computer, and among computers, while at the same time being precise enough to support implementation. The course introduces basic speech act theory, planning, and reasoning through a number of classic papers. Plan-based theories are examined in detail, including their incorporation into spoken dialogue systems, and their potential effects upon speech recognition components. Students will develop dialogue components and integrate them into working systems. Prerequisite: CSE 560.

3 credits

CSE562 Natural Language Processing
An introduction to artificial intelligence techniques for machine understanding of human language. The course introduces key aspects of natural language, along with the analyses, data structures and algorithms developed for computers to understand it. Computational approaches to phonology, morphology, syntax, semantics, and discourse are covered. Programming assignments are written in Prolog. Prerequisite: CSE 560 or equivalent.

3 credits

CSE563 Multi-Agent Systems
This course covers the emerging theory and practice of multi-agent systems: semi-autonomous, semi-intelligent distributed computing systems that can be organized ad hoc to meet the immediate needs of a user. The course covers a variety of individual and multi-agent architectures, including the Contract Net protocol, distributed blackboard systems, and mobile agents. Also discussed are principles for building networks of heterogeneous agents, ranging from simple rule-based systems to databases and humans. In order to collaborate to solve a user’s problem, agents need to communicate. We examine agent communication languages, including KQML and FIPA, as well as the underlying general speech act theories. Students learn how to model these systems formally, and will develop and program individual agents that can participate in a multi-agent system.

3 credits
CSE564 Human-Computer Interaction
This course emphasizes the experience of computing, which centers on an understanding of real users and the specific tasks they need to accomplish when computing. In the pursuit of optimal user support, an interdisciplinary approach to system design and evaluation is stressed. The course reviews current research viewpoints and activities in the field of human-computer interaction, surveys key research challenges that exist, and discusses trends in next-generation system design. Students gain hands-on experience by critiquing existing interfaces, as well as hearing reports from experts in industry on the state of the field. An introduction to this topic is essential for everyone working in the field of computer science. 3 credits

CSE567 Developing User-Oriented Systems
This course explores a range of issues and methods needed to design and evaluate user-oriented software applications. Topics focus on field and ethnographically based design studies, participatory design methods, user laboratory studies, and usability testing. The purpose is to have access to a range of methods that help uncover opportunities, breakdowns, and interactions that affect the design and use of developing systems. Students are challenged to evaluate the underlying perspectives of the approaches and decide which approach or combination of approaches works best for particular problems. They apply the methods in field and classroom exercises and produce a real-world project or paper using course methods. The intended result is to make students more effective not only at gathering relevant user-based information, but also at integrating it into the development process. 3 credits

CSE568 Empirical Research Methods
This course introduces principles of experimental design and data analysis for empirical research. Topics include the goals and logic of experimental design, hypothesis formation and testing, probability and sampling theory, descriptive statistics, correlation and regression, basic parametric and nonparametric tests of statistical significance (e.g., Binomial, t-test, chi-square, analysis of variance), standard designs for single- and multi-factor experiments, and strategies of scientific investigation (e.g., Exploratory vs. Directed). The course is fundamental for anyone who plans to conduct independent research in the future or needs to critically evaluate the research of others. Students participate in designing and analyzing data in order to answer scientific questions and present the results of these activities both orally and in writing. 3 credits

CSE569 Scholarship Skills
Scientific results have little value if they are not communicated clearly or are disconnected from prior work in a field. This course teaches students to research, write, present, and review effectively for the computer sciences. It emphasizes learning by doing, and students have frequent writing and presentation assignments. Students learn how to locate and organize background materials, how to write clearly about technical topics, organizing web content, the structure and stylistic conventions of scientific documents (such as conference abstracts, journal papers, theses, and proposals), how to prepare and deliver short and long presentations, the refereeing process, and how to prepare and respond to a review. This course is required for Ph.D. students and strongly recommended for master's students, especially those pursuing the thesis option. It also is useful for professionals who must write or speak to a technical audience. 3 credits

CSE58X Special Topics
Under this number, we offer courses of particular relevance to the research interests of faculty or in state-of-the-art subjects of interest to the community. 3 credits

CSE600 Research
Supervised research activity. Variable and repetitive credit.

CSE610 Nonthesis Research
Supervised research for up to six credits as a component of the nonthesis master's degree. Students are required to produce concrete research deliverables, including a final report equivalent to a CSE technical report. 1 to 3 credits per quarter

CSE620 Professional Internship
These courses provide the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers in computer science. A written report must be submitted to the CSE faculty advisor at the end of the experience. Enrollment requires a faculty advisor and is limited by the number of internship opportunities available.

CSE700 M.S. Thesis Research
Research toward the thesis for the M.S. degree. Variable and repetitive credit.

CSE800 Ph.D. Dissertation Research
Research toward the dissertation for the Ph.D. degree. Variable and repetitive credit.

FIN541 Principles of Modern Finance
This course examines the theory and practice of modern corporate finance stressing the six central concepts in finance: Net Present Value, Capital Asset Pricing Model, Efficient Capital Markets, Value Additivity (Capital Structure Theory), Option Theory and Agency Theory. Topics include discounted cash flow analysis, capital budgeting, capital structure theory, mean-variance portfolio theory, arbitrage-pricing theory, Black-Scholes option pricing, and real options theory. In addition, students will learn the nuances of evaluating an Ebsusness. The principal goal of the course is to provide students with an intuitive foundation of modern finance upon which the student can apply advanced computational techniques. This will be accomplished through interaction between the text, instructor, case studies, MATLAB assignments, and student presentations/discussions. This course fulfills all or part of the prerequisite requirements for FIN576 Financial Markets and Trading. 3 credits

FIN544 Investment and Portfolio Management
This course provides students with an overall introduction to practical and theoretical aspects of investment analysis and portfolio management. Specifically, the course surveys various models of asset valuation and their use in constructing effective investment portfolios. Topics include investment vehicles and asset classes, market structure and market efficiency, security valuation models, financial statement analysis, setting investment goals and policies, designing investment portfolios, equity and fixed-income portfolio strategies, measuring investment performance, and managing investment risk. To help students integrate the course knowledge into their actual investment practice, the course includes team projects to analyze actual investment securities and design investment portfolios. Students have access to investment data and analytics provided by Barra and Standard and Poor's Micropal. 3 credits

FIN547 Global Markets and Foreign Exchange
This course surveys the modern paradigms in international finance. Specifically, the course examines the theory linking the world's various foreign exchange, money, and securities markets, emphasizing global investment and risk management. Topics include spot and forward FX markets, FX options, interest rate parity, purchasing power parity, exchange rate theory, global investing, global FX risk management, and emerging markets and currency crises. Course assignments make use of MATLAB’s-Plus and Barra on campus. 3 credits

FIN551 Options and Futures I
This course introduces the trading, pricing and risk-management applications of financial derivatives including futures, swaps, and option contracts. Emphasis is given to pricing models including arbitrage pricing theory, risk-neutral valuation, and Black-Scholes analysis. Topics covered include futures and swap pricing methods for pricing American style options, hedging and speculation using derivatives, Ito calculus, portfolio insurance, option trading strategies, dynamic hedging strategies, and numerical models. Course assignments require use of MATLAB. 3 credits

FIN552 Options and Futures II
A continuation of FIN551 Options and Futures I, this course examines derivative pricing models since Black-Scholes, models for the term structure of interest rates and relevant numerical methods. The course begins with a review of stochastic calculus and stochastic differential equations. Specific topics include arbitrage pricing, equivalent martingale measures, risk neutrality, and optimal stopping times as applied to American options. Equilibrium and no-arbitrage term structure models are presented, from Vasicek through Heath-Jarrow-Morton. In addition, emphasis is given to pricing fixed-income derivatives, credit derivatives, and exotics using numerical solution methods such as the Crank-Nicholson, finite difference methods, and Monte Carlo search. Prerequisite: FIN551 Options and Futures I or permission from instructor. 3 credits
FIN558 Advanced Numerical Computing in Finance
This course introduces the major numerical methods needed for quantitative work in finance, focusing on derivatives pricing and fixed income applications. Topics include binomial and trinomial methods, finite difference solution of partial differential equations, Crank-Nicholson methods for various exotic options, treatment of discrete dividends, projectedsor method for American options, numerical methods for stochastic differential equations, random number generators, Monte-Carlo methods for European and least-squared Monte-Carlo methods for American options. The course is lab oriented. Prerequisite: FIN552 Options and Futures II or permission from instructor. 3 credits

FIN561 Risk Management
This course explores various aspects of management of risk associated with operating a multinational enterprise. Emphasis is on evaluating and hedging financial risks (fixed-income, equity, commodity, and foreign exchange risk exposures), with emphasis on value-at-risk (VAR) models. Topics include sources and measurement of risk and exposure, value at risk, hedging linear and nonlinear derivatives risk, delta-normal VAR, historical simulation VAR, Monte-Carlo approaches to VAR, and implementation and evaluation of risk management systems. Course assignments make use of MATLAB and BAKRA On Campus. 3 credits

FIN573 Financial Time-Series Analysis
This course reviews advanced time-series techniques and their application to the analysis and forecasting of financial time-series. Emphasis is given to multivariate and nonlinear methods applied to high-frequency financial data. Topics covered include ARIMA models, GARCH models, martingales and random walks, stochastic trends, co-integration and error-corrections models. The primary analysis tool for this course is S-PLUS. Prerequisite: CS548 Modern Applied Statistics. 3 credits

FIN576 Financial Markets and Trading
This course provides a survey of the structure and dynamics of financial markets, the behavior of financial price series, and trading techniques. Topics include market microstructure, market efficiency and documented anomalies, noise traders and bounded rationality, properties of high frequency data, nonlinear price behavior, speculative bubbles and crashes, market psychology, and technical trading systems. The course draws upon the academic literature and the practitioners’ lore. Students use MATLAB, S-PLUS, and extensive data resources to analyze price behavior and build and test simple technical trading systems. Prerequisites: FIN541 Principles of Modern Finance and FIN573 Financial Time-Series Analysis. 3 credits

FIN620 Professional Internship in Finance
This course provides the student with an opportunity to earn credit for relevant work experience in finance and related industries. It enables students to enhance their understanding of the practical realities of modern finance, including such areas as corporate treasury operations, investment analysis, portfolio management, risk management, derivatives pricing, forecasting and trading. Students gain valuable industrial experience that both allows them to learn to apply their knowledge gained in the classroom and to better prepare for their future careers in finance. Enrollment requires the permission of the instructor and is limited by the number of internship opportunities available. 1-3 credits

APPLIED COMPUTING COURSES

APC501 Accelerated Development with Visual Basic
This course uses Visual Basic 6.0 and Visual Basic for Applications as tools to introduce the concepts of rapid application development, systems integration and customization on Windows platforms. While studying Visual Basic, students will gain an understanding of the architecture of Windows applications and create COM components, of ActiveX Data Objects (ADO). Students will gain expertise in advanced analysis and data manipulation, developing and customizing applications, and integrating them with existing systems. Prerequisites: experience with Microsoft Excel and Access, and knowledge of a programming language. 3 credits

APC505 Development with Visual Basic for Applications
This course introduces Visual Basic for Applications as a tool for rapid application development, customization and system integration in Windows environments. The course focuses on combining VBA with Microsoft Office. Topics covered include the structure of the VBA programming language and built-in functions, enhancing recorded macros using VBA code, applying the MS Office object models and accessing relational databases using ADO. Students will gain expertise in advanced analysis and data manipulation, developing and customizing applications, and integrating them with existing systems. Prerequisites: experience with MS Excel and Access, and knowledge of a programming language. 3 credits

APC511 Computational Tools for Engineering and Finance
This course provides a comprehensive introduction to computing in finance. The course reviews key topics in linear algebra, explores basic numerical methods, and provides a comprehensive introduction to computing in Matlab. Mathematical topics include vector spaces, matrix computation, solution of linear systems, interpolation, regression, approximation, numerical precision, convergence and algorithm complexity. Matlab topics include language features, handling of vectors, matrices, and cell arrays, programming in Matlab (functions and script files), 2D and 3D graphics, using key toolboxes, developing a graphical user interface, and other advanced features. 3 credits

APC512 Computational Tools for Engineering and Finance
This course provides an introduction to essential programming skills needed for engineering and finance. The course reviews key topics in linear algebra, explores basic numerical methods, and provides a comprehensive introduction to computing in Matlab. Mathematical topics include vector spaces, matrix computation, solution of linear systems, interpolation, regression, approximation, numerical precision, convergence and algorithm complexity. Matlab topics include language features, handling of vectors, matrices, and cell arrays, programming in Matlab (functions and script files), 2D and 3D graphics, using key toolboxes, developing a graphical user interface, and other advanced features. 3 credits

APC506 Advanced Applications Programming in C++
This course explores advanced topics concerning applications programming in C++. The course will focus on writing efficient, extensible and reusable programs, and introduce concepts in software engineering, programming analysis and design, and data modeling. Students will develop class libraries, and learn how to apply design patterns. The course is suitable for students in science, engineering and finance who wish to further their understanding of the language. On completion, students will be in a position to design and develop systems using C++. Assignments include writing programs and a programming project. Prerequisites: APC 505 or equivalent knowledge of C++. 3 credits

APC508 Web Development with Java 2
This course uses “Java 2” technology to introduce the essential concepts needed to develop web applications with client side scripting. Topics include the structure and elements of Java, Java Foundation Classes (JFC), Java applets and servlets, Java Beans and Remote Method Invocation (RMI). Other topics, such as JDBC and XML may be introduced, time permitting. On completion, students will understand the conceptual architecture of web applications with client side automation and be in a position to contribute to their design and development. Assignments include writing programs and a project to develop a web application. Prerequisites: knowledge of a programming language. 3 credits

APC551 Computational Tools for Engineering and Finance
This course provides an introduction to essential programming skills needed for engineering and finance. The course reviews key topics in linear algebra, explores basic numerical methods, and provides a comprehensive introduction to computing in Matlab. Mathematical topics include vector spaces, matrix computation, solution of linear systems, interpolation, regression, approximation, numerical precision, convergence and algorithm complexity. Matlab topics include language features, handling of vectors, matrices, and cell arrays, programming in Matlab (functions and script files), 2D and 3D graphics, using key toolboxes, developing a graphical user interface, and other advanced features. 3 credits
OMSE500 Principles of Software Engineering
This course serves as an introduction to software engineering. The course focuses on understanding the software engineering process and its attendant problems as manifest in real development projects. The course compares and contrasts different models of the software engineering process and approaches to process improvement. It includes the analysis of where and how things go wrong motivated by case studies. This course is intended as a leveling course where and how things go wrong motivated by case studies. This course is intended as a leveling course.
Prerequisites: Knowledge of a programming language. 3 credits

OMSE511 Managing Software Development
This course provides the knowledge and skills needed to plan, organize, lead, and control software projects. Topics include planning and estimating, measuring and controlling, and achieving results in environments that include a great deal of ambiguity and contradictory information. Quantitative measures and risk management will be emphasized throughout the course. Students will prepare project plans for real or hypothetical software projects, to include effort, cost, and schedule estimates and risk management plans.
Prerequisite: OMSE 500. 3 credits

OMSE512 Understanding the Software Business
This course provides a familiarity with the business and economic aspects of software companies and other high-technology companies that develop software. Topics include fundamental macro-economic concepts, basic accounting and financial principles and methods, basic business law, and the functions and role of marketing in enterprises that develop software products or products that include software. Prerequisite: OMSE 500. 3 credits

OMSE555 Software Development Practicum I
The development practicum provides an opportunity for students to apply the knowledge and skills gained in other courses as they synthesize a solution to a significant, realistic, and practical problem. Students work in teams to analyze a problem, develop a software concept, plan a software development process and systematic reuse of life-cycle products over multiple developments. This course covers the principles and methods of software architecture to requirements and its effects on downstream design. Students will examine domain analysis and the architectural design process and products in context including the effect of decisions on function, quality, cost, and schedule.
Prerequisites: OMSE 500, OMSE 522. CSE students may not receive credit for both CSE 504 and OMSE 553 because there is significant overlap in content. 3 credits

OMSE556 Software Development Practicum II
The development practicum provides an opportunity for students to apply the knowledge and skills gained in other courses as they synthesize a solution to a significant, realistic, and practical problem. Students work in teams to analyze a problem, develop a software concept, plan a software development effort, define requirements, and implement a solution.
RESEARCH PROGRAMS

The specific research projects under way at any given time depend upon current interests and obligations of faculty, students, and research sponsors.

Agent-Based Systems
This project will design a new agent communication language (AGENTTALK) and multiagent architecture. Unlike DARPA’s current language (KQML), the language offers a true semantics, and provably correct dialogue protocols, based on joint intention theory. The Adaptive Agent Architecture, a successor to our earlier Open Agent Architecture, offers platform and application interoperability, facilitated communication, proper concurrent operation, dynamic reconfigurability of facilitators, and separation of data and control. Quickset has been reimplemented to use this architecture, gaining a more robust capability for supporting human-human collaboration, multimedia, and dynamic adaptation to processing environments. Cohen

Autonomix: Component, Network, and System Autonomy
Autonomix pragmatically seeks to provide autonomic defenses for commodity information systems. Our contribution is in three complementary areas: Component Autonomy, to make existing individual components more robust to attack; Network Autonomy, to allow existing components to access CIBP capabilities via current Internet standard protocols, and Systemic Autonomy, to model, analyze and implement coordinated, adaptive responses of multiple components. Component autonomy is developing a family of tools (StackGuard, PointGuard, FormatGuard, and RaceGuard) that make applications vulnerability tolerant by making broad classes of vulnerabilities (buffer overflows, printf format string bugs, and temporary file races) unexploitable. Network and Systemic Autonomy are providing a family of tools to enable large-loop intrusion tolerant responses, where in a distributed network of machines can adaptively respond to intrusions. Component Autonomy work is being done at WireX Communications, Inc., and Network and Systemic Autonomy work is being done at OGI. Cowan, Maier, Delcambre

Constructing Software from Specifications
Research in formal methods for software engineering has been concerned primarily with software specification. This research explores the next step: given a declarative specification, to generate practical and efficient software by the technologies of program transformation and specialization.

We have demonstrated a new software development method in which software components are constructed from executable specifications by typed, staged functional programs and a translation directed by an interface specification that determines data representations. Systematic techniques for proving the semantic validity of representations for data types are explored. Kieburtz, Hook, Sheard, Launchbury

Digital Government
DOT is collaborating with the US Forest Service, Bureau of Land Management, Fish and Wildlife Service and other government agencies to build a forest information portal for the Adaptive Management Area (AMA) program. The AMAs develop and test innovative approaches to forest management. We are developing an information model called Metadata++ to locate documents and document fragments along several dimensions and to search for documents based on similarity search between locations. The Forest project also includes participants from the MST and ESE departments at OGI, from UNIX and from the private sector: Delcambre, Maier, Toccalino, Phillips, Steckler, Tolle, Landis, Palmer

Domain Specific Languages
A domain-specific language can provide a declarative programming interface for specialists in an application domain who are not primarily software engineers. A well-designed domain-specific language improves productivity, reduces the incidence of programming errors and furnishes an easily understood medium for documentation of a software artifact. A barrier to the widespread adoption of domain specific languages is the inherent difficulty of language design and implementation. We are developing semantics combinators to allow rapid implementation of declarative, domain-specific languages. We are also pursuing staged implementations as a means of efficiently embedding a domain specific language into a broad-spectrum functional language framework. Sheard, Hook, Kieburtz, Launchbury

Functional Programming Languages
Functional programming languages are based upon the idea that programs can be designed as mathematical functions with logical properties. Functional abstraction is a powerful and flexible means of constructing concise programs. ParSoft faculty have a continuing interest in techniques for analysis and efficient implementation of functional programming languages including ML and Haskell. These techniques include staged programming, partial evaluation, effects encapsulation with monads, automatic program transformation, and advanced type systems. Black, Hook, Jones, Kieburtz, Launchbury, Sheard

Machine Learning and Adaptive Systems
Machine learning, neural computation and adaptive systems are studied from both theoretical and practical standpoints. Research in theory, architectures, and algorithm design includes learning algorithms (supervised, unsupervised, and reinforcement), generalization theory (including model selection and pruning, invariant learning), deterministic and stochastic optimization, context-sensitive learning, signal processing, time series analysis, and control. Practical application domains include adaptive signal processing, pattern recognition, speech recognition, image processing, medical screening technology, control systems, macroeconomics, and finance. Hersmansky, Leon, Moody, Pavel, Song, Wun

Multimodal Systems
Multimodal interfaces enable more natural and efficient interaction between humans and machines by supporting multiple coordinated channels through which input and output can pass. The Center for Human-Computer Communication is engaged in empirical investigation of multimodal interaction. This informs our research and development of architectures for multimodal language processing, work which draws on a range of fields such as cognitive science, natural language processing, multimedia, user interface design, speech recognition, gesture recognition, and visual parsing. The Quickset system developed at CHCC supports multimodal pen/voice interaction with complex visual/spatial displays such as maps. Cohen, Oviatt

Natural Language Dialogue
The performance of speech recognition systems improves significantly when the spoken language understanding system can predict the next utterance. Accordingly, we are performing perceptual studies of dialogue and building models of human-human and human-computer dialogue in order to develop computational models of conversation that can be used to track and predict spoken language. This work is based on speech-act theory, multiagent architectures, and models of spontaneous speech. Cohen, Heeman, Oviatt

Net Data Management
We believe that data management systems of the future must stress data movement over data storage. NIAGARA is an initial effort, conducted with the University of Wisconsin, to move beyond disk-centric data management to net-centric systems. Current work includes algebras and special operators for XML, exploiting stream semantics for efficient processing, and data-query hybrids for distributed query evaluation. Maier, Devitt, Naughton

Operating Systems
Our operating systems-related research focuses primarily on adaptive systems software and its application in distributed, mobile, and multimedia computing environments. Several large projects are currently under way in the areas of quality of service control, adaptive resource management and dynamic specialization for enhanced performance, survivability and evolvability of large software systems. Black, Steere, Walpole
Query Optimization

Our work on query optimization and evaluation deals with both general frameworks and specific techniques for different data model and query language features. Columbia is a C++-based, top-down framework for construction of cost-based query optimizers. We are currently examining pruning techniques for searching, transforms for collection-valued attributes and nested queries, and multiplex query optimization for efficiently optimizing groups of queries. Columbia is a joint project with Portland State University. Maier, Shapiro

Speech Recognition

The goal of Large Vocabulary Continuous Speech Recognition research is to enable normal human speech as an input device in next generation computers alongside today’s keyboard and mouse input. This technology can be used for dictation and command control applications when used by itself. It can also form part of a powerful information processing system when used together with information retrieval and natural language understanding systems. The research focuses include accurate acoustic modeling, speaker adaptation, confidence measure and rejection, and modeling spontaneous speech. Tan, Heeman

Spoken Language Systems

Spoken language systems make it possible for people to interact with computers using speech, the most natural mode of communication. A spoken language system combines speech recognition, natural language understanding and human interface technology. It functions by recognizing the person’s words, interpreting the words in terms of the context and goals of the task, and providing an appropriate response to the user. We are involved in the analysis and development of various components of such systems, ranging from empirical studies of human dialogues through the construction of interactive systems to the development of abstract models of behavior. Cohen, Oviatt, Heeman, van Santen

Superimposed Information and Superimposed Applications

We are interested in providing typical database system capabilities in an environment where we do not own or manage the underlying, base information. We seek to develop a superimposed layer of information that can reference selected information from the base layer and can also add new information to highlight, interconnect, elaborate, or annotate the selected information. We have defined an architecture for building superimposed applications and have implemented our first tool: SLIMPad, a scratchpad application that allows users to easily create “scraps” that reference selected items from the base layer and organize scraps into bundles. The tendency to use scraps and bundles to organize our thoughts is common practice, as confirmed by our observational research team that is studying how clinicians seek and use information in a hospital intensive care unit. Observational team: Gorman, Ash, Lavelle; computer science team: Delcambre, Maier, Shapiro

Tracking Footprints through an Information Space: Leveraging the Document Selections of Experts

The goal of this project is to help expert problem solvers find needed information in a large, complex information space. The focus is on one example of expert problem solving: the physician seeking to diagnose and treat a patient while using the medical record. Sorting through a heterogeneous collection of electronic and other media materials to find needed information, sometimes under time pressures, can be formidable. This project proposes to capture the trace of information used by experts—monitor the paths taken and collection resources used by physicians, in moving from observation, to information gathering, to solution of a given health care problem. By capturing the trace information artifacts associated with information seeking and selection, it is hypothesized that greater insight can be gained into behaviors of users and patterns of usage. This knowledge can then be fed back into the design and development of new information environments. The work is conducted by a cross-disciplinary team comprised of an MD focusing on information seeking behaviors of physicians, and a group of computer scientists focusing on extracting and using regularly structured information. The usefulness of the approaches will be tested in domains other than health care, in particular the aircraft design industry through the active support of the Boeing Corp. Delcambre, Maier, and Dr. Paul Gorman, Oregon Health & Science University

COLUMBUS: Computer Science and Engineering

The Hawk project is developing new means of programming embedded applications that involve both time-critical and critical-rate tasks. The goal of the Hawk project is to help expert problem solvers find needed information in a large, complex information space. The focus is on one example of expert problem solving: the physician seeking to diagnose and treat a patient while using the medical record. Sorting through a heterogeneous collection of electronic and other media materials to find needed information, sometimes under time pressures, can be formidable. This project proposes to capture the trace of information used by experts—monitor the paths taken and collection resources used by physicians, in moving from observation, to information gathering, to solution of a given health care problem. By capturing the trace information artifacts associated with information seeking and selection, it is hypothesized that greater insight can be gained into behaviors of users and patterns of usage. This knowledge can then be fed back into the design and development of new information environments. The work is conducted by a cross-disciplinary team comprised of an MD focusing on information seeking behaviors of physicians, and a group of computer scientists focusing on extracting and using regularly structured information. The usefulness of the approaches will be tested in domains other than health care, in particular the aircraft design industry through the active support of the Boeing Corp. Delcambre, Maier, and Dr. Paul Gorman, Oregon Health & Science University

RESEARCH CENTERS

CENTER FOR HUMAN-COMPUTER COMMUNICATION

Kimberly Tice, Center Administrator
(503) 748-7806
ticek@cse.ogi.edu

The Center for Human-Computer Communication is dedicated to realizing a vision of transparent information and service access. Research projects are broadly interdisciplinary, and include collaborations with numerous universities, federal research laboratories, and the Data-Intensive Systems Center at OGI. Research activities focus on:

- Multimodal human-computer interaction that allows people to state their needs using speech, writing, and gestures, and that provides multimedia output.
- User-centered design of next-generation interface technology, including spoken language and multimodal interfaces, and interfaces for mobile and multimedia technology.
- Intelligent agent technologies - software systems that assist users in accomplishing tasks and can reason about how and where to carry out the users’ requests in a worldwide distributed information environment.
- Collaboration technologies to support human-human communication, and collaborative decision making among groups of people.

CHCC organizes an annual Distinguished Lecture Series on the Future of Human-Computer Interaction. World-class researchers are invited to share current topics.

Dr. Philip Cohen and Dr. Sharon Oviatt are co-directors of the center. Other center faculty include Dr. Peter Heeman, and Dr. Misha Pavel. For more information, visit CHCC’s web pages at www.cse.ogi.edu/CHCC/.

PACIFIC SOFTWARE RESEARCH CENTER

Kelly Atkinson, Center Administrator
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SHERIDAN@CSE.OGI.EDU

The Pacific Software Research Center (PacSoft) is a team of faculty, students and professional research staff who study mathematically based techniques for the specification, development and validation of complex computer software. Our goals are to explore and test new techniques that can support the development of software products in which clients can have high confidence. PacSoft’s approach to software specification and development is grounded in functional programming, type theory, and formal semantics of programming languages. Our research methods extend from theoretical investigation through prototype software tool development to experimental validation.

Much of our work during the past decade has focused on techniques for the design and implementation of domain-specific languages. A domain-specific language is able to express the abstractions and operations used in a particular engineering domain, in terms familiar to domain experts. One domain in which this work has demonstrated considerable success is the design of complex microarchitectures for high-performance microprocessors.

The Hawk project has exploited abstraction and equational specification techniques from functional programming languages to produce a new kind of hardware specification language. A microarchitectural specification written in Hawk can be directly executed as a simulation, symbolically manipulated as a hardware algebra, or submitted to formal verification of its properties by model checking or by a theorem prover.

Among current PacSoft projects is Programatica, an exploration of computer-supported techniques for developing property-certified programs (programming as if properties mattered). Project Tinkter is developing new means of programming embedded applications that involve both time-critical and critical-rate tasks.

Dr. Tim Sheard is the current Director of the Center. Dr. Richard Kieburtz is the founding Director. Other faculty members of PacSoft are Dr. James Hook, Dr. Mark Jones and Dr. John Sheard.
Launchbury of OHSU/OGI and Dr. Andrew Tolmach of Portland State University. The Center employs six postdoctoral researchers and has numerous visitors each year.

Research by PacSoft scientists is supported by grants and contracts from the National Science Foundation, DARPA, the National Security Agency, Intel Corp. and Compaq.

For additional information, visit the PacSoft web site, http://www.cse.ogi.edu/PacSoft/.

**THE SYSTEMS GROUP**

Database and Object Technology Laboratory
Jo Ann Binkerd, Center Administrator
503-748-1112
binkerd@cse.ogi.edu

Systems Software Laboratory
Cynthia Pfaltzgraff, Center Administrator
503-748-7109
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The Systems Group consists of two research laboratories — the Systems Software Laboratory and the Database and Object Technology Laboratory.

The Database and Object Technology Lab (DOT) conducts theoretical and applied research related to database management and object-oriented systems. Query processing is a long-term focus, particularly query optimization frameworks as well as design, optimization and evaluation of object-oriented query languages. Another area of interest is scientific data management, most recently in support of multi-disciplinary studies in forest canopy science.

DOT research includes conceptual modeling, including semantic and object-oriented database models, models for object-oriented analysis and design, and models for superimposed information. Other topics include data dissemination, focusing particularly on information utility and superimposed information management.

Superimposed information enhances the utility and value of existing data sources by layering small amounts of information over them. We are examining superimposed information in connection with improving accessibility of medical records. Finally, we are investigating architectures for adaptable software and middleware support for application building, especially object-oriented approaches.

Dr. Dave Maier of OGI is the director of DOT. Additional DOT-affiliated faculty members are Dr. Crispin Cowan, Dr. Lois Delcambre, and Dr. Dylan McNamee of OGI, and Dr. Leonard Shapiro of Portland State University.

**FACILITIES**

OGI's Department of Computer Science and Engineering provides a state-of-the-art computing environment designed to support the needs of research and education. The computing facilities staff has a wide range of skills that allows the computing environment at CSE to be flexible and responsive in meeting the changing needs of the department.

Support for central services such as mail, dial-up access, video conferencing, database access, and file and printer sharing as well as access to Internet and Internet2 services are distributed across a group of Sun computers and a Network Appliance file server that comprise the core support environment.

While Sun computers are highly visible at CSE, both Intel and Alpha based machines running Windows or Linux are mainstays of our research activities. The generous support of our industry and government research partners allows CSE to maintain a high-quality computing infrastructure capable of supporting a high degree of heterogeneity as required for high-quality research.

In all, a facilities staff of nine supports almost 400 computer systems, X terminals, and peripheral devices spanning multiple networks using a variety of automated techniques, many developed internally, to cope with the high degree of complexity inherent in such a heterogeneous environment.
REPRESENTATIVE PUBLICATIONS


RESEARCH INTERESTS

Numerical computing, simulation, optimization, genetic algorithms, information systems, time series analysis and computational finance.

REPRESENTATIVE PUBLICATIONS


**PHIL COHEN**
Professor and Co-Director, Center for Human-Computer Communication
Ph.D., Computer Science
University of Toronto, 1978
pcohenc@cs.ogi.edu

**RESEARCH INTERESTS**
Multimodal interfaces, human-computer interaction, natural language processing, dialogue, delegation technology, cooperating agents, communicative action, applications to mobile computing, information management, network management, manufacturing.

**REPRESENTATIVE PUBLICATIONS**

**CRISPIN COWAN**
Assistant Research Professor
Ph.D., Computer Science
University of Western Ontario, 1995
crispin@cse.ogi.edu

**RESEARCH INTERESTS**
System security and survivability, operating systems, distributed systems, computer architecture, optimism, programming languages.

**REPRESENTATIVE PUBLICATIONS**

**LOIS DELCAMBRE**
Professor
Ph.D., Computer Science
University of Southwestern Louisiana, 1982
lmd@cse.ogi.edu

**RESEARCH INTERESTS**
Superimposed information, database system data models, scientific data management.

**REPRESENTATIVE PUBLICATIONS**
WU-CHANG FENG
Assistant Professor
Ph.D., Computer Science
University of Michigan, 1999
wuchang@cse.ogi.edu

RESEARCH INTERESTS
Scalable Internet systems, Internet congestion control and queue management, wireless networking, programmable network infrastructure.

REPRESENTATIVE PUBLICATIONS

WU-CHI FENG
Assistant Professor
Ph.D., Computer Science
University of Michigan, 1996
wuchi@cse.ogi.edu

RESEARCH INTERESTS
Networking, multimedia systems, multimedia networking, video coding, middleware services, and massively scalable streaming infrastructures.

REPRESENTATIVE PUBLICATIONS

PETER A. HEEMAN
Assistant Professor and
Ph.D., Computer Science
University of Rochester, 1997
heeman@cse.ogi.edu

RESEARCH INTERESTS
Spontaneous speech recognition, modeling disfluencies and intonation, dialogue management, collaboration, spoken dialogue systems, natural language processing.

REPRESENTATIVE PUBLICATIONS

MICHAEL JOHNSTON
(on leave 2001-02)
Assistant Research Professor
Ph.D., Linguistics, University of California at Santa Cruz, 1994
johnston@cse.ogi.edu

RESEARCH INTERESTS
Natural language processing, human-computer interaction, multimodal interfaces, spoken dialogue systems, syntax, semantics, and pragmatics of human language, computational models of phonology, morphology, and the lexicon, natural language understanding and computational semantics.

REPRESENTATIVE PUBLICATIONS
REPRESENTATIVE PUBLICATIONS


DAVID MAIER
Professor
Ph.D., Electrical Engineering and Computer Science
Princeton University, 1978
maier@cse.ogi.edu

RESEARCH INTERESTS
Database systems (including object-oriented database management systems, query processing, scientific information management, superimposed information and net data management), object-oriented and logic programming languages, algorithms, survivability of information systems, and health information technology.

REPRESENTATIVE PUBLICATIONS


JOHN E. MOODY
Professor
Ph.D., Theoretical Physics
Princeton University, 1984
moody@cse.ogi.edu

RESEARCH INTERESTS
Computational finance, time series analysis, analysis of financial markets, forecasting, and statistical learning theory and algorithms. Applications of machine learning to problems in finance, economics and the sciences.

REPRESENTATIVE PUBLICATIONS


SHARON L. OVIATT
Professor
Co-Director for Center for Human-Computer Interaction
Ph.D., Experimental Psychology
University of Toronto, 1979
oviatt@cse.ogi.edu

RESEARCH INTERESTS
Multimodal and spoken language systems, modality effects in communication (speech, writing, keyboard, etc.), communication models, telecommunication and technology-mediated communication, mobile and interactive systems, human-computer interaction, empirically based design and evaluation of human-computer interfaces, cognitive science, and research methodology.

REPRESENTATIVE PUBLICATIONS


CALTON PU
Professor
Ph.D., Computer Science
University of Washington, 1986
callon@cse.ogi.edu

RESEARCH INTERESTS
Transaction processing, distributed databases, scientific databases, parallel and distributed operating systems.

REPRESENTATIVE PUBLICATIONS


**REPRESENTATIVE PUBLICATIONS**


**RESEARCH INTERESTS**

Functional programming, software specification, program generation, meta-programming and staging.

**REPRESENTATIVE PUBLICATIONS**


JOINT FACULTY
DR. ANTONIO BAPTISTA
Environmental Science and Engineering
OGI School of Science and Engineering

DR. FRANCOISE BELLEGARDE
University of Franche Comte, France

DR. DAN HAMMERSTROM
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. HYNEK HERMANSKY
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. JODY HOUSE
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. MISHA PAVEL
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. LEONARD SHAPIRO
Department of Computer Science
Portland State University

DR. XUBO SONG
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. ANDREW TOLMACH
Department of Computer Science
Portland State University

PART-TIME FACULTY
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University of Franche Comte, France

DR. CHARLES CONSEL
University of Bordeaux

DR. DAVID G. NOVICK
University of Texas, El Paso

ADJUNCT FACULTY
DR. LOUCIE ANDERSON
Gemstone Systems Inc.

MR. JON BATECHELLER
Synopsys, Inc.

MR. ROBERT BAUER
Rational Software Corp.

DR. C. MIC BOWMAN
Intel Corporation

DR. TED BRUNNER
Tektronix Inc.

DR. SHANWEI CEN
Tektronix Inc.

DR. CHRISTOPHER DUBAY
Oregon Health & Science University

MR. ROY HALL
Crisis in Perspective

DR. DAVID HANSEN
George Fox University

DR. SEBASTIEN HILY
Intel Corporation

MR. SCOTT LYMAN
Merix Corporation

DR. RICHARD SPROAT
AT&T Labs, New Jersey

MS. ELISABETH SULLIVAN
TruSec Solutions

DR. ANDREW TOLMACH
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MR. SANJEEV QAZI
Intel Corporation

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MR. BRUCE SCHAFFER
Oregon College of Engineering and Computer Science

MR. RANDAL SCHWARTZ
Stonehenge Consulting

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Intel Corporation

MR. MARK MORRISSEY
Portland State University

DR. GIL NEIGER
Intel Corporation

MR. RANDAL SCHWARTZ
Stonehenge Consulting

MR. SANJEEV QAZI
Intel Corporation
The primary mission of the Department of Electrical and Computer Engineering is to provide quality graduate education, research and technology transfer in the areas of Intelligent Signal Processing, Semiconductor Materials and Devices, Computer and Systems Engineering, and Biomedical Engineering.

We currently have a very successful and well-focused program in Intelligent Signal Processing, which includes speech recognition and synthesis, image processing, adaptive filtering and control, and anthropomorphic signal processing. The department has two centers in this area, the Center for Information Technology (CIT) and the Center for Spoken Language Understanding (CSLU). Close interaction with the high-tech industry is a critical element of the activities reflected in numerous collaborative projects funded by industrial organizations including Intel, Qualcomm, and many others.

The Semiconductor Materials and Devices program has many new people and is in the middle of a rebuilding process. We have an excellent group, and investment includes a 5-year, $1 million Intel grant. We are creating a number of new laboratories. Although some semiconductor processing will be done, most of the effort and laboratory space will be devoted to education and to semiconductor materials and device characterization, including high-speed devices. These, plus our existing electron microscopy facility, are of value to local industry.

Computer and Systems Engineering is focused primarily on research into hardware and systems for implementing intelligent signal processing and robotic control. This process also includes the VLSI design of specialized devices for computation and intelligent sensing. Computational neuroscience plays an important part of this work. A new laboratory with 8 stations for DSP and FPGA programming is available, with help from Intel and Altera, to support education and research in this area. This area has several adjunct faculty from companies such as Intel, RadiSys, IDT, Cypress, Maxim and Triquint. There is one center in this area, the Center for Biologically Inspired Information Engineering (CBIIE).

The Biomedical Engineering (BME) program concentrates on Biomedical Optics, Tissue Engineering, and Medical Informatics. Biomedical Optics develops optical technologies for imaging and characterizing tissues and laser-tissue interactions for machining tissues and surgical techniques. Faculty are emphasizing tissue engineering with research at the affiliated Oregon Medical Laser Center (OMLC). Several people are also faculty at Oregon Health & Science University (OHSU) with a laboratory at OGI where students conduct research that interfaces with medical clinicians and investigators.

The department offers a wide variety of formal courses in core areas as well as in specific research areas. The curriculum for each student is determined in part by his or her academic background and interest, and is set after discussion with a faculty advisor.

The major fields of research activity in the department are:
  - Advanced Lithography
  - Atmospheric Optics
  - Biomedical Engineering
  - Biosensors
  - Digital Signal Processing
  - Display Technology including Thin Film Transistors and Phosphors
  - Electro-Optic Systems
  - Human Information Processing
  - Image and Video Processing
  - Man-Machine Interfaces
  - MEMS
  - Neural Networks
  - Optical Remote Sensing
  - Pattern Recognition
  - Processing for Ultra Shallow Device Technology
  - Semiconductor Electronic Devices
  - Semiconductor Materials and Processing
  - Speech Recognition, Enhancement, and Synthesis
  - Systems Dynamics
  - Technology Transfer

Jinshan Huo is a Ph.D. student and Intel intern whose interests involve copper interconnects for microelectronic device and materials characterization.
• Transient Thermal Processing
• VLSI/FPGA Design
• VLSI Architecture for Intelligent Computing

Students may become involved in relatively fundamental investigations (such as atmospheric effects on laser beams, and semiconductor materials characterization and processing) or in advanced engineering applications (such as video display technology or signal/image processing). In all cases, the emphasis is on scientific and engineering investigations having well-defined goals and real utility in an atmosphere resembling that of a working research and development laboratory. The academic program, while rigorous, is innovative and individually planned to meet each student’s needs. The limited number of students in residence assures close attention to each student and progress at a rate determined by the student’s ability and effort.

DEPARTMENT SEMINARS

The department and other local educational and corporate organizations host invited talks and seminars on topics of interest in the field of electrical engineering. M.S. students are required to obtain at least three credits of seminar to graduate. Seminar schedules are posted each quarter. Additionally, the ECE Department in conjunction with Portland State University’s Department of Electrical and Computer Engineering sponsor the Portland Area Semiconductor Seminar Series (PASSS). These seminars offer an opportunity to meet leading local and nationally recognized EE professionals and learn about the latest technical advancements in the high-technology industry.

ADMISSIONS REQUIREMENTS

Admission requirements are the same as the general requirements of the institution. The GRE is not required for the part-time program or the twelve-month M.S. program. It is recommended for M.S. students who may want to apply for the Ph.D. at a later date. The GRE is required for all applicants to the Ph.D. program. The TOEFL is required of all international student applicants for both the M.S. and Ph.D. programs.

Prerequisite: B.S. or M.S. in physics, applied physics, engineering physics, electrical engineering, or equivalent. Since modern electrical engineering programs are broad and diverse, students with undergraduate degrees in applied mathematics as well as other branches of engineering are encouraged to apply.

OGI offers the Ph.D. in Electrical Engineering. Students must have a Master of Science degree acceptable to the ECE Department to be considered for the Ph.D. program. The M.S. degree may be from OGI or another institution of higher education.

DEGREE REQUIREMENTS

MASTER OF SCIENCE (M.S.) PROGRAM

The M.S. program in Electrical Engineering is designed to enable professionals or recent graduates to adapt quickly to the changing needs of their fields. ECE’s M.S. program offers three degree options for full-time and part-time students. The M.S. degree requires successful completion of 48 credits and may be obtained with a non-thesis option, a non-thesis project option, or a thesis option. All courses, non-thesis research, and thesis research must be taken for graded credit to be counted towards the ECE M.S. degree. Courses taken outside of the ECE Department must also be taken for graded credit; Pass/No Pass is not acceptable. A minimum grade point average of 3.0 must be maintained throughout the degree program. Students’ course of study should be reviewed and approved by a faculty advisor. Students are limited to 12 credits per quarter unless a waiver is obtained from their advisor.

NON-THESIS OPTION

The non-thesis option requires completion of a minimum of 48 credits of graded course work. While students are strongly encouraged to focus on courses in ECE, students may take up to 24 credits of course work in other OGI academic departments provided the courses fall within the curriculum standards set by the ECE Department. For students seeking an M.S. degree in Electrical Engineering, a minimum of 24 credits must be taken from the OGI’s ECE department curriculum. All courses, regardless of OGI department, must be taken for graded credit.

NON-THESIS PROJECT OPTION

The non-thesis project option requires completion of a minimum of 48 graded credits, comprising 40 credits of course work and a minimum of 8 credits of research (ECE610). The research project is more limited in scope than a thesis and may include experimental work, a critical literature review, or a specific contribution to a larger project. Completion of the non-thesis project requires the submission of a written report to satisfy the research grade requirements. The student is encouraged to work with a faculty advisor in formulating an appropriate project.

THESIS OPTION

The M.S. thesis option requires successful completion of a minimum of 32 credits of graded course work and a minimum of 16 credits of graded research (ECE700). The thesis is an original independent work resulting in publication. The student will work with a faculty member to select courses and design an appropriate thesis research program. A thesis committee is assigned to guide and advise the research program. Completion of the M.S. thesis requires the submission of the written thesis and a successful oral defense. Thesis research credits earned towards an M.S. degree must be graded.

SUMMER PROJECTS

Although not required, students should seriously consider taking at least one project course for the M.S. degree. Because most faculty use the summer to do research, it is an ideal time to do a project. In addition, there are often summer internships available at local companies, which also qualify. The department is not required to provide projects for students, but usually there are many opportunities. Projects can involve real implementation and often are done in a team setting, which makes them an ideal preparation for a career in engineering. Projects are done as Special Topics courses, ECE 580, and they are graded. The specifics of a project are the responsibility of the sponsoring faculty member. Industrial adjunct faculty may also advise projects.

TRANSFER CREDITS

Up to 12 credits from accredited institutions may be transferred to OGI. Students may petition for transfer of up to 18 credits from the following institutions: Portland State University, Oregon State University, and University of Oregon. Students petitioning for acceptance of transfer credits should provide...
ECE CURRICULUM FOCUS AREAS

Students can elect to focus exclusively within one area of specialization or may combine two or more of these focus areas into a broader course of study.

- Biomedical Engineering
- Communications & Networking
- Computer Engineering & Design
- Materials, Semiconductors & Devices
- Signal Processing, Speech & Imaging

Students should refer to the ECE Department’s 12-month Curriculum Plan for the scheduled offering of courses in the 2001/2002 academic year.

BIOMEDICAL ENGINEERING

Biomedical engineering is a rapidly developing broad field of study comprising basic biology and medicine, bioinformatics, biomedical signal processing, imaging, biomaterials, information technology and many other areas. Within the biomedical engineering program, the ECE Department, in conjunction with other departments in the OGI School of Science and Engineering as well as departments at the OHSU Schools of Medicine, Dentistry, and Nursing, offers students a variety of opportunities to acquire breadth and depth of knowledge and expertise in this field. The research efforts are expanding to cover an increasing number of areas, including biomedical sensors and instrumentation, biomechanics (including laser-tissue interaction and tissue engineering), intelligent biomedical signal processing and analysis, computational neuroscience, biomedical image analysis, data mining, and technology in healthcare delivery. Current research topics also include intelligent rehabilitation and assistive technologies for future healthcare delivery in smart homes (home health) using wearable sensors and networked devices, exploiting intelligent data fusion and incorporating the latest results in functional genomics.

Because of the diversity of the field, each student is encouraged to devise a program tailored to his or her specific career objectives. The available courses include introductory courses in biology and medicine, biomedical sensors and instrumentation, laser-tissue interactions, biomaterials, biomechanics, neuroscience, molecular engineering, audio and video processing by humans and machines, biomedical signal processing, biological pattern recognition and datamining, bioinformatics, and medical informatics. To be prepared for the challenge, students are expected to take, in addition to specific biomedical engineering courses, a number of basic engineering courses in statistical signal analysis and recognition, digital signal processing, image processing, pattern recognition, databases, and information retrieval.
ECE | ELECTRICAL AND COMPUTER ENGINEERING

PHY611 Physiology - Nervous and Cardiovascular Systems
PHY612 Physiology Respiratory, Renal, and Alimentary Systems
PHY615 Physiological Instrumentation and Techniques
PHY607 Seminar: Biophysical Physiology
PHY617 Advanced Cardiovascular Physiology
MED791 Electrocardiology
NEU792 Experimental Neurology
PTH610 General Pathology

* May be offered in alternating years, beginning FY03

COMMUNICATIONS AND NETWORKING
Job opportunities in communications and computer networking are exploding. This field is enjoying a renaissance due to the rapid progress of optical fiber technology and digital signal processing techniques, and the need to move larger and larger amounts of information on a global basis.

ECE525 Analytical Techniques in Statistical Signal Processing & Communications
ECE526 Analog and Digital Communication Systems
ECE540 Auditory and Visual Processing by Human and Machine
ECE541 Speech Processing
ECE542 Introduction to Image Processing
ECE543 Introduction to Digital Video Processing
ECE544 Introduction to Signals, Systems and Information Processing
ECE550 Linear Systems
ECE551 Introduction to Digital Signal Processing
ECE552 Digital Signal Processing II
ECE554 Adaptive Signal Processing
ECE557 Computer-Aided Analysis of Circuits (alternating years, FY03)
ECE580-DCC Design of Digital Communication Circuits
ECE580-CN Introduction to Computer Networks
ECE580-DCS Digital Fiber-Optic Communication Systems
ECE580-IE Internet Engineering
ECE580-IVC Information Visualization and Computer Graphics
ECE580 Wireless Communications Systems - WCSI
ECE580-MC Multimedia Communications
ECE580-SSY Speech Synthesis

* May be offered in alternating years, beginning FY03

COMPUTER ENGINEERING AND DESIGN
Computer engineering is a hybrid program utilizing electrical engineering and computer science courses. It involves the engineering aspects of hardware, including logic design, integrated circuit design, and computer architecture.

ECE500 Introduction to Electronics and Instrumentation
ECE551 Introduction to Digital Signal Processing
ECE557 Computer-Aided Analysis of Circuits (alternating years-FY03)
ECE558 High Speed Interconnect Design
ECE559 Design with Programmable Logic
ECE571 Analog Integrated Circuit Design
ECE572 Digital Integrated Circuit Design
ECE573 Introduction to Computer Logic Design
ECE574 CMOS Digital VLSI Design I
ECE575 CMOS Digital VLSI Design II
ECE580 Introduction to Computer Organization and Design
ECE580-ACD Special Topics in Analog IC Design
ECE580-AIC Analog CMOS IC Design
ECE580 COD and Design
ECE580-ACD Special Topics in Analog IC Design
ECE580-ACD Special Topics in Analog IC Design
ECE580-MEM Microelectromechanical Systems (MEMS)
ECE580-TP Technology of Photoresists
ECE580-COP Copper Plating
ECE580 Microelectromechanical Systems (MEMS) - MEM
ECE580-CDR Reliability and Failure of Device Packaging
ECE580-CCM Capstone Course: MEMS & Microsensors Project
ECE580-MTF Mechanics and Thin Films

* May be offered in alternating years, beginning FY03

SIGNAL PROCESSING, SPEECH & IMAGING
With rapid advances in technology, we are experiencing a paradigm shift toward information-intensive systems for sophisticated multimedia telecommunication and human-machine interaction. This master-level program represents a unique combination of traditional engineering signal processing with human information processing that prepares students for the information-intensive society of the coming century. Multimodal communication is an emerging area that comprises multiple disciplines extending from human factors and algorithm development to network protocols and designing electronic devices. Existing and future multimedia applications combine audio and video (and other possible modalities) to extend the capabilities of a human operator. Students benefit from exposure to real problems through partnerships with industry and government.

ECE500 Analytical Techniques in Statistical Signal Processing & Communications
ECE540 Auditory and Visual Processing by Human and Machine
ECE541 Speech Processing
ECE542 Introduction to Image Processing

* May be offered in alternating years, beginning FY03
ECE500 Introduction to Electronics and Instrumentation
Review of fundamental electronics components and design: passive components, transistor circuits, op amps, RF circuits, frequency domain, and time domain response. Feedback theory, op amp limitations, precision op amp circuits. Noise, interference, grounding, and shielding. Phase-locked loops, lock-in amplifiers. Practical advice on component selection and circuit design. Equipment and circuit demonstrations in class. Homework includes Pspice circuit simulation problems. 4 credits

ECE507 Introduction to Electromagnetics for Modern Applications
This series (ECE507-509) cover essentials of electromagnetic theory for modern practitioners in such areas of engineering and applied science as semiconductor devices; IC design; optics, lasers, and optoelectronics; wireless and optical communications; electronic displays; electron and ion beam technology; vacuum electronic devices; and various biomedical applications. The course is practically oriented, and presents both analytical and numerical methods. The first course introduces basic experimental laws and theoretical concepts. Laplace and Poisson equations for static electric and magnetic potentials. Basic properties of electromagnetic materials. Maxwell equations for static and time-varying fields. Wave equations and Poynting theorem. Finite-difference numerical solution of boundary-value problems. Prerequisite: Some undergraduate electromagnetism, calculus through ordinary and partial differential equations, some vector calculus, or consent of instructor. 4 credits

ECE508 Electromagnetics for Modern Applications II
This course introduces additional mathematical tools and covers topics basic to circuit design, semiconductor device operation, IC design, optics, transmission lines, and antenna design. Covered are waves in conductors and skin effect. Retarded potentials for time-varying fields. Electromagnetics of lumped-element circuit theory. Plane wave propagation, reflection, and refraction. Polarization states and Stokes parameters. Analytical methods for boundary-value problems and numerical solution by boundary-element method. Introductory (TEM) field theory of transmission lines, and its relation to circuit model. Prerequisite: ECE507 and some linear algebra or consent of instructor. 4 credits

ECE509 Electromagnetics for Modern Applications III
This course covers advanced transmission line and waveguide field theory for high speed interconnects, microwave and optical waveguides; resonant cavities for frequency control and lasers; and radiation basics for communications and optics. Topics include TE and TM transmission-line and waveguide modes. Field theory of multiple-conductor transmission lines: Modes, coupling, crosstalk, and termination. Dielectric waveguides. Resonant cavities. Radiation from antennas and apertures. Additional topics as time permits, chosen from: electromagnetic properties of materials; variational formulation of field problems and finite element numerical solution; analytical and numerical calculation of charged-particle motion in electromagnetic fields; suggestions of students. Prerequisite: ECE508 and some linear algebra or consent of instructor. 4 credits

ECE510 Introduction to Quantum Mechanics for Electrical and Computer Engineers
Courses ECE510-511 present basic quantum theory for understanding practical applications such as solid state devices, lasers and other optoelectronic devices, properties of electronic materials, band-gap engineering, quantum effects due to shrinking IC feature sizes, quantum-dot and quantum-well devices, and quantum computing. The first course introduces basic concepts and results essential to understanding solid-state band structure, devices based on tunneling, and quantum-well device operation. Topics include a review of classical mechanics. The Schroedinger equation, postulates of Quantum Mechanics, and basic Hilbert-Dirac formalism. The free particle. One-dimensional quantum-well bound states and tunneling through potential barriers. Bloch functions in periodic potentials and the origin of solid-state band structure. Prerequisite: Calculus through ordinary and partial differential equations, or consent of instructor. 4 credits

ECE511 Advanced Quantum Mechanics for Electrical and Computer Engineers
This course covers two- and three-dimensional applications, and introduces new physical phenomena, mathematical formulations, and tools essential for understanding materials science, lasers, solid state devices, quantum optics, and quantum computing. Covered are two- and three-dimensional quantum wells. The simple harmonic oscillator and algebraic methods. Angular momentum and spin. Matrix formulation of Quantum Mechanics. Atomic structure. Approximation methods, including perturbation theory. Interaction of matter and electromagnetic waves. Prerequisite: ECE510 plus some linear algebra, or consent of instructor. 4 credits

ECE521 Operation of Semiconductor Devices: Diodes and Bipolar Transistors.
Short review of semiconductor basics; metal-semiconductor contacts and Schottky diodes; pn junction diodes: Depletion approximation, capacitance/voltage behavior and current/voltage characteristics, role of minority carrier diffusion and storage, ideal and nonideal behavior; Shockley-Hall-Read recombination. Fundamentals of bipolar transistors: Ideal Shockley model, current gain, low- and high-level injection effects, transit-time concepts. Ebers-Moll and Gummel-Poon models. Device parameter extraction for SPICE models. 4 credits

ECE531 Operation of Semiconductor Devices: MOS Transistors.
Fundamentals: Contact potentials and semiconductor surfaces, analysis of the MOS capacitor, the role of oxide charge. MOSFET modeling, one-dimensional approaches based on depletion and charge sheet approximations: Threshold voltage and body effect, sub-threshold behavior based on concepts of weak, moderate, and strong inversion; ion implanted channels; short and narrow channel effects, such as channel length modulation, velocity saturation, effective threshold variations, series resistance effects, breakdown and punch-through; device parameter extraction for SPICE models, device scaling. 4 credits

ECE541 MOSFET modeling for VLSI circuit design
A comprehensive study of compact models used in circuit simulators for VLSI design. Topics covered include modeling of small geometry effects, high speed and frequency (non-quasistatic) models, quantum effects, substrate and gate current models for reliability simulation and device scaling issues. In-depth study of parameter extraction, optimization and device characterization techniques required for developing compact models. Development of statistical, mismatch and noise models for analog circuit design. Review of state of the art models used in industry. Implementation algorithms for MOSFET models in circuit simulators. 4 credits

ECE551 Introduction to Semiconductors
The fundamental properties and concepts needed to understand semiconductors are introduced in this course. We begin with semiconductor crystals, their structure and bonding, and thermal properties. We then examine electron interactions in semiconductor crystals. The physics behind the energy bandgap in semiconductors is examined, and used to ultimately derive the energy band structure, effective mass, and equilibrium carrier statistics. Next, we use these statistics to define carrier transport in semiconducting materials. Finally, we study and understand the dielectric and optical response of semiconductors. This course is recommended if you have never taken a semiconductor device course (or if you need a refresher). The materials covered will provide you with background for other semiconductor device, processing, and characterization courses offered at OGI. Although not required, you will achieve a more advanced understanding of the concepts discussed in this class if you have taken quantum mechanics. 4 credits
ECE516 Fundamental Semiconductor Device Structures
Semiconductor bulk, junction and surface properties. We develop the fundamentals of semiconductor structures; bulk defects; mechanisms affecting electron/hole transport at low and high electric fields; junction formation/stability (p-n, metal-semiconductor, and metal-insulator); and relationships between semiconductor properties and device performance. The underlying concepts of minority carrier and majority carrier devices are expounded and clarified.

4 credits

ECE517 Advanced Semiconductor Devices: Structures and Materials
The complex interplay between materials properties, fabrication technologies, and device performance will be examined in the context of elucidating such current technology developments as silicon on insulator (SOI), high-K dielectrics, SiGe heterojunctions, heterojunction bipolar transistors (HBT), pseudomorphic high electron mobility transistors (PHEMT), Vertical Cavity Surface Emitting Lasers (VCSEL), quantum dots, single electron transistors, and organic semiconductors. 4 credits

ECE520 Transmission-Line Theory
Maxwell's equations; Field analysis of transmission-lines; Circuit analysis of transmission-lines (telegrapher's equations, equivalent circuit models); Microstrip, Stripline; Signal integrity (transient response, impedance mismatch, reflections, bounce diagrams); Skin effect; Dispersion; Discontinuities (bends, via's); Multi-conductor transmission-lines in multi-layered dielectric systems ([L] and [C] matrices). Numerical analysis of multi-conductor transmission-line networks (method of moments technique); Crossstalk. 4 credits

ECE521 Microwave Engineering Concepts
Traveling waves and transmission-line concepts; Time harmonic transmission-line equations; Smith chart (construction and applications); Impedance matching networks; Impedance transformation; Matrix representation of multi-port transmission-line networks ([S], [Z], [Y], and chain matrices); [S] parameters properties; Matrix conversions ([Z] to [S] and vice-versa); Numerical analysis of transmission-line discontinuities at microwave engineering frequencies (Finite Difference Time Domain, FDTD technique). 4 credits

ECE525 Analytical Techniques in Statistical Signal Processing and Communications
Development of the mathematical techniques needed to analyze systems involving random variables and/or stochastic processes with particular application to communications and instrumention. Topics include Bayes Theorem (discrete and continuous forms), Tchebycheff inequility, Chernoff Bound, Central Limit Theorem, stationary processes and linear systems, mean square estimation, Poisson process, Gaussian process, Markoff process, and series representations. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE526 Analog and Binary Digital Communications Systems
Mathematical descriptions of signals and noise, bandwidth requirements, sampling theorem, inter-symbol interference, digital multiplexing, line encoding, pulse code modulation, quantizing, quantization and noise error in PCM, bandpass random processes, quadrature representation, Wiener-Hopf filter, amplitude modulation systems (AM, DSB, SSB, VSB), angle modulated systems (PM, FM) pre-emphasis/de-emphasis. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE527 M-ary Communication Systems, Information Theory, and Coding
Often times in communication systems, the bandwidth available for the system is fixed. This constrains the communication rate to a maximum of twice the bandwidth if a binary digital system is used. However, in many modern systems such as wireless communications and computer communications, communication rates in excess of twice the bandwidth are needed. This problem has been solved by using M-ary communication systems where the number of states is more than just two. Using M-ary communication in conjunction with long sequences for communication efficiency and coding for error correction allows for modern communication systems that meet the requirements of such systems. This course covers topics that relate to modern communication systems, including Optimum threshold detection, geometrical representation of signals, optimum M-ary Communication (MASK, MPSK, MFSK) systems, Gram-Schmidt orthogonalization procedure, measure of information, source encoding, channel capacity, error-correcting codes (linear block, cyclic, burst-error detecting and correcting, interlaced, convolutional), Viterbi's Algorithm. MATLAB and the MATLAB Statistics Tool Box are used in this course. 4 credits

ECE529 Fiber Optics
An introductory course in fiber optics aimed at scientists and engineers from widely varying backgrounds. Topics include light propagation in dielectric media, attenuation in optical fibers, step- and index-graded fibers, photon generation and detection devices used in fiber optics, and integration of fiber optics with the photon devices. 4 credits

ECE532 Biomedical Optics I: Tissue Optics
Light propagation in tissue: This course treats light transport in scattering and absorbing media such as biological tissue. Light transport is modeled using a variety of theories and computational techniques, including Monte Carlo simulations and approximate solutions of the radiative transport equation. Steady-state and time-dependent problems are treated. Spectroscopy and fluorescence measurements are introduced. Optical imaging techniques are presented. Students learn the basics required for design of optical devices for therapy and diagnostics. 4 credits

Course offered every other year; next session, Fall 2002/03

ECE533 Biomedical Optics II: Laser-Tissue Interactions
Physics of laser-tissue interactions: The course treats the immediate physical processes that accompany the absorption of light by biological tissues, including photochemical reactions, heating and tissue coagulation, vaporization, creation of plasmas, and production of stress waves in tissue. Such processes are modeled using finite-difference techniques. Applications in medicine and biology are discussed. Prerequisites: ECE 532 or permission of instructor. 4 credits

Course offered every other year; next session, Winter 2002/03

ECE534 Biomedical Optics III: Engineering Design
The students work as a team in preparing five business plans throughout the quarter. Each business plan is devoted to a potential medical device or protocol using optical technologies. The team is divided into a CEO, scientific officer, marketing manager, regulatory affairs manager, and manufacturing manager. The roles are rotated amongst the students for each business plan. Feasibility studies are conducted in a laboratory exercise designed by the students. The team formally presents a business plan every two weeks. Prerequisites: ECE 532 and ECE 533, or permission of instructor. 4 credits

Course offered every other year; next session, Spring 2002/03

ECE535 Thin Film Deposition and Applications in Semiconductor Fabrication
Covers thin film deposition topics, such as thermal evaporation, plasma deposition, chemical vapor deposition (CVD and MOCVD), molecular beam epitaxy (MBE), atomic layer epitaxy (ALE), electrochemical deposition, and electrodeposition. Thin film deposition forms the basis for manufacture of modern integrated circuits; a knowledge of methods available for thin film deposition is essential for IC process engineers. Course is designed to cover the theory and applications of main deposition techniques in use or being considered for future IC fabrication processes. 4 credits

ECE536 Surface Science for Semiconductor Technology
The study of gas-solid surface science with emphasis on understanding semiconductor systems and the mechanisms of epitaxial growth of semiconductor films by molecular beam epitaxy (MBE), metal-organic molecular beam epitaxy (MOMBE), atomic layer epitaxy (ALE), etc. The study of thermal desorption, surface diffusion. Surface electronic properties such as work function. Physical absorption, the growth of multilayer films and the application of this phenomena to the study of the BET equation as a tool for the determination of surface area. 4 credits

ECE537 Characterization of Thin Films for Semiconductor Technology
An introduction to the techniques of surface analysis, such as Auger analysis, X-ray photoelectron spectroscopy, energy dispersive X-ray analysis, X-ray wavelength dispersive spectroscopy, secondary ion mass spectroscopy, Rutherford Back scattering Spectroscopy, together with their interpretations. Particular emphasis on semiconductor technology applications. 4 credits

ECE540 Auditory and Visual Processing by Human and Machine
Interaction between humans and machines could be greatly enhanced by machines that could communicate using human sensory signals such as speech and gestures. Knowledge of human information processing including audition, vision, and their combination is, therefore, critical in the design of
effective human-machine interfaces. The course introduces selected phenomena in auditory and visual perception, and motor control. Students learn how to interpret empirical data, how to incorporate these data in models, and how to apply these models to engineering problems. The anthropomorphic (human-like) signal processing approach is illustrated on engineering models of perceptual phenomena.

ECE541 Speech Processing
Speech is one of the most important means of communication. This course teaches theory of human speech production, properties of speech signal and techniques for its processing in speech coding, and automatic speech and speaker recognition. Emphasis is on active research in auditory modeling that exploits special properties of speech to improve performance of speech technology in practical applications. Prerequisites: ECE 540, ECE 551, or consent of instructor.

ECE542 Introduction to Image Processing
Course covers basic image processing principles and techniques with a brief introduction to machine vision. Students acquire theoretical and working knowledge of image processing approaches including image representation, transform methods, image filtering, multi-resolution representation, edge detection, texture characterization, and motion analysis. Course demonstrates application of these methods to image enhancement, image restoration, and image compression, with emphasis on image quality metrics based on human visual perception. Selected areas in machine vision include image segmentation, elementary techniques in pattern recognition, and object representation. Application of these techniques is illustrated in numerous examples. Prerequisite: ECE 551.

ECE543 Introduction to Digital Video Processing
Course provides introduction to digital video processing for multimedia systems. The course first introduces video capture, image formation, analog and digital video signal and standards, and spatiotemporal sampling. Subsequent topics include motion estimation, segmentation and tracking, video filtering, and video standards conversion. Students are familiarized with video compression techniques and standards (JPEG, MPEG2, H.261, H.263), and model-based video quality estimation. Students gain working knowledge of these video techniques through class projects. Familiarity with digital signal processing and transform methods is desirable.

ECE544 Introduction to Signals, Systems and Information Processing
This course provides the essential mathematical tools and analytical techniques needed for the analysis of continuous-time and discrete-time systems. Basic signal and system characteristics — linearity, time-invariance, convolution and correlation — are first examined from the time domain perspective. We then proceed to study a family of Transforms - Fourier Series, Fourier Integral Transform, Laplace Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) and z-Transform — which take the study of these systems to a deeper level and introduce a host of useful properties which the time perspective alone does not reveal. Basic applications taken from the areas of information processing, communication and control will serve to fill out the mathematically derived results.

A greater portion of the syllabus in ECE 544 is allotted to continuous time signals/systems than to discrete time signals/systems, for reason that the latter are taken up in detail in other information processing courses, particularly ECE 551. A goal of the presentation in ECE 544 is to impart the essential unity of all the Transforms and the almost perfect correspondence of approach in continuous-time and discrete-time contexts. You then become a well equipped practitioner who knows the way around the entire territory. This course is a useful prerequisite or co-requisite to ECE 551 and all other courses in the information processing area.

ECE545 Speech Systems
Speech is one of the most natural means for communication and carries information from many sources. The explosive growth of communications and computer technologies puts new demands on techniques for machine extraction of information content of speech signals, for its storage or transmission, and for reconstruction of the speech signal from its parametric representation. Course covers techniques for processing of speech signal used for speech coding and synthesis, enhancement of degraded speech, speech recognition, speaker recognition, and language identification.

ECE547 Signals for Multimedia Engineering
The course discusses concept of signal as a carrier of information, basic principles of signal analysis in engineering, and fundamentals of human auditory and visual perception. It is intended for those who have a good undergraduate-level of basic knowledge in mathematics and physics but who need an introduction to or refreshing of fundamental concepts of signals, systems, and human information processing, necessary for further mastering specialized multi-media topics in speech and image processing, classification, and transmission.

ECE550 Linear Systems
This course introduces the State Variable representation of linear dynamical systems and studies a large body of State Space techniques to reveal both inner structure and external behavior of the systems modeled in this way. A general framework for treating time-varying linear systems is developed and utilized. Major emphasis is placed, however, on the time-invariant systems, whose structure and dynamics are investigable and knowable to the very utmost detail. Both continuous-time and discrete-time linear systems are explicitly studied. The course provides a strong body of foundational material, which is utilized either explicitly or implicitly in virtually all applications-specific areas pertaining to system analysis/design and signal/information processing. The major topics covered are: canonical realizations, equivalent systems, canonical transformations, canonical decompositions, solution of state equations, stability, controllability and observability, design of asymptotic observers, state-feedback compensation schemes. Linear Quadratic Regulator and Kalman Filter are also introduced. The Linear Algebra material required for this study — matrices as linear operators, solutions of sets of linear equations, eigenvalues and eigenvectors, eigenstructure factorizations and spectral decompositions — will be presented and developed concurrently, as needed. The relevant Differential Equations material will also be concurrently reviewed.

ECE 551 Introduction to Digital Signal Processing
The representation and processing of signals and systems in the discrete or digital domain is the preferred mode in today’s computer and information driven technologies. DSP provides the core building block from cell phones to modems, HDTV to video conferencing, or from speech recognition to MP3 audio. This class covers the fundamental concepts (introduction to optimal control). The course covers analysis and design of discrete time signals and systems, Z-Transforms, Discrete-Time Fourier Transform (DTFT), and the Discrete Fourier Transform (DFT), sampling and windowing techniques pertaining to discrete time processing of continuous signals, analysis and design of recursive (IIR) and nonrecursive (FIR) digital filters, signal flow graph realizations of finite word-length implemented discrete-time linear systems, and applications of the Fast Fourier Transform (FFT) to convolution, spectral analysis, and audio processing.

ECE552 Digital Signal Processing II
This follow-up course to ECE 551 examines several widely used advanced signal processing. Topics include computational complexity considerations in DSP algorithm development, multirate signal processing, filterbanks and wavelets, and their application in audio and image processing (e.g. MPEG standards). Topic coverage is weighted toward the interests of the students enrolled.

ECE553 Control Systems: Classical, Neural, and Fuzzy
Applications of modern control systems range from advanced fighter aircraft to processors control in integrated circuit manufacturing, to fuzzy washing machines. The aim of this class is to integrate different trends in control theory. Background and perspective are provided through the study of basic classical techniques in feedback control (root locus, bode, etc.), as well as state-space approaches (linear quadratic regulators, Kalman estimators, and optimal control). The course covers recent movements at the forefront of control technology. Neural network control is presented with emphasis on nonlinear dynamics, back-propagation-through-time, model reference control, and reinforcement learning. The course also covers fuzzy logic and fuzzy systems as a simple heuristic-based, yet often effective, alter-native for many control problems. Prerequisite: ECE 551, ECE 554, or equivalent.

ECE 554 Adaptive Signal Processing
The field of adaptive filters and systems constitutes an important part of statistical signal processing. An adaptive system alters or adjusts its defining parameters in such a way that it improves perform-
ance through contact with the environment. Adaptive filters are currently applied in such diverse fields as communications, control, radar, seismology, and biomedical electronics. This course will cover the theory and applications of adaptive linear systems. Topics include Wiener filters, least squares, steepest descent, LMS, RLS, Newton’s method, FIR and IIR adaptive structures, and Kalman filters. Applications covered include noise canceling, signal enhancement, adaptive control, adaptive beam-forming, system identification, and adaptive equalization. The theory also lays the foundation for study in nonlinear signal processing with neural networks and will be introduced in the later half of the class. This course should be of interest to electrical and computer engineers specializing in signal processing and the information sciences. This course should also be taken as background for additional classes offered in artificial neural networks, connectionist models, and machine learning.

4 credits

ECE555 Engineering Optimization
Issues of Optimization appear in virtually every area of Engineering and Applied Research. Most practitioners tend merely to rely on “canned” routines when optimization needs to be performed. But successful Optimization entails both a lot of science and a lot of art — deep mathematical derivations and formal convergence proofs on the one hand, conventional engineering “folklore and experiential ”rules of thumb on the other. Through this course you will be able to choose intelligently among the very wide range of available optimization strategies, customize given algorithms, to your own specific applications, and even write your own routines entirely from scratch when this approach is needed or preferred. After reviewing some necessary mathematical fundamentals from Linear Algebra and Multivariable Calculus, including Lagrange Multipliers and Kuhn-Tucker conditions, the following topics will be covered. Unconstrained and Constrained nonlinear Multivariable Optimization, via direct-search and gradient-based methods, including: Pattern Search, Simplex Search, Conjugate Gradient, Variable Metric, Feasible Directions, Cutting Plane, Gradient Projection and Penalty Function methods. Algorithms for specially structured problems, such as: Linear Programming, Quadratic Programming, Integer Programming, Geometric Programming. Methods which utilize random heuristics, including: Genetic Algorithm, Dynamic Evolution and Simulated Annealing. Time permitting, an introduction to Dynamic Programming and the Optimal Control problem will also be included. 4 credits

ECE556 Principles of Electronic Packaging
This course introduces the principles and tradeoffs involved in the design of electronic packaging for integrated circuits. Topics include packaging architecture, electrical design concepts in electronic packaging design, thermal management, mechanic design, electrical contacts, reliability and testing, material selection and fabrication, plated through hole technology, etching by wet processes, joining materials, stress issues, diffusion problems, chemical and physical methods of analysis, and trends in electronic packaging. 4 credits

ECE557 Computer-Aided Analysis of Circuits
Course covers the algorithms and techniques for formulation and solution of circuit equations for large-scale VLSI circuits. Topics include Equation formulation, linear AC and DC networks, linear transient networks, and stability analysis. Solution of nonlinear DC and transient problems. Frequency domain (AWE) techniques for VLSI interconnections, Sensitivity analysis, harmonic balance, circuit optimization, and statistical design. The implementation of device models in circuit simulators and convergence issues is covered. Assignments stress computer-aided implementation techniques and use of simulators such as PSPICE. 4 credits

ECE558 High Speed Interconnect Design
Electrical analysis, design, and validation of interconnect for digital buses operating at speeds greater than 1 GHz. Key topics include: transmission line analysis and tools, digital signals and timing analysis, measurement equipment and techniques, crosstalk, and coupled transmission lines, advanced signaling techniques, design tools and methodology. A design project is used to give students practical insight into high-speed bus design problems. 4 credits

ECE559 Design with Programmable Logic
Programmable logic, such as FPGA and PLD devices, has become a major component of digital design. This course will discuss design tools and techniques for creating logic designs using programmable logic. A design is first created in Verilog, a high-level Register Transfer Level (RTL) language, and simulated. Synthesis to a programmable logic device is then performed. In addition, common problems of poor routing and placement are discussed while presenting the student with a comprehensive understanding of the operation of synthesis tools. The course has a strong project orientation. Students will take several designs from concept to RTL verification and synthesis, then to programmable device implementation. A commercial set of software tools will be used. PREREQUISITES: ECE533 Intro to Computer Logic Design or consent of instructor. 4 credits

ECE560 Microelectronic Device Fabrication I
This course is the first in a full year, three term sequence that treats both the science and practice of modern microelectronic fabrication. The principles of crystal growth and wafer preparation, ion implantation, doping and diffusion, and oxidation are all covered. Emphasis is placed on understanding the basic chemistry, physics, and material science of wafer processing. This includes crystal structure and defects, heterogeneous chemical reactions, the thermodynamics and kinetics of diffusion, etc. In addition, the practical implementation of these processes is also discussed. This includes realistic process flows, physical metrology, device structure and electrical behavior, trade-offs, etc. The course is intended to serve a wide community including both working process engineers and matriculating graduate students. 4 credits

ECE561 Microelectronic Device Fabrication II
In the second class of this series emphasis is on metallization and dielectrics. Metallization issues examined include silicides, barrier layers, interconnects (e.g., Cu), multilevel metallization, and low k dielectrics. This followed by discussion of deposition and properties of different dielectric films. Finally, processing issues of epitaxial growth and properties of SOI devices are covered. Class assignments include computer simulation of device fabrication. 4 credits

ECE562 Microelectronic Device Fabrication III
This class starts with electron beam, x-ray, and photolithography, including discussion of resist technology (e.g., chemically amplified resists). This followed by fundamentals and applications of plasmas for etching and deposition (e.g., high density plasmas), including plasma damage. Other topics considered are process integration that includes several devices such as BiCMOS and memories. Finally yield and reliability statistics as related to microelectronic device fabrication is discussed. Class assignments include computer simulation of device fabrication and testing. 4 credits

ECE563 Plasma Processing of Semiconductors I
Fundamental plasma properties. Plasma production, properties, and characterization. DC and RF plasmas. Sputtering as a deposition process for the growth of thin films. Multicomponent films. Plasma etching. 4 credits

ECE564 Plasma Processing of Semiconductors II
This course, a continuation of ECE 563, covers specific applications of plasmas for processing semiconductor materials. Topics include etching and deposition and the dependence of these processes on plasma parameters. Materials based on both silicon and III-V technology are examined. 4 credits

ECE565 Analytical Scanning Electron Microscopy
This course introduces the operation and theory of SEM and covers sources, lenses, accelerating voltage, detectors, image formation, beam-specimen interactions, beam-produced signals, the combined effects of signal-to-noise ratio and spot size in determining resolution, and stereo imaging SEM. The process of specimen preparation, metallographic grinding and focused ion beam-produced transverse cross sections, planar sections, coating techniques for nonconductors, sampling of powders, and isolation of contaminants are some of the topics covered. Students are encouraged to work on materials they provide. This course covers the operation and performance of X-ray detectors, qualitative analysis, quantitative analysis, elemental mapping, spectrum artifacts, and contaminant and compound identification. The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade. 4 credits

ECE566 Focused Ion Beam Technology
This course covers operation and theory of a FIB workstation, including ion sources, accelerating voltage, electrostatic lenses, beam-material interactions, resolution, beam intensity distribution, beam produced signals, detectors, metal and oxide deposition, and enhanced etch. FIB-produced site-
specific SEM transverse cross sections, the location and sectioning of micron and sub-micron scale structures on the surface and buried in multilayered stacks or bulk materials, cross sections in metals, semiconductors, ceramics, and composites are covered. The location and sectioning of micron and submicron surface and buried structures to create electron transparent foils with little or no damage in metals, semiconductors, ceramics, and composites, and artifacts of specimen preparation are presented. Ion beam lithography and microfabrication of structures on the micron and sub-micron scales are also covered. This course uses a combination of lectures and hands-on practice to cover these topics. The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the FIB at the students convenience during the remainder of the quarter and a written report is the basis for a grade.

4 credits

ECE567 Transmission Electron Microscopy

Electron microscopy is a continually evolving discipline, which, has developed a wide range of techniques to solve specific problems. This course is designed to help the student develop a broad appreciation and knowledge of the important techniques for the analysis of crystalline and amorphous materials. Modern transmission electron microscopes can give the investigator detailed information of crystal structure, crystal defects and quantitative local chemistries on a nanometer scale. This information is often critical to the understanding of material properties. Principles, methods and application of transmission electron microscopy to crystalline materials. The construction and design of electron microscopes, electron diffraction, reciprocal-lattice and Ewald sphere construction will be covered. Kinematic and dynamic theories of image formation will be introduced. Combining lectures with hands-on laboratory practice, students will be instructed in the use of sample preparation equipment and an analytical transmission electron microscope. Students will be expected to carry out basic experiments on selected materials which illustrate fundamental concepts covered in the lecture. The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade.

4 credits

ECE568 Failure and Reliability in Microelectronics

The failure and reliability of microelectronics depends on the stability of thin films and the purity of the bulk semiconductors. Contamination, film thickness, diffusion and phase changes all drive mechanisms of failure. Characterization of a failed device depends on analysis of thin film structure, crystalline structures, contaminant identification and microchemistry. This requires a variety of microanalytical techniques involving the SEM, TEM, and FIB. This course covers the potential defects, failure mechanisms and the methodology used to analyze them. Case studies also are discussed. The lecture portion of this course can be presented on site at companies in a 6 week period. Corresponding lab sessions are done at OGI. A project requiring operation of the SEM at the students convenience during the remainder of the quarter and a written report is the basis for a grade.

4 credits

ECE569 Electronic Materials and Device Characterization

This class is designed for engineers and scientists who wish to understand the basic principles behind the electrical and optical techniques used to characterize semiconductor materials and devices. These techniques are crucial in determining the causes of failure in semiconductor devices. Among the parameters to be covered include contact resistance, carrier mobility and lifetime, defects, oxide and interface trapped charges, as well as series resistance, channel length/widith, threshold voltage and hot carriers in MOSFETs. This class will include some lab time.

4 credits

ECE570 Gallium Arsenide MESFET Integrated Circuit Design

Technology overview, device structures, SPICE models, limitations, regions of MESFET operation. Transconductance, output resistance, biasing. Single-stage, high-gain, and feedback amplifiers, current sources, compensation. Buffered FET logic, enhancement/depletion technology, data conversion, comparators, digital-to-analog converters. 4 credits

ECE571 Analog Integrated Circuit Design


4 credits

ECE572 Digital Integrated Circuit Design


4 credits

ECE573 Introduction to Computer Logic Design

This course constitutes a basic introduction to the design and implementation of computer logic. Basic principles of discrete logic will be presented, including Boolean algebra, finite-state machine theory, minimization, and optimization. Students will apply logic design theory to actual PLD (Programmable Logic Devices) and FPGAs (Field Programmable Gate Array) devices. In addition, students will learn the basics of the hardware design languages, Verilog and VHDL. This course or its equivalent is a prerequisite to all other ECE Electronics Design Automation courses.

4 credits

ECE574 CMOS Digital VLSI Design I

An introduction to CMOS digital IC design. Course covers basic MOS transistor theory; operation of basic CMOS inverter; noise margins; switch level modeling of MOS devices; capacitive characteristics of MOS devices; introduction to device fabrication, design rules and layout issues; power consumption, gate design/transistor sizing; pass transistors and complimentary pass transistor logic; dynamic domino and precharge/discharge circuits; memory element design (RAM/ROM/latch-flip-flops) and subsystem design (adders, multipliers, etc.). An understanding of basic digital design concepts is assumed. Lab exercises use industry standard design tools. Laboratories include circuit validation and characterization. Prerequisite: ECE 573.

4 credits

ECE575 CMOS Digital VLSI Design II

Concentration on advanced digital VLSI circuit design techniques. Architecture and micro-architecture of VLSI components, clocking schemes, input/output circuits, and special functional blocks such as random access memories, read only memories and programable logic arrays. The course covers design tradeoffs, especially considering cost, power and performance. The course devotes a considerable amount of time to layout, parasitics and performance verification. Introduction to design and verification tools with hands-on experience. Prerequisites: ECE 574, familiarity with MOS transistor operation; computer architecture and organization; logic design.

4 credits

ECE577 Principles for Technology Development and Introduction to Manufacturing

A project-oriented course on management procedures and key underlying concepts for effective manufacturing technology planning and development; an introduction to commercial production in a competitive environment. While emphasis is on semiconductor technology, most principles and methodology are generally applicable to both hardware and software technology management. Issues of technology strategic planning, process definition and characterization, decision making, technology transfer, product definition, yield and reliability improvement, and concurrent engineering are explored to identify effective management approaches to shorten time-to-volume production, reduce risk, and minimize engineering effort.

4 credits

ECE578 Embedded and Real Time Operating Systems

A study of concepts, techniques, and standards in embedded operating systems including real time embedded operating systems. Topics include kernel design, device driver and interface techniques, scheduling, robustness and industry standards such as Windows-CE and Tornado (VxWorks). This is a hands-on lab course where students will experience real-world real time embedded systems using commercial software tools. Prerequisites: CSE 521 Introduction to Computer Architecture or a demonstrable understanding of computer architecture.

4 credits

ECE579 Embedded Computer Systems

A study of concepts, techniques, and standards in embedded systems from design through deployment to retirement. Topics include programable logic, interfacing, power supply, packaging, robustness, certification, and maintenance. This is a hands-on lab course based on a student project, where students will experience real-world embedded systems using commercial software and hardware tools. Prerequisites: CSE581 Introduction to Computer
Architecture, ECE 578 Embedded and Real Time Operating Systems, or permission from instructor.

4 credits

ECE580-XXX Special Topics
Under this number, we offer courses of particular relevance to the research interests of faculty or in state-of-the-art subjects of interest to the community.

Individual course descriptions are listed as follows. Special Topic courses are subject to change and are offered intermittently. For Special Topics offered during the current term, please view www.ogi.edu/schedule.

ECE580-ACD Selected Topics in Analog IC Design
ECE580-ACS Advanced Control Systems: Nonlinear, Neural & Fuzzy
ECE580-AFA Applied Functional Analysis
ECE580-AIC Analog CMOS Integrated Circuit Design
ECE580-CLI Computational Approaches to Laser Interaction with Biological Tissues
ECE580-CLT Computational Approaches to Light Transport in Biological Tissues
ECE580-CMP Chemical Mechanical Planarization
ECE580-CN Introduction to Computer Networks
ECE580-COD Introduction to Computer Organization and Design
ECE580-CP The New Millennium in Copper Plating: Faster Chips with Slower Plating
ECE580-DDC Design of digital Communication Circuits
ECE580-FLC Fabrication Lab Class
ECE580-FSM Fundamentals of Sensors and MEMS Fabrication
ECE580-GAP Introduction to Genetic Algorithms and Programming
ECE580-IUB Introduction to Biomaterials (formerly MSE589)
ECE580-IE Internet Engineering
ECE580-ISM Introduction to Sensor Microfabrication
ECE580-IVC Information Visualization and Computer Graphics
ECE580-LCD Introduction to Liquid Crystal Displays
ECE580-MBD Introduction to Modeling of Business Dynamics
ECE580-MC Multimedia Communications
ECE580-MEM Microelectromechanical Systems
ECE580-MPE Modern Photolithographic Engineering
ECE580-MTF Mechanics and Thin Films
ECE580-ONE Optical Non-destructive Evaluation
ECE580-PREM Phase Equilibria in Microelectronics (offered Fall 2001)
ECE580-PGO Physical and Geometric Optics,
ECE580-QM Quantitative Microscopy
ECE580-RFD Reliability and Failure of Electronic Devices, Packages, and Assemblies
ECE580-SIM Soldering and Joining in Microelectronics
ECE580-SLD Statistical Learning and Data Mining
ECE580-SMW Simulation & Modeling of VLSI Interconnect
ECE580-SEM Semiconductor Sensors
ECE580-SSL Structure of Spoken Language
ECE580-SSY Speech Synthesis

ECE580-TP Technology of Photoresists
ECE580-WCS Wireless Communication Systems
ECE580-USD Understanding Operation of Semiconductor Devices

ECE580-XXX Special Topics

ECE580-XXX Independent Study
Student works with professor on selected topic(s). Requires pre-approval of professor, ECE Department, as well as formal agreement between student and professor outlining objectives and expectations of independent study topic. May only be taken once during a student’s graduate program at OGI for a maximum of 3 credits.

ECE580-XXX Prequalifying Ph.D. Research
Supervised research participation. Pre-qualifying Ph.D. research prior to passing ECE department qualifying examination.

Variable and repetitive credit.

ECE580-XXX M.S. Nonthesis Project Research
Supervised research for up to eight credits as a component of the nonthesis M.S. degree. Students are required to produce cogent research deliverable(s) including, but not limited to, a final report equivalent to an EE project paper. This research classification requires the approval of the department head and the student’s TPC.

Variable and repetitive credit.

ECE580-XXX Professional Internship
This course provides the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable industrial experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers.

U.S. citizens, permanent residents, students on F-1 visas enrolled in Curricular Practical Training take ECE620 and must obtain additional permission from OGI personnel department. Enrollment requires a faculty advisor and is limited by the number of internship opportunities available.

Variable and repetitive credit.

ECE580-XXX M.S. Thesis
Research toward the thesis for the M.S. degree.

Variable and repetitive credit.

ECE580-XXX Ph.D. Dissertation
Research toward the dissertation for the Ph.D. degree.

Variable and repetitive credit.

RESEARCH CENTERS
CENTER FOR BIOLOGICALLY INSPIRED INFORMATION ENGINEERING (CBIIE)
Science and engineering have achieved great advances in automating and creating information processing and analysis tools. Microelectronics, programming, signal processing and information theory underpin these achievements. Modern microprocessors and those that will be produced over the next decade will provide huge computational power, enabling new information processing applications. In fact, it will soon be possible to place one billion transistors on a single piece of silicon. Many information-processing applications involve huge amounts of real world data that have to be processed and analyzed for making decisions. The complexity of the analysis is often beyond current science and engineering’s techniques and methodologies. Yet, natural evolution has evolved very sophisticated information processing systems, and the information analysis performed by the human brain, or even by the brain of simple animals, is far superior to what current state-of-the-art human-developed techniques can achieve.

A new research area is now coalescing which is devoted to consolidating and refining existing solutions, and finding better solutions to these transformation problems. The term Intelligent Signal Processing (ISP) is being used to describe algorithms and techniques that involve the creation, efficient representation, and effective utilization of complex models of semantic and syntactic relationships. Even the most primitive biological systems perform complex ISP. In addition, biological computing is energy efficient, consists of networks of sparsely connected and sparsely activated nodes, and requires only moderate levels of computational precision.

We believe that the merging of neuroscience and semiconductor engineering is creating what Andy Grove, ex-CEO of Intel, refers to as a strategic inflection point. Therefore, the mission of the Center for Biologically Inspired Information Engineering is to harvest biology for solutions to real-world information engineering and Intelligent Signal Processing problems, and leverage the incredible functional density of GSI (Giga-Scale Integrated) Silicon. The Center was established in 2001 and currently consists of two professors - Dan Hammerstrom and Marwan Jabri - and their staff and graduate students. The Center currently receives funding from NASA, NSF, SRC, ONR, Intel and others.

Current projects focus on:
- Computational models of sensorimotor control;
- High-level visual feature extraction using unsupervised learning techniques;
- Top-down/bottom up sensory fusion and sensorimotor control;
- Simulation of large-scale networks on PC clusters;
- Mapping computational neurobiology to FPGAs and eventually custom silicon; and
- Understanding the issues involved in scaling neural models to very large configurations.

CENTER FOR INFORMATION TECHNOLOGY (CIT)
Digital signal processing has made a significant impact on human lives since its introduction several decades ago. The broad field of information technologies has become a vital driving force in the
The main research interests of our group are twofold. One thrust is image processing and image recognition. One of the techniques we are investigating is incorporating contextual information into recognition. Context incorporation is a mechanism with concurrent theoretical work, are contributing significantly to fundamental understanding of the effects of atmospheric turbulence on laser beam, speckle propagation and its application to optical remote sensing. 

**Biomedical Optics**

The program in Biomedical Optics prepares the student to use lasers and light to measure, image, modify and machine materials, with emphasis on biological materials but with broad application to a variety of materials. The program offers a series of courses and labs on tissue optics, laser-tissue interactions, and engineering design, with elective courses in optics, spectroscopy, optical fibers, biomechanics, imaging and image analysis, optical measurement techniques, and computational methods for simulating light transport through and interaction with biological materials. Students have the opportunity to work in the hospital based research laboratories at the Oregon Medical Laser Center at Providence St. Vincent Medical Center and the Biomedical Optics Laboratory on the OHSU Medical Center campus. 

**Electronic Materials**

An active research program in the area of electronic materials growth and characterization is focused on demands of the ever shrinking, microelectronic devices. The main materials growth technique investigated is atomic layer deposition which allows growth of highly conformal thin films, one atomic layer at a time. Materials investigated using this approach include thin gate dielectrics, including nanodiamantes and metallic films which include copper seed layers and barrier metals. Another area of research involves electrodeposition of copper films for microelectronic device interconnect applications. The focus of this investigation is to determine the correlation between the bath chemistry to the physical properties of the films and their electromigration lifetimes. 

**Flat Panel Displays**

The video screen is becoming an indispensable link between information processing electronics systems and human beings. Although the cathode ray tube (CRT) remains the dominant display technology, its size, weight, and power requirements become unsuitable for many applications. As a replacement for CRTs, several flat panel display technologies are being developed to serve compactness, light weight and low power consumption. A flat panel display research group has been established to develop research capabilities and to work closely with the emerging display companies to assist them in overcoming technological hurdles. At present, research is directed towards electroluminescent, field emission, and liquid crystal displays.

**Image Processing and Analysis**

The main research interests of our group are twofold. One thrust is image processing and image recognition. One of the techniques we are investigating is incorporating contextual information into recognition. Context incorporation is a mechanism...
that ensures accurate perception and appropriate interpretation of ambiguities. Ambiguities arise either because information is missing or because information is partially or completely obscured by noise. Probabilistic or statistical models can be developed for context incorporation, and it has been demonstrated that utilizing contextual information is crucial for improving recognition accuracy. Another research thrust is on machine learning and data mining. We are interested in a fundamental understanding of learning, and in the development of learning systems that achieve state of the art performance. Song

**Modification of Semiconductor Materials**

Research is under way on the processing and characterization of semiconductor materials as affected by localized transient heating, plasma passivation, and thermal annealing. The recrystallization of polysilicon is studied using various laser sources and rapid thermal annealing. Solanki, Preout, McCarthy

**Neural Networks and Adaptive Systems**

Neural computation and adaptive systems are studied from both theoretical and practical standpoints. Current research in theory, architecture, and algorithm design includes deterministic and stochastic network dynamics, learning algorithms (supervised, unsupervised, and reinforcement), generalization theory (including model selection and pruning, invariant learning), context-sensitive learning, signal processing, time series analysis, and control. Practical application domains include adaptive signal processing, pattern recognition, speech recognition, image processing, control systems, macroeconomics, and finance. Leen, Moody, Pavel, Song, Wan

**Optical Remote Sensing**

Analytical and experimental studies are being made on the use of the interaction of electromagnetic radiation and turbulence to measure winds and turbulence. Recent efforts include analytical, numerical and experimental work on a CO2, optical heterodyne system for remote measurement of atmospheric cross winds and strength of turbulence. Holmes

**Organizational Evolution**

In recent years an increased understanding of evolutionary processes has emerged from work in molecular biology, computer science and complex systems analysis. This new understanding potentially can be harnessed by managers to create human organizations which evolve rapidly in new directions. Our objective is to develop a conceptual toolkit for "evolutionary management". In our research, we draw analogies between policies and genes, between mutations and policy innovations, and between recombination and learning. We present a theoretical framework drawing on a computer simulation environment combining system dynamics modeling with genetic algorithms. Currently, we use this framework to explore the evolutionary implications of management hierarchy and team learning. House

**Speech and Speaker Recognition in Adverse Communication Environments**

Biological signals such as speech carry large amounts of information from different information sources. Typical engineering applications such as automatic speech recognition, speaker verification, or low bit-rate coding of speech may require information from only one particular source, and all other information introduces undesirable and harmful variability into the signal. Humans appear to be able to partially separate the various information sources in the speech signal. This ability spurred interest in modeling human-like processing of speech by modern discrete signal processing techniques. The anthropomorphic signal processing techniques could, in principle, yield improved performance of man/machine I/O technologies in real practical environments. Our research project on speech analysis, carried on jointly with the International Computer Science Institute, Berkeley, Calif., focuses on human-like processing of speech in realistic telecommunications environments to ensure reliable recognition of speech in adverse conditions such as the current mobile cellular telephone. Hermansky

**VLSI Architecture for Intelligent Computing**

Some of the most fundamental problems in computing involve teaching computers to act in a more intelligent manner. Key to this is the efficient representation of knowledge or contextual information. In this project a variety of highly parallel algorithms are studied, including neuromorphic structures, with the intent of implementing knowledge representation and manipulation in silicon. Hamnerstrom

**MEMS and Micro-sensors**

Microelectromechanical systems (MEMS) and micro-sensors are rapidly becoming ubiquitous in technological society. Research applications range from micro-cilia, micro-turbines, and chips that

**RESEARCH FACILITIES**

The department has a complete complement of electronic measuring, recording, amplifying, signal generating, data processing, and servicing gear with associated power supplies and component stocks. Additional facilities and equipment include:

- Access to FT-IR, fluorescent, diode array UV/VIS, scanning UV/Vis near IR spectrophotometers
- NT/PC Computer Lab
- Solaris Servers with X-terminal access
- DTV Lab
- Intel Semiconductor Educational Lab
- Embedded Computer Lab
- High-end PCs & workstations
- Far-infrared Fourier spectrometer
- Parallel field-vibrating sample magnetometer
- Massbauer spectrometer
- Field electron and ion microscopes
- Ultra-high vacuum systems
- Thin-film evaporation equipment
- Electron energy analyzers for Auger and field electron spectroscopy
- Micromachining capabilities
- Scanning electron microscope and transmission electron microscope
- High-resolution electron and ion microprobes
- Work function analysis instrumentation
- Quadrupole mass spectrometers for surface desorption studies
- Arc zone refinement system for single crystal specimen preparation
- Wire bonder
- Die attach system
- X-ray diffraction generator and cameras
- Facility for electronic transport and luminescence measurements as a function of temperature
- Visible, ultraviolet, and infrared gas, solid state, and dye lasers
- MOCVD crystal growth reactors
- 1.25 meter visible and IR spectrometer
- High-performance optical microscope
- Depth profiling ellipsometer
- Photolithography and semiconductor metallization
- Sputter etching
- Device interconnect and packaging
- C-V, I-V measurement facilities
- Pulsed uv-laser processing system
- Electrical characterization (Hall)
- Sputtering machine
- Atomic layer epitaxy
- Liquid crystal display lab with pretilt rubbing, and single-cell electro-optic characterization facilities
- Scanning Auger Microprobe
- Spectroscopic Ellipsometers
walk to MEMS & micro-sensors that have been commercialized in diverse applications such as airbag accelerometers and 'electronic noses' used to detect gases and chemicals. While VLSI fabrication techniques are exploited to produce MEMS and micro-sensor devices economically, these devices can be fabricated by an even greater range of processes and with a far wider variety of materials. The MEM/micro-sensor microfabrication laboratory in ECE is building glucose sensors, pressure sensors, and even micro-peristaltic pumps with a multidisciplinary exposure to mechanics, electronics, physics and fluid dynamics. Research and courses on MEMS and micro-sensors are focused on developing understanding of a large toolbox of processes and materials to design and fabricate these devices. Scholl, House, McCarthy

**Microanalysis**
The characterization, failure studies and in-situ testing of materials and structures used in microelectronics, opto-electronics, micro electro-mechanical systems(MEMS), sensors and biotechnology require a range of techniques that allow the measurement of properties on an ever decreasing scale. Probing materials on the sub-micron and nanometer scales was first necessary in the fabrication of sub-micron transistors to provide feedback on the thin film fabrication processes. These same thin film processes are now being employed by the budding biotechnology, MEMS and sensor industries. The probing is accomplished by scanned atomic force microscope tips, light, electron and ion beams. The signals produced by the probes are used to create high resolution images of surfaces and internal structures, measure compositions, thickness, roughness and identify crystal structures. The geometries, crystal structures, elements present and compositions revealed can then be correlated with electrical, mechanical, thermal and optical properties or more generally the performance of a microelectronic device, MEMS or sensor. The development of microanalysis techniques and application to research and development projects at OGI-ECE has a long history and continues to be a major portion of efforts here. Optical, atomic force, scanning electron, scanning Auger electron and transmission electron microscopes are used to characterize materials following tests, changes in processes or failures in service. The recent addition of a heating straining stage to the SEM and a heating stage with electrical feed-through's to the TEM will permit the complete evolution of microstructures during thermal processing or mechanical failures to be recorded digitally giving a more complete and accurate picture of mechanisms of change in materials on the micron and nanometer scales. McCarthy, House, Freeouf

**Focused Ion Beam Technology**
The use of focused ion beam workstations(FIB) in the microelectronics industry as development and production tools is widespread. The first research and development steps in producing practical FIB workstations in collaboration with local microelectronics companies were taken here at OGI.

Focused ion beams are used to locate micron and sub-micron structures and produce cross-sections of these structures for examination in scanning and transmission electron microscopes. The deep sub-micron development efforts now in progress require the nano- and atomic scale characterization feedback on fabrication processes provided by these FIB produced cross-sections for the development efforts to be successful. The FIB is also used to modify existing microelectronic devices by adding or removing components by the removal or addition of conductors and insulators. This permits designers to test a change in a device quickly and inexpensively before making a costly change to a fabrication line or a mask. More generally the FIB provides the ability to micro-machine and microform on the micron and sub-micron scale in three dimensions. This has applications in the MEMS, sensor and biotechnology fields as a micron and sub-micron prototype fabrication tool. The FIB is also a lithography tool that does not require resists. A region is made chemically more active by careful control of the area of beam scan, beam energy and dwell to produce a volume of material that reacts when subjected to wet or dry etches. There is active research at OGI-ECE on the development of sub-micron cantilevers as high frequency electromechanical switches using ion lithography. McCarthy
DAN HAMMERSTROM
Doug Strain Professor and Department Head
Ph.D., Electrical Engineering 1977, University of Illinois
hammerstrom@ece.ogi.edu

RESEARCH INTERESTS
Neuromorphic computing: Application of FPGAs to image processing, digital video, intelligent and neuromorphic computing, VLSI design. Highly parallel computer architecture and microarchitecture. Technology transfer.

REPRESENTATIVE PUBLICATIONS

ANTHONY E. BELL
Associate Professor
Ph.D., Physical Chemistry University of London, 1962
bella@ece.ogi.edu

RESEARCH INTERESTS
Development of liquid metal field ion sources, field ionization, surface physics, and chemistry; field emission microscopy and energy distribution measurements. Selected area processing for microcircuit fabrication using focused electron beams. Direct-write electron-beam lithography for both mask making and IC fabrication using multiple photoemitted electron beams. Plasma processing for thin film deposition and etching.

REPRESENTATIVE PUBLICATIONS

C. NEIL BERGLUND
Professor
Ph.D., Electrical Engineering Stanford University, 1964
berglund@ece.ogi.edu

RESEARCH INTERESTS
Management of technology, and advanced lithography for semiconductor fabrication.

REPRESENTATIVE PUBLICATIONS

JOHN L. FREEOUF
Professor
Ph.D., Physics University of Chicago, 1973
jfreeouf@ece.ogi.edu

RESEARCH INTERESTS
Graphene and electronic materials. The large and growing semiconductor industry has clearly established that to control something you must be able to measure it. A major thrust of my research efforts is to determine how to measure the specific parameters required to best understand and improve our semiconductor materials and devices. Typically, these measurements will involve incident photons; the output may be either photons or some electrical response.

REPRESENTATIVE PUBLICATIONS
KENTON GREGORY
Associate Professor
M.D. School of Medicine
University of Southern California, 1980

RESEARCH INTERESTS

REPRESENTATIVE PUBLICATIONS


RYNEK HERMANSKY
Professor
Dr. Eng., Electrical Engineering
University of Tokyo, 1983
hydrk@ece.ogi.edu

RESEARCH INTERESTS
Communication between human and machine, human perception and its computer simulation; speech production and perception; automatic recognition of speech, speech coding, synthesis and enhancement; identification and extraction of linguistic information in realistic communication environments.

REPRESENTATIVE PUBLICATIONS


J. FRED HOLMES
Professor Emeritus
Ph.D., Electrical Engineering
University of Washington, 1968
jhfred@ece.ogi.edu

RESEARCH INTERESTS
Speckle propagation through turbulence, optical remote sensing of wind and turbulence, electro-optic systems, instrumentation signal processing, and biomedical optics.

REPRESENTATIVE PUBLICATIONS


JODY HOUSE
Assistant Professor
Sc.D., Electrical Engineering 1998
Massachusetts Institute of Technology
jhhouse@ece.ogi.edu

RESEARCH INTERESTS
Electronic and photonic device design for microsensor applications with a current concentration on materials. Applications in genetic algorithms and programs as applied to electronic materials and devices as well as human organizations. System dynamics modeling of human organizations for public policy development. The role early engineering education processes have in retention and attraction of female engineering students.

REPRESENTATIVE PUBLICATIONS


ROBERT S. JAFFE
Instructor
Ph.D., in Electrical and Computer Engineering
Portland State University in 1988
jaffe@ece.ogi.edu

RESEARCH INTERESTS
Robert S. Jaffe is a full-time instructor in ECE. He teaches in the areas of signals and systems, applied mathematics and mathematical systems theory. His area of specialization is linear systems and robust control. He received a Ph.D. in Electrical and Computer Engineering from Portland State University in 1988. During an earlier career phase he was a Professor of Philosophy and a researcher in the philosophy of education.

MARWAN JABRI
Gordon and Betty Moore Professor of Microelectronics
Ph.D., Electrical Engineering
University of Sydney 1988
marwan@ece.ogi.edu

RESEARCH INTERESTS
Artificial intelligence, computer architecture. The understanding of the principles by which humans and/or other organisms perceive the environment, process sensory signals, reason, make decisions and learn. The design and engineering of humanoids that exhibit faculties similar to humans.

REPRESENTATIVE PUBLICATIONS

STEVEN L. JACQUES
Professor
Ph.D., Biophysics and Medical Physics
University of California, Berkeley, 1984
jacques@ece.ogi.edu

RESEARCH INTERESTS

REPRESENTATIVE PUBLICATIONS
JOHN-PAUL HOSOM  
Assistant Professor  
Ph.D., Computer Science and Engineering  
2000, Oregon Graduate Institute of Science and Technology  
hosom@ece.ogi.edu

RESEARCH INTERESTS
Automatic speech recognition  
Assistive technology.

REPRESENTATIVE PUBLICATIONS

SEAN J. KIRKPATRICK  
Associate Professor  
Ph.D., Biomechanics  
University of Miami, 1992  
Scottpark@providence.org

RESEARCH INTERESTS
Development and application of coherent light techniques to address issues in biomaterials science and tissue mechanics. Laser speckle techniques are of particular interest. Recent investigations have focused on the evaluation of the micromechanical behavior of vascular, dermatological, and skeletal tissues using novel laser speckle strain measurement methods. We envision that these investigations will lead not only to an expansion of our basic science understanding of tissue mechanics and laser-tissue interaction, but will also result in optical instrumentation to assist in the diagnosis and treatment of disease. Other interests include experimental investigations into the micromechanics of synthetic biomaterials used to replace or augment damaged or pathological tissue.

REPRESENTATIVE PUBLICATIONS

JACK MccARTHY  
Assistant Professor  
Ph.D., Materials Science and Engineering  
Oregon Graduate Institute of Science and Technology, 1996  
jmccarthy@mse.ogi.edu

RESEARCH INTERESTS
Mechanisms of change in metallization and insulator thin films used in microelectronic applications, in-situ testing of these films in transmission and scanning electron microscopes to develop better processing techniques and more reliable thin films. The development of focused ion beam processes for the fabrication of structures on the micron and sub-micron scales to produce sensors and electro-mechanical devices for testing the physical properties of sub-micron thin films. Thin film transmissive photocathodes for use in multi-beam electron lithography and surface reactions at the emission site. Materials characterization techniques using analytical electron microscopy and focused ion beam technology.

REPRESENTATIVE PUBLICATIONS
Accepted 8/31/99.
S. Gosavi, J.M. McCarthy, C.N. Berglund, W.A. Mackie, L.A. Southall


MISHA PAVEL
Professor
Ph.D., Experimental Psychology
New York University, 1980
pavel@ece.ogi.edu

RESEARCH INTERESTS
Analysis and modeling of complex behaviors of biological systems, including visual and auditory processing, pattern recognition, information fusion and decision making. Development of engineering systems mimicking these abilities to support multimodal communication between humans and machines (speech and video), machine vision, visually guided vehicular control, and virtual reality. Applications of these techniques to the development of future biomedical and healthcare systems.

REPRESENTATIVE PUBLICATIONS


SCOTT A. PRAHL
Assistant Professor
Ph.D., Biomedical Engineering
University of Texas at Austin, 1988
prahl@ece.ogi.edu

RESEARCH INTERESTS
Diagnostic and therapeutic applications of light in medicine: laser thrombolysis, non-invasive optical diagnostics, hemostasis and tissue repair.

REPRESENTATIVE PUBLICATIONS


REPRESENTATIVE PUBLICATIONS

Critical Phenomena. Displays, Phase Transitions and Liquid Crystals, Flat Panel Antiferroelectric and Amphitropic complex systems, Ferroelectric, and Photoresists, Dynamics of Nanotechnology: Nanoparticles

RESEARCH INTERESTS

Nanotechnology, Nanoparticles and Photoelectrics, Dynamics of complex systems, Ferroelectric, Antiferroelectric and Amphitropic Liquid Crystals, Flat Panel Displays, Phase Transitions and Critical Phenomena.

SHANKAR RANANAVARE

Associate Research Professor
Ph.D., Physical Chemistry
University of Missouri,
St. Louis, 1983
shankarr@ece.ogi.edu

REPRESENTATIVE PUBLICATIONS

Ciro Di Meglio, S. B. Rananavare,


MILTON R. SCHOLL

Associate Professor
Ph.D., Materials Science and Engineering
OGI School of Science and Engineering,
1987
milts@ece.ogi.edu

RESEARCH INTERESTS

Micro-mechanical systems and their design and use, particularly the mechanics, the materials, and interaction of contacting surfaces, i.e. tribology of microsystems. Tribological systems ranging from chemical mechanical polishing, to fiber-plate interactions in chip refining and woodcutting, to wheel-rail interactions. Tribological performance of materials including abrasive and erosive wear, sliding behavior, rolling / sliding conditions and the interactions of the phenomena with the working environment, focusing on surface response to external stimuli and mitigation techniques to reduce or eliminate surface damage.

REPRESENTATIVE PUBLICATIONS


RAJ SOLANKI

Professor
Ph.D., Physics
Colorado State University, 1982
solanki@ece.ogi.edu

RESEARCH INTERESTS

Atomic Layer Deposition, copper electrodeposition and electromigration, multilevel metalization, high k gate dielectrics, inorganic and organic electroluminescent devices, polysilicon thin film transistors.

REPRESENTATIVE PUBLICATIONS


XUBO SONG  
Assistant Professor  
Ph.D., Electrical Engineering  
California Institute of Technology, 1998  
xubosong@ece.ogi.edu

RESEARCH INTERESTS:  
Digital Image/Video Processing;  
Sensor Fusion; Computer Vision;  
Pattern Recognition; Machine Learning; Information Theory and Coding; Biomedical Engineering.

REPRESENTATIVE PUBLICATIONS  

Jan P.H. van Santen  
Professor and Center Director of CSLU  
Ph.D., Mathematical Psychology, University of Michigan, 1979  
vansanten@ece.ogi.edu

RESEARCH INTERESTS  
Speech timing, intonation, signal processing, statistical analysis of text and speech corpora, and text-to-speech (TTS) system evaluation.

REPRESENTATIVE PUBLICATIONS  

Eric A. Wan  
Associate Professor  
Ph.D., Electrical Engineering  
Stanford University, 1994  
evrcwan@ege.ogi.edu

RESEARCH INTERESTS  
Learning algorithms and architectures for neural networks and adaptive signal processing, applications to time-series prediction, speech enhancement, adaptive control, and telecommunications.

REPRESENTATIVE PUBLICATIONS  
JOINT FACULTY APPOINTMENTS

ROB DAASCH
Electrical Engineering
Portland State University

JACK FERRACANE
School of Dentistry
Oregon Health & Science University

ANDREW FRASER
Portland State University

TODD LEAN
Computer Science and Engineering
OGI School of Science & Engineering

SHIH-LIEN LU
Computer Science
Oregon State University

JOHN E. MOODY
Computer Science and Engineering
OGI School of Science & Engineering

NELSON MORGAN
Electrical Engineering & Computer Sciences
University of California

MINGDE YAN
Chemistry
Portland State University

ADJUNCT FACULTY

JOHN C. ABELE
Lewis and Clark College

SHARIAR S. AHMED
Intel Corp.

CHEDLEY AQURIRI
Intel Corp.

AHMED RAHHAL-ARABI
Intel Corp.

SHEKHAR BORKAR
Integrated Device Technology, Inc.

ROB CONTOLINI
Novellus

ALAN COPPOLA
Cypress Semiconductor, Inc.

DOUGLAS C. DRAPER
Portland Community College

STEPHEN R. EARLY
Consultant

YOUSSEF A. EL-MANSY
Intel Corp.

REINHART ENGLEMANN
Consultant

DAVID EVANS
Sharp Microelectronics Technology Inc.

WAYNE K. FORD
Intel Corp.

MARK FRANK
Conexant

R. THOMAS HAWKINS II
Consultant

HOWARD HECK
Intel Corp.

DAE MANN KIM
Pohang Institute of Science & Tech., Korea

RICHARD Y. KOYAMA
TriQuint Semiconductor Inc.

ROY KRAVITZ
Radisys Corporation

WILLIAM A. MACKIE
Linfield College

V. DAKSHINA MURTY
University of Portland

HAMID RABIEE
Intel Corp.

KARTIK RAOL
Intel Corp.

EDWARD F. RITZ, JR.
Consultant

LAWRENCE RUBY
University of California, Berkeley

LYNWOOD W. SWANSON
FEI Co.

STEWART S. TAYLOR
Maxim

THOMAS THOMAS
Intel Corp.

TRAN THONG
Microsystems Engineering, Inc.

JAMES A. VAN VECHTEN
Transient Thermal Processing
Global positioning system (GPS) technology is an important component of field-investigation activities in the department's curriculum.

The Department of Environmental Science and Engineering is one of the oldest stand-alone environmental and engineering programs in the country. Founded more than 25 years ago, we are known for our research and graduate education programs that balance practical applications with fundamental investigations of the physical, chemical, and biological processes underlying environmental phenomena. The curriculum is highly interdisciplinary and is built on a solid foundation of fundamental science and engineering.

The department offers graduate study leading to the degrees of Doctor of Philosophy (Ph.D.) and Master of Science (M.S.). M.S. programs are offered with both thesis and non-thesis options. All programs may be pursued on a full-time or part-time basis. Ph.D. students and M.S. thesis students participate in a program that includes both formal course work and research. The research experience is intensive and consists of laboratory, computational, theoretical and/or field studies. Thesis students are involved in all aspects of departmental research and have ready access to modern analytical instrumentation and computers.

The Ph.D. program can be completed in 4 to 5 years, and the M.S. thesis option takes approximately 2 years to complete. Thesis students can concentrate their studies in the following areas:

- Environmental Science and Engineering (ESE) (traditional program)
- Environmental Information Technology (EIT)

The non-thesis M.S. program can be completed in 12 months. Students in the non-thesis M.S. program can concentrate their studies in the following areas:

- Environmental Science and Engineering (ESE) (traditional program)
- Ecosystem Management and Restoration (EMR)
- Environmental Information Technology (EIT) (beginning Fall 2002)

ADMISSION REQUIREMENTS
Applications for admission to full-time and part-time degree programs are invited from persons with bachelor's degrees in the physical or biological sciences, mathematics, or engineering. Previous course work in chemistry, biology, and mathematics (through at least one year of calculus) is expected.

Requirements for admission to the Department of Environmental Science and Engineering are the same as the OGI School of Science and Engineering's admission requirements, except for the minimum TOEFL score. The department requires TOEFL scores of all applicants whose native language is not English. The minimum acceptable TOEFL score is 600 for the written test or 250 for the computer-based test. Students who earned undergraduate degrees in the United States are not required to submit TOEFL scores. GRE general aptitude scores are required for admission to all of the department's M.S. and Ph.D. programs. A GRE subject examination score is not required.

Completed Ph.D. applications should be received by February 15 for matriculation in the fall of the same year. M.S. applications are accepted year-round, although most new M.S. students apply by July for matriculation in the fall. Prospective applicants for the Ph.D. program should examine the faculty research programs at http://www.ese.ogi.edu/people.html to determine whether their professional goals can be fulfilled in the department. Communication with individual faculty members prior to applying is encouraged.

DEGREE REQUIREMENTS

DISTRIBUTION REQUIREMENTS
To achieve the necessary breadth in training, students in all programs take courses that cover a range of scientific disciplines and environmental media. Five courses must be taken that satisfy the following distribution requirements. No course can satisfy more than one requirement.

At least one course must be taken from three of the following four discipline groups:

- **Applied Mathematics**
  - ESES00; ESES04; ESES06; ESES08
- **Chemistry**
  - ESES10; ESES11; ESES34; ESES16
- **Fluid Dynamics**
  - ESES20; ESES30; ESES37; ESES39
- **Biology**
  - ESES50; ESES54

And, at least one course must be taken from each of the following environmental media groups:

- **Surface Waters**
  - ESES20; ESES30; ESES37; ESES39
- **Ground Water**
  - ESES40; ESES42; ESES43

Global positioning system (GPS) technology is an important component of field-investigation activities in the department's curriculum.
All full-time students are required to take Environmental Science Seminar (ESE599) during the Fall, Winter, and Spring quarters. However, this course does not count toward degree credit requirements.

For all ESE educational programs, up to 8 credits may be granted for courses taken in other OHSU departments. Up to 12 quarter credits may be transferable from other accredited institutions for graduate courses comparable in content and level to courses offered in the department. The Student Program Committee (SPC) decides on the appropriateness of internship and transfer credits.

Transfer credits do not reduce the annual tuition, but may allow for greater flexibility in scheduling.

**PH.D. IN ENVIRONMENTAL SCIENCE AND ENGINEERING**

Students may complete the Ph.D. program in Environmental Science and Engineering (ESE) or Environmental Information Technology (EIT). The EIT program is a track within the ESE Department. Students who complete the EIT program receive their degree in Environmental Science and Engineering with a concentration in EIT.

Ph.D. students must complete 5 distribution courses as outlined above. Students must also complete additional courses for a total of at least 52 credit hours of course work, selected with the approval of their SPC.

Ph.D. candidates must also pass a two-part comprehensive exam. The first part is a written examination covering four subject areas selected by the department. The second part is the preparation and oral defense of a proposal that defines the student’s Ph.D. dissertation research. A written Ph.D. dissertation with an oral defense is also required.

**M.S. IN ENVIRONMENTAL SCIENCE AND ENGINEERING**

**M.S. THESIS OPTIONS**

Students may pursue M.S. thesis options in Environmental Science and Engineering (ESE) or, beginning Fall 2002, Environmental Information Technology (EIT). The EIT program is a track within the ESE Department. Students who complete the

EIT program receive their degree in Environmental Science and Engineering with a concentration in EIT.

Students pursuing the M.S. thesis option must complete at least 45 credits. These credits include the distribution requirements outlined above, additional courses selected with the approval of the SPC, and research credits. Master’s thesis research (ESE 700) is usually no more than 9 credits.

Comprehensive examinations are not required of M.S. thesis students. However, a written M.S. dissertation with an oral defense is required.

**M.S. NON-THESIS OPTIONS**

Students may pursue the M.S. non-thesis options in Environmental Science and Engineering (ESE), Ecosystem Management and Restoration (EMR) or, beginning Fall 2002, Environmental Information Technology (EIT). The EMR and EIT programs are tracks within the ESE Department. Students who complete the EMR or EIT programs receive their degree in Environmental Science and Engineering with a concentration in EMR or EIT.

For the non-thesis M.S. degree, 5 distribution courses must be taken as outlined above. Students must complete additional courses for a total of at least 45 credit hours. Up to 8 credits may be granted for approved participation in non-thesis research or approved work as an intern with a local company or government agency. No comprehensive examinations are required for the non-thesis M.S. options.

**DEGREE PROGRAMS**

**ENVIRONMENTAL SCIENCE AND ENGINEERING (ESE) (TRADITIONAL PROGRAM)**

The department offers Ph.D., M.S. thesis, and M.S. non-thesis options in Environmental Science and Engineering (ESE). The ESE program is known for its research and education programs that balance practical applications with fundamental investigations of the physical, chemical, and biological processes underlying environmental phenomena. The curriculum is highly interdisciplinary and is built on a solid foundation of fundamental science and engineering. For more information, please see http://www.ese.ogi.edu/curriculum.html.

**ECOSYSTEM MANAGEMENT AND RESTORATION (EMR)**

The Ecosystem Management and Restoration (EMR) program is a 12-month, non-thesis M.S. track offered within the Department of Environmental Science and Engineering. The objective of the EMR program is to integrate rigorous environmental principles, field and laboratory applications, modeling, project management, and policy/regulation into a cohesive curriculum. The program emphasis is on timely issues, including nonpoint source pollution, water quality, and ecological and human risk assessments. For more information, please see http://www.ese.ogi.edu/EMR/. Requirements for the EMR program are the same as for the non-thesis M.S. option described above, except that students must include ESE570 and ESE589 in their elective course work.

**ENVIRONMENTAL INFORMATION TECHNOLOGY (EIT)**

The Environmental Information Technology (EIT) program is the newest program offered within the Department of Environmental Science and Engineering. The Ph.D. option in EIT began Fall 2001, and the M.S. thesis and non-thesis options in EIT will begin Fall 2002. The EIT program combines the expertise and coursework found in ESE and in the Computer Science and Engineering (CSE) and Electrical and Computer Engineering (ECE) Departments at the OGI School of Science and Engineering. The goal of the EIT program is to combine a deep understanding of environmental processes with mastery of sensing, modeling, and information technology. Requirements for the EIT program are the same as the thesis and non-thesis options described above, except that students in the EIT program complete approximately 20% of their coursework in the CSE and ECE Departments. The EIT curriculum includes fundamental courses, science courses, technology courses, elective courses, and capstone integrative courses. Elective courses may include classes offered through OHSU’s Medical Informatics program. For more information on the EIT program and its curriculum, please see http://www.ese.ogi.edu/EIT/.

**A NOTE ABOUT TUITION**

Tuition for the full-time non-thesis M.S. program is $19,620 for the 2001-2002
academic year, which is typically spread equally over the first four quarters. Upon admission to the department, a $100 deposit is required with the return of a student’s acceptance to reserve a place in the department. This deposit will be applied toward tuition and is non-refundable.

COURSE OFFERINGS

ESE500 Introduction to Discrete Methods
This course is an introduction to discrete methods for environmental fluid dynamics. Lectures cover the theory and application of the numerical solution of boundary-value and mixed initial-boundary value problems. Emphasis is on finite differences, finite elements and finite volumes. Prerequisites: Calculus.

ESE504 Uncertainty Analysis
A survey of basic probability concepts followed by introductions to several statistical advanced techniques that play an important role in environmental data analysis. Topics may include distribution functions, propagation of error, hypothesis testing, analysis of variance, experimental design, sampling theory, regression analysis, time-series analysis, and spatial statistics techniques. The course provides a balance of theory and application using environmental data sets.

ESE506 Environmental Systems Analysis
Introduction to techniques of systems analysis applied to environmental quality management. Emphasis is placed on development and application of mathematical models with computer simulation and optimization. Analysis is efficient computational algorithms and search techniques. Linear and separable programming applied to evaluate management alternatives. Applications to air, water, solid, and hazardous waste management. Prerequisites: Computer programming and calculus.

ESE508 Computational Fluid Dynamics
This course describes advanced topics in computational fluid dynamics, including specialized discrete methods (e.g., for advection-dominated problems), formal analysis of stability and accuracy, and selected simulations of complex environmental and biological systems. Prerequisites: Advanced calculus and ESE 500.

ESE510 Aquatic Chemistry
General acid/base concepts (mono- and polyprotic systems); activity corrections; numerical calculations; titration concepts as applied to natural systems; buffer intensity; dissolved CO2 chemistry; pH, acidity, and alkalinity in open CO2 systems; minerals and their role in controlling natural water chemistry; solubility characteristics of oxide and hydroxides; redox chemistry in natural systems; pe-pH diagram.

ESE514 Distribution and Fate of Organic Pollutants
Discussion of the physico-chemical processes that control the behavior and fate of organic chemicals in the environment. Introduction considers all environmental compartments, water, soil, and air, and partitioning between these phases. Recommended prerequisite: ESE 510.

ESE516 Chemical Degradation and Remediation
A thorough introduction to the transformation reactions that contribute to the fate of organic substances in the environment. The course covers pathways, mechanisms and kinetics of hydrolysis, oxidation, reduction, elimination, conjugation, etc. Treatment is balanced to reflect the importance of these processes in all types of environmental waters ranging from engineered systems to groundwater, surface water, rain, and fog. Recommended preparation: ESE 510 and ESE 514.

ESE519 Air Pollution: Origins, Chemistry, and Control
This course will focus on tropospheric air pollution with particular emphasis on the urban and regional scales. It will discuss the following items: basic structure of the atmosphere and relevant meteorological considerations; sources of tropospheric air pollutants; atmospheric photochemistry; the ozone, oxides of nitrogen, and hydrocarbon chemical cycles; chemistry of toxic organic compounds in the atmosphere; gas and aqueous phase chemistry of sulfur dioxide; size distributions, lifetimes, origins and formation mechanisms of aerosols; and control of atmospheric emissions.

ESE520 Introduction to Environmental Observation and Forecasting Systems
This course introduces environmental observation and forecasting systems and their application towards the enhanced understanding and management of natural resources. Emphasis is on estuaries and coasts. Students are exposed to a novel, cross-disciplinary culture for understanding and interacting with environmental systems. This culture relies heavily on "real-time" generation of modeling and observational data, which are integrated and distributed through information networks designed to bring the right environmental information at the right time to the right user. Prerequisite: Instructor permission.

ESE522 Introduction to Spatial Sciences
Students will learn theoretical and practical applications of geospatial sciences within the context of Environmental Sciences and Engineering. Theory of satellite-based Geographic Positioning Systems (GPS) will be studied while performing practical, hands-on laboratory experiments using the latest in GPS equipment. Classroom discussions will then focus on relating location on the Earth's surface to a common mapping grid. Non-projected and projected maps, ellipsoids and spheroids, and geoids will be discussed. Spatial relationships, or analysis, of continuous and categorical data will be addressed through the application of standard statistics and probability. ARC/INFO, a popular Geographic Information System (GIS) software tool will be stressed.

ESE523 Introduction to Remote Sensing of the Environment
This course will explore the acquisition, analysis and visualization of remotely sensed data. The physics behind the collection of remotely sensed data will be introduced as will both airborne-platform and satellite-platform sensors. Data from the Light Detection and Ranging (LIDAR) sensor as it pertains to Airborne Topographic Mapping will be used. Single band, multi-spectral and hyper-spectral data sets will be used to discuss such concepts as image statistics, radiometric and geometric corrections, spatial filtering and special transformations like the Normalized Difference Vegetation Index. Supervised and Unsupervised classification schemes will be discussed as will change detection. The course pedagogy is designed to address the needs of the advanced level Environmental Science and Engineering graduate student. While there is no prerequisite for this course, many topics from ESE522, Introduction to Spatial Science are incorporated into this course. It is therefore recommended that students unfamiliar with classification methods and the fundamental concepts of Geographic Information Systems complete ESE522 or equivalent.

ESE524 Transport Processes
An introductory course in the physics of transport processes in the natural environment. The course examines heat, mass, and momentum transport via conservation principles and the Reynolds Transport Theorem, but strongly emphasizes the environmental applications of these processes. Example studies include atmospheric and oceanic circulation, flow and dispersion in rivers, and heat budgets for lakes and reservoirs.

ESE525 Modeling Coastal Circulation and Transport I
This course introduces the students to the process of modeling coastal circulation and transport. Topics include governing equations, review of state-of-the-art models, in-depth description of selected models, and solution of benchmark problems. Prerequisites: ESE502 or ESE502, and ESE530.

ESE526 Modeling Coastal Circulation and Transport II
This course provides an advanced treatment of coastal circulation and transport modeling. Students are introduced to the detailed modeling of complex estuarine, plume, and continental shelf processes, through a combination of lectures and labs focused on specific sites and processes. Prerequisites: ESE530.

ESE530 Transport Processes
An introductory course in the physics of transport processes in the natural environment. The course examines heat, mass, and momentum transport via conservation principles and the Reynolds Transport Theorem, but strongly emphasizes the environmental applications of these processes. Example studies include atmospheric and oceanic circulation, flow and dispersion in rivers, and heat budgets for lakes and reservoirs.

ESE532 Modeling Coastal Circulation and Transport I
This course introduces the students to the process of modeling coastal circulation and transport. Topics include governing equations, review of state-of-the-art models, in-depth description of selected models, and solution of benchmark problems. Prerequisites: ESE500 or ESE500, and ESE530.

ESE533 Modeling Coastal Circulation and Transport II
This course provides an advanced treatment of coastal circulation and transport modeling. Students are introduced to the detailed modeling of complex estuarine, plume, and continental shelf processes, through a combination of lectures and labs focused on specific sites and processes. Prerequisites: ESE530.

ESE534 Modeling Coastal Flow and Transport
Description of state-of-the-art modeling principles and techniques for simulation of flow and of conservative and nonconservative transport in coasts and estuaries. Students have the opportunity to model an actual coastal system through a hands-on term project that includes a realistic sequence of modeling steps: data analysis, grid generation, flow modeling, modeling of conservative transport, and modeling of nonconservative transport. Prerequisites: ESE 500, ESE 532.

not offered 2001/2002

4 credits
ESE537 Methods in Oceanography
This course covers the fundamentals of processing estuarine and coastal oceanographic data, including time series (e.g., surface elevation, currents, and winds) and data obtained from vessels (e.g., profile and bathymetric data).

ESE539 Methods in Estuarine Oceanography: Field Observation
This course covers the fundamentals of estuarine and coastal oceanographic data collection using vessels and remotely moored equipment. Topics include vessel logistics and sampling, navigation systems, interfacing of instruments with personal computers, types of moorings and their deployment and recovery, and telemetry.

ESE540 Subsurface Hydrology
Hydrologic cycle infiltration theory; principles of unsaturated and saturated flow in the subsurface; well hydraulics; analytical models of drawdown, capture zones and velocity plots; porous media characterization methods and tools.

ESE541 Groundwater Modeling
Applied groundwater modeling using finite difference and finite element methods. Introduction to numerical methods for solving the partial differential equations for saturated and unsaturated subsurface flow. Model execution and calibration. Prerequisite: ESE 540.

ESE542 Contaminant Hydrology
Processes controlling subsurface contaminant movement in porous and fractured media, including groundwater flow, dispersion, diffusion, sorption, and degradation. Parameter estimation, mathematical and laboratory modeling of aquifers is also covered.

ESE543 Modeling in Contaminant Hydrogeology
This course is designed to be taken concurrently with ESE 542. It emphasizes the hands-on use of common mathematical models for groundwater flow and transport (e.g., MODFLOW, RANDOMWALK, SUMATRA) to examine real groundwater contamination problems. Prerequisite: ESE 542.

ESE550 Environmental Microbiology
Introduction to environmental microbiology, with emphasis on the role of microbes in the environment and in remediation processes. Microbes and their interaction and activities in soil and aquatic environments will be discussed, as well as elemental cycling as influenced by microbes. Microbially-mediated transformation of organic pollutants, transformation kinetics, and remediation technologies will be considered.

ESE554 Biodegradation and Bioremediation
A process-oriented survey of microbially mediated transformations of organic pollutants. Transformations occurring in the natural environment as well as in remediation technologies are considered. Emphasis is on the pollutant properties, micro-biological factors, and medium properties that determine the pathways and kinetics of biodegradation. Recommended preparation: ESE 550.

ESE560 Environmental Soil Science
Soil physics, chemistry, and microbiology; soil development, soil description and mapping, soils and land use, agricultural and urban forestry; soil-plant relationships for environmental restoration; soil process modeling. Prerequisites: ESE 510 and ESE 550.

ESE562 Ecosystem Ecology
Principles of ecology and of ecosystem process, description, and measurement, with emphasis on ecosystem health assessment. Simulation modeling of ecosystem processes; transport and transformation.

ESE570 Principles of Toxicology and Risk Assessment
This course applies toxicological principles to both human and ecological risk assessments. The principles and methodologies for risk assessments are presented within a regulatory context. Topics include hazard identification, exposure assessment, LIDp, dose-response relationships, deterministic and probabilistic risk assessments, responses of various receptors to different contaminants, and environmental management decisions.

ESE580 Ecosystem Management and Restoration
An intensive capstone course that integrates field processes with theory from previous lecture material. Approximately 1 week is spent at site locations where students critically examine current techniques for collecting surface water, groundwater, and soil samples to characterize chemical, biological, and physical properties. Laboratory methods for analyzing organic and inorganic chemicals are included. Students work in teams on projects to collect and evaluate data, write reports, and make recommendations for future management of the sites. Anticipate overnight travel.

ESE585 Environmental Law and Regulation
Course focuses on the legal aspects of environmental science and engineering. Statutory and regulatory interpretation, application to specific facilities, and negotiation of Clean Air Act issues with EPA and the states.

ESE586 Special Topics: Advanced Topics in Field Sampling and Analysis
An intensive capstone course that integrates field processes with theory from previous lecture material. Approximately 1 week is spent at site locations where students critically examine current techniques for collecting surface water, groundwater, and soil samples to characterize chemical, biological, and physical properties. Laboratory methods for analyzing organic and inorganic chemicals are included. Students work in teams on projects to collect and evaluate data, write reports, and make recommendations for future management of the sites. Anticipate overnight travel.

ESE589 Organization of Environmental Science and Engineering Seminar
This course is for the Ph.D. student responsible for managing the weekly Environmental Science and Engineering Seminar series (ESE599). Students enroll for this course with their advisor's approval.

ESE590 Research
Research toward the dissertation for the Ph.D. degree before completing the comprehensive examinations. Variable and repetitive credit.

ESE591 Non-Thesis Research
Supervised research as a component of the non-thesis M.S. degree. The plan of research and final deliverables must be approved by the research advisor and the Student Program Committee. Deliverables include a written report and/or seminar given as part of ESE 599. A maximum of 8 credits from ESE 610 and ESE 620 can be applied to a degree.

ESE592 Professional Internship
This course provides the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers. Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. International students need to submit appropriate paperwork for Immigration and Naturalization Service. A maximum of 8 credits from ESE 610 and ESE 620 can be applied to a degree.

ESE700 M.S. Thesis Research
Research toward the M.S. thesis degree. Variable and repetitive credit.

ESE701 Ph.D. Thesis Research
Research toward the Ph.D. degree before completing the comprehensive examinations. Variable and repetitive credit.

ESE702 Professional Internship
This course provides the student with an opportunity to earn credit for relevant work experience in industry. Students gain valuable experience that allows them to both apply the knowledge gained in the classroom and prepare for their future careers. Enrollment requires a faculty advisor and is limited by the number of internship opportunities available. International students need to submit appropriate paperwork for Immigration and Naturalization Service. A maximum of 8 credits from ESE 610 and ESE 620 can be applied to a degree.

ESE703 Research
Research toward the doctoral degree before completing the comprehensive examinations. Variable and repetitive credit.
RESEARCH PROGRAMS

Contaminant Diffusion in Clay
Clay liners are often used in waste disposal facilities to prevent the advective transport of contaminants into the surrounding groundwater. Even when advective transport is small, however, contaminant transport through liners may be significant as the result of molecular diffusion. This phenomenon has been studied in the laboratory and at actual waste disposal facilities to evaluate its roles in mass transport and groundwater contamination. Johnson

Processes Controlling the Subsurface Transport of Dense Chlorinated Solvents
The uncontrolled release of chlorinated solvents is a common cause of serious groundwater contamination in many parts of the world. It is in this context that it is important to understand the physical and chemical principles that govern the movement of these dense nonaqueous phase liquids (DNAPLs). Experiments under way at OGI and in conjunction with the University of Waterloo are examining the behavior and remediation of chlorinated solvents in the saturated and unsaturated zones. Johnson

Simulation of Subsurface Processes Using Very Large Scale Experimental Aquifers
Many important chemical, physical, and biological processes are difficult to study in the laboratory because of problems of scaling. Many of these processes are also difficult to characterize in the field, because of the complex and uncontrolled nature of environmental systems. For these reasons, OGI has established the Large Experimental Aquifer Program (OGI/LEAP). At present, the facility consists of five large aquifers used to examine the movements of organic solvents and petroleum compounds in the unsaturated and saturated porous media. Future LEAP aquifers will examine inorganic geochemistry and the interactions between chemical, biological, and physical processes in contaminated aquifers. Johnson and other faculty

Gas-Phase Transport in Unsaturated Porous Media
Gas-phase transport is important in controlling many subsurface processes including respiration, pesticide behavior, and contaminant volatilization and movement. Laboratory experiments have been conducted to determine diffusion rates of a variety of organic compounds in porous media and the kinetics of adsorption and desorption for a variety of soil types and a range of water contents. Johnson

Multi-Phase Monitoring of Gasoline Movement Using a Very Large Physical Model (OGI/LEAP)
Leaks from underground storage tanks (UST) represent a major ongoing source of groundwater contamination. The rapid detection of leaks is, therefore, a major goal of UST legislation. The OGI/LEAP facility is used to study the movement of gasoline components in the vapor, aqueous, and pure-product phases. This work will help establish which of a variety of leak-detection technologies is best suited to detect leaks under a range of environmental conditions. Johnson

Remediation of Halocarbon-Contaminated Groundwater
There is enormous demand for improved ways to clean up aquifers that have been contaminated with halogenated hydrocarbon solvents like carbon tetrachloride and TCE. Recent field-scale tests have shown that technologies based on dechlorination with granular iron may have substantial value. The goal of our research in this area is to provide a sound scientific basis for designing and operating such technologies by determining the mechanisms of dechlorination by iron and the geochemical and microbiological processes that affect the performance of this technique in the field. For more information on this work, see http://cgr.ese.ogi.edu/iron. Tratnyek

Reduction Reactions of Organic Pollutants in Anaerobic Environments
Some organic pollutants undergo rapid reduction in anaerobic sediments, soils, and groundwaters. Despite the potential importance of this process, little is known about the natural reducing agents that are responsible for these reactions. In this project, assays are being developed that will identify and quantify environmental reducing agents in situ. These assays will be used in kinetic studies of important pollutant reduction reactions. Tratnyek

Oxidation Reactions of Organic Pollutants
Some organic pollutants undergo rapid oxidation in natural waters, when catalyzed by sunlight, and in technological systems, when chemical oxidants are added to effect remediation. These reactions are usually mediated by “activated oxygen species” such as hydroxyl radical. We are studying the kinetics, mechanisms, and products of these reactions with a wide variety of contaminants. The aim of this work is help assess the suitability of various advanced oxidation technologies (AOTs) for remediation of groundwater, as well as to better understand the fate of contaminants in natural waters that are exposed to sunlight. Tratnyek

Correlation Analysis of Contaminant Reactivity
Quantitative Structure-Activity Relationships (QSARs) are of enormous importance in environmental chemistry and toxicology because of their predictive power, but they also reveal a great deal about reaction mechanisms and the nature of substituent effects. We are involved in the development of QSARs for a wide range of redox reactions involving organic contaminants. This work involves the use of computational chemistry methods as well as advanced statistical techniques in exploratory data analysis. Tratnyek

Fate and Effects of Fuel Oxygenates
The recent realization that oxygenated fuel additives such as MTBE are becoming widely distributed groundwater contaminants has created a sudden and pressing demand for data on the processes that control their environmental fate. On-going work in this area includes modeling of MTBE infiltration to the groundwater, laboratory studies of MTBE biodegradation, and field studies of several contaminated sites for MTBE and its possible breakdown products. For more information on this work, see http://cgr.ese.ogi.edu/mtbe/. Pankow, Tratnyek, Johnson

Hydrocarbon Biodegradation in Soil
Petroleum hydrocarbon contamination is prevalent in soils and groundwater. Efforts to clean up this extensive petroleum contamination have prompted research into in-situ bioremediation. Depending on site characteristics, in-situ hydrocarbon biodegradation is a cost effective and environmentally sound remediation alternative or partner to pump-and-treat and vacuum extraction technologies. We have studied the processes by which the biodegradation rates of organic compounds can be optimized. Toccalino

Human-Health Assessment of Water Quality
A national effort is underway with the U.S. Geological Survey’s National Water-Quality Assessment (NAWQA) program, in collaboration with the U.S. Environmental Protection Agency (USEPA) and State agencies to conduct a pilot effort to develop, test, and refine concepts to more effectively communicate water-quality information in a human-health context. The study includes determining how to effectively communicate the data from this study in a human-health context to Congress, the media, the public, etc. Toccalino

Distribution of Organic Compounds Between the Gas and Urban Aerosol Particulate Phases
The behavior of organic compounds in the atmosphere depends in large part on the extent to which they partition from the gas phase to aerosol particulate matter. Processes that are affected by this partitioning process include precipitation scavenging of gases and particles as well as dry deposition of gases and particles. Fundamental gas/solid sorption theory is being used to investigate important aspects of atmospheric gas/particle partitioning. The study involves the investigation of basic partitioning behavior of a wide range of representative atmospheric compounds (including alkanes and polycyclic aromatic hydrocarbons) on a variety of representative model particulate substrates, including elemental carbon, organic carbon, silica, and clay. Pankow

Thermodynamics of Inorganic Solid Solutions
The manner in which inorganic solid solutions behave is one of the last major research frontiers in ambient temperature aqueous geochemistry. Coprecipitation of metal ions is well known in nature, e.g., Sr2+ can form a solid solution in calcium carbonate (CaCO3(s)). Unfortunately, little is known about the thermodynamics of such solid solutions. That is, little is known about how the activity coefficients of metal ions vary as a function of composition in solid solutions of various types. The values of the activity coefficients are of interest because they control the extent to which the constituents in the solid solutions will be soluble in water, e.g., the extent to which a toxic metal ion like Cd2+ that is present in calcium carbonate will...
be soluble in water. In this work, activity coefficient values for a variety of environmentally important divalent metal ions are being sought as a function of composition in calcium carbonate. Pankow

**Global Distributions and Mass Balances of Halocarbons, Nitrous Oxide, and Other Trace Gases**

Gases such as CClF (F-11), CClF₂ (F-112) CHClF₂ (F-22), CF₃ (F-14), C₂Cl₃F₂ (F-113), CH₂Cl₂, CH₃Cl and N₂O are being added to the atmosphere by various industrial processes and the use of high-technology products by the public. Such chlorine-containing compounds are believed to threaten the flux of gases into or out of the oceans. The oceans and thus be removed from the atmosphere. Rasmussen

Some atmospheric gases are greatly influenced by natural processes, but over the past century human activities have been adding growing amounts to their natural abundance. This process can upset the cycles of these gases and lead to possibly adverse environmental effects such as the warming of the earth’s surface (N₂O, CO₂, CH₄). When both natural and anthropogenic processes contribute to the current atmospheric abundance of a trace gas, it is of interest to determine the amount which existed before human activities had any effect. Perhaps the only realistic method to determine the composition of the ancient atmosphere is to analyze the air in bubbles buried deep in polar ice. The depth of the ice indicates the age of the air in the bubbles. By going far enough back in time, the relationship between past atmospheric composition and climate might be found. The novel and simple method of studying the old atmosphere of the earth is beset by many problems that complicate the relationship between the gases in the bubbles and the composition of the old atmosphere. Theoretical and experimental research for resolving these problems as well as the measurement of trace gases are the major goals of this project. Rasmussen

**Studies of Past Atmospheres**

Atmospheric gases such as N₂O, CO₂, CO, CH₃Cl, carbonyl sulfide (OCS), and CH₄ are primarily produced by natural processes, but over the past century human activities have been adding growing amounts to their natural abundance. This process can upset the cycles of these gases and lead to possibly adverse environmental effects such as the warming of the earth’s surface (N₂O, CO₂, CH₄). When both natural and anthropogenic processes contribute to the current atmospheric abundance of a trace gas, it is of interest to determine the amount which existed before human activities had any effect. Perhaps the only realistic method to determine the composition of the ancient atmosphere is to analyze the air in bubbles buried deep in polar ice. The depth of the ice indicates the age of the air in the bubbles. By going far enough back in time, the relationship between past atmospheric composition and climate might be found. The novel and simple method of studying the old atmosphere of the earth is beset by many problems that complicate the relationship between the gases in the bubbles and the composition of the old atmosphere. Theoretical and experimental research for resolving these problems as well as the measurement of trace gases are the major goals of this project. Rasmussen

**Ocean-Air Exchange of Gases**

Some atmospheric gases are greatly influenced by the earth’s oceans. For instance, a large amount of the atmospheric methyl chloride (CH₃Cl) and methyl iodide (CH₃I) are produced in the oceans, possibly by biogenic processes. It has also been shown recently that carbonyl sulfide (OCS) is produced in the oceans and subsequently emitted to the atmosphere. On the other hand, man-made gases such as CClF (F-11) can dissolve in the oceans and thus be removed from the atmosphere. This research project is devoted to determining the solubility of such gases in water and to modeling the flux of gases into or out of the oceans. The results obtained are essential ingredients in determining the sources and fates of atmospheric trace gases and in estimating the effects of human activities on the future warming of the earth or depletion of the ozone layer. Rasmussen

**Studies of Atmospheric Methane**

Considerable evidence has been accumulated showing that methane (CH₄) is increasing in the atmosphere, most likely as an indirect result of growing human population. In the future, such an increase of CH₄ can lead to a global warming by enhancing the earth’s natural greenhouse effect and create more ozone and carbon monoxide in the atmosphere. However, it might also prevent some of the destruction of the stratospheric ozone layer by the man-made fluorocarbons 11 and 12. In this project, experimental and theoretical research is focused on statistical trend analyses for the global increase of CH₄, its seasonal variation, sources and sinks, models of its effect on the CO, O₃, and OH cycles and its role in the future of the environment. Rasmussen

**Development of Experimental Methods for Trace Gas Measurements**

At present, some 50 atmospheric gases can be measured at the Trace Gas Laboratory. Still, new methods are needed to improve the accuracy and precision of measurements and to satisfy the stringent demands of ultra-clean background air sampling. New methods are also being developed for automated real-time analysis of many trace gases. Research programs include development of gas chromatographic and mass spectrometric methods for the analysis of trace gases. At present, GC/MS systems in the laboratory are being used to routinely measure C₂-C₁₂ nonmethane hydrocarbons at tens of parts per trillion levels. Techniques for collecting and storing air and water samples also are being developed. Rasmussen

**Biogenic Sources of Atmospheric Gases**

Living organisms produce and consume a variety of gases and may therefore form an integral part of the global cycle of a trace gas. Selected plants and animals, living in the sea or on land, are being studied to determine their role in the cycles of CH₄, N₂O, CH₂Cl₂, CH₄, isoprene and other hydrocarbons. Rasmussen

**The Global Cycle of Carbon Monoxide (CO)**

Based on 15 years of global sampling and the application of modern trend analysis techniques, our data have shown that CO increased in the atmosphere until around 1987 and has since declined. These changes in CO have major implications for atmospheric chemistry and the role of biomass burning in causing global increases of trace gases. Present research includes modeling of the global budgets, seasonal cycles, and potential environmental effects. Rasmussen

**Methane Emissions from Rice Fields**

Methane concentrations have nearly tripled compared to the natural atmosphere of 300 years ago (based on ice core analyses). The increase of rice agriculture to sustain an increasing population may be a major contributor to the increase of methane during the last century. This research program is designed to determine the role of rice agriculture in the global methane cycle. Field experiments are being conducted in China, Indonesia and the U.S. Laboratory experiments and theoretical research are being done at the Global Change Research Center (Portland State University) in a comprehensive research program. This work includes modeling the production, oxidation and transport of methane in the rice paddy ecosystem and measuring the controlling parameters. Rasmussen

**Land-Margin Ecosystem Research in the Columbia River Estuary**

The Columbia River Estuary Land-Margin Ecosystem Research (LME) Program funded by the National Science Foundation focuses on the estuarine turbidity maximum, which is the heart of the estuarine ecosystem. Long-term funding allows analysis of seasonal and interannual variability in estuarine processes and evaluation of the impacts of flow regulation on the system. The extensive data sets collected by this program provide a basis for studies of estuarine circulation, hydraulic control processes at the estuary mouth, nonstationary tidal processes, suspended sediment transport, turbulence and mixing, and biological processes. Jay, Baptista, and external collaborators

**Internal Circulation in Tidal Channels and Straits**

This project, funded by the Office of Naval Research, seeks to use wavelet data analysis techniques and novel modeling strategies to improve our conceptual understanding of estuarine circulation and scalar transport. Continuous wavelet transforms allow resolution of time variation in tidal processes in each frequency band. Dr. Jay's group is using this technique to understand estuarine internal circulation and shelf internal tides in buoyant plumes. Modeling efforts use symbolic mathematics software to provide a balance between the intuitive understanding and compact nature of analytical solutions and the superior flexibility and accuracy of full-numerical solutions. Jay

**CORMIX Graphic User Interface and GIS Database Integration**

This project develops computer information systems for the CORMIX mixing zone water quality model. A fully interactive Windows-based application is proposed, designed to give CORMIX additional functionality, flexibility, and power using object-oriented rule-base technology for forms-based interactive data entry, flow classification, simulation logic description, and GIS database integration. Donecker

**D-CORMIX Decision Support System**

This project involves development, validation, and scientific review of the D-CORMIX decision support system. D-CORMIX is a physically-based simulation model linked to a knowledge-based classification system for predicting of water quality and sediment deposition impacts resulting from dredging operations. The purpose of the project is to assist water quality managers in performing waste load allocations for continuous dredge discharges. The methodologies developed in this project are also necessary for long term pollutant fate and trans-
The overall goal of this project is to advance our quantitative understanding of the fate and bioavailability of chemical elements in estuaries by coupling meso-scale experimentation with diagnostic numerical modeling and field observations. In a preparatory phase, we designed, constructed and instrumented a meso-scale biogeochemical rotating annular flume (RALF). We are beginning the process-based research phase on the project, in which we will focus on elements important for both water quality and ecosystem dynamics, namely the cycling of Fe, Mn, and other divalent metals at sediment-water interfaces (SWI). We are especially interested in quantifying the effect of episodic sediment disruptions on the speciation and phase (dissolved, particulate, and colloidal) of these metals. We are also interested in the effect of shear upon particle desegregation, differential settling, sorption, precipitation, and dissolution. We will place the chemical reactions in a controlled, yet realistic, shear-driven physical environment by conducting primary experiments in the controlled environment of RALF. For more information on this work, see http://www.ccalmr.ogi.edu/ralf/

Baptista, Tratneyk, external collaborators

**CASCADIA SUBDUCTION ZONE TSUNAMIS**

Large tsunamis are believed to be locally generated in the Cascadia Subduction Zone (CSZ) every 200 to 600 years, based on geological records. The last large tsunami dates back about 300 years, raising concerns about the protection of coastal communities in Oregon, Washington, California, and British Columbia. The coastal impact of potential CSZ tsunamis is being investigated through numerical modeling. The need to use geological evidence on paleotsunamis as the sole, loose reference for model validation makes this an unusually interesting and challenging problem. The Oregon Department of Geology and Mineral Industry (DOGAMI) has incorporated our joint research results into the development of tsunami inundation maps for the Oregon and Washington coasts. 

**Baptista, Jay, external collaborators**

**RESEARCH CENTERS**

**CENTER FOR GROUNDWATER RESEARCH**

The principal mission of the Center for Groundwater Research (CGR) is to conduct state-of-the-art research in areas relating to the transport and fate of contaminants in the subsurface. This is accomplished through a combination of research grants and contracts, support from Center corporate sponsors, and through collaboration with other universities, industries, and government agencies.

The Center coordinates a range of projects relating to the transport and fate of contaminants in soils and groundwater. The scope of the Center includes, among other things, the development of: 1) new sampling and site characterization techniques; 2) new analytical techniques; and 3) improved groundwater remediation methods.

The Center operates the Large Experimental Aquifer Program (LEAP) which contains the experimental cells outlined below. The LEAP facility provides staff with the capability to conduct both bench-scale experiments and pilot-scale demonstrations. Current projects include transport through fractured clay, air sparging of source petroleum zones containing MTBE, and a pilot scale demonstration of zeolite as an in-situ permeable barrier material.

Students involved in LEAP research graduate with a rare combination of experience in full-scale remediation engineering and a process-level understanding of contaminant hydrology and chemistry.

Additional information about CGR may be obtained from:

**DR. RICHARD JOHNSON**

phone: (503) 748-1193  e-mail: rjohnson@ese.ogi.edu

CGR Web site: cgr.ese.ogi.edu

**CGR FACULTY**

Richard Johnson, Associate Professor
Paul Tratnyek, Associate Professor
James F. Pankow, Professor
Patricia L. Toccalino, Assistant Professor

**LEAP EQUIPMENT**

- Five tanks: one 10 m x 10 m x 3 m, two 10 m x 10 m x 5 m, one 10 m x 2.5 m x 0.5 m, and one 8 m x 2.5 m x 0.5 m
- In situ instrumentation, including: automated temperature, pressure, and water level monitoring; multilevel samplers; down hole video camera; and automated vapor and product sensing equipment
- Remediation equipment, including soil vapor extraction and air sparging capabilities
- Automated on-site analytical equipment, including capillary GC-MS instrumentation

**CENTER FOR COASTAL AND LAND MARGIN RESEARCH (CCALMR)**

The Center for Coastal and Land Margin Research (CCALMR) is an interdisciplinary research center affiliated with the Department of Environmental Science and Engineering. CCALMR conducts research, graduate education and advanced technology development that directly address the need for better scientific understanding of coasts, land margins and estuaries. Improved knowledge of these complex systems is necessary to preserve and enhance their environmental integrity, maintain the economic viability of communities dependent on them and protect human populations from natural and man-made hazards.

Real-world natural resource management issues motivate CCALMR research and education activities. Insights drawn from the experience of science and engineering professionals in the public and private sectors influence the identification of emerging research challenges, the design of research projects, the development of supporting tools and applications and the transfer of knowledge and technology.

Additional information about CCALMR may be obtained from:
CCALMR FEATURED PROJECTS
- Cascadia Subduction Zone tsunamis
- CORIE: a pilot estuarine nowcast-forecast system
- CORMIX: mixing zone decision support system
- Coupled physical and biogeochemical processes at sediment-water interfaces
- Internal circulation in tidal channels and straits
- Land-margin ecosystem research in the Columbia River estuary
- Ocean survival of salmonids
- Reduction reactions of organic pollutants in anaerobic environments
- Trace element distributions
- Watershed analysis

CCALMR FACILITY
The Center is well equipped to conduct state-of-the-art scientific research. The following is a list of facilities and instruments available in addition to those available through the Department of Environmental Science and Engineering.

OCEANOGRAPHIC EQUIPMENT
- 300, 600 and 1200 kHz Acoustic Doppler current profilers (RD)
- 500 and 1500 kHz Acoustic doppler profilers (Sontek)
- Conductivity and temperature pairs (Seabird)
- Conductivity, temperature and pressure sensors (Coastal Leasing and Ocean Sensors)
- Echosounder and digitizer (Ross)
- Optical backscatter sensors (Downing Associates)
- Wind gauges (Coastal Leasing)
- High-density thermistor chains (CCALMR)
- Differential GPS (Trimble)
- Spread spectrum radio data modems (FreeWave)

REAL-TIME DATA ACQUISITION NETWORK (CORIE)
The pilot nowcast-forecast system CORIE includes a real-time data acquisition network with twelve multi-sensor oceanographic stations in the Columbia River estuary. Field operations are conducted from the Marine Environmental Research and Training Station (MERTS). MERTS is a facility developed in partnership with and operated by the Clatsop Community College (CCC). CCC operates two training and research vessels: the 50-foot M/V Forerunner and the 21-foot R/V Tansy Point.

BIOGEOCHEMICAL ROTATING ANNULAR FLUME (RALF)
RALF, a 2-meter biogeochemical rotating annular flume, supports research on coupled physical and biogeochemical processes at sediment-water interfaces. Instrumentation providing real-time or pseudo real-time data include:
- 3-dimensional Acoustic Doppler Velocimeter (Sontek)
- DO (Orion) and pH/ISE (Orion)
- DLK-100 Potentiostat (AIS)
- Solid State Au/Hg amalgam microelectrodes
- Bipotentiostat equipped with rotating disk electrode (Pine)

RESEARCH FACILITIES
The department is well equipped to carry on a vigorous research program. Instruments and equipment available, in addition to those listed for the centers, include:

GENERAL AND ANALYTICAL EQUIPMENT
- Carbon/nitrogen/sulfur analyzer
- Several high-performance liquid chromatographs with UV-absorbance, fluorescence, refraction index, and conductivity detectors.
- Ion chromatograph
- Graphite furnace atomic absorption spectrophotometer
- Access to FT-IR, fluorescence, diode array UV/VIS, scanning UV/VI Spearmet spectrophotometers
- Access to scanning electron microscopes
- Access to a complete Raman spectroscopy facility
- Purge and trap concentrator and thermal desorption apparatus
- Rain and air sampling equipment
- Groundwater and soil sampling equipment
- Groundwater monitoring equipment, including water table, ambient, and ground temperature measurement, and pressure transducers all integrated into a data logging system
- Equipment for supercritical fluid extraction and supercritical fluid chromatography
- Several rapid flow injection analysis systems
- Sediment samplers
- Two-dimensional polycrylamidgel densitometer
- Aerosol samplers
- Trace reduction-gas analyzer
- Liquid nitrogen freezer

COMPUTER EQUIPMENT
- Computer lab with numerous Pentium and Pentium Pro PCs running Windows NT
- SPARC workstations
- Network access via X-terminals and personal computers
- Numerous IBM compatible and Apple Macintosh computers with HP LaserJet printers, digitizing tablets, plotters and a film image recorder

SUPPORT FACILITIES
- Fully equipped machine shop
- Toxic chemicals handling laboratory
- Electronics support personnel
- Greenhouse facility and growth chambers
ANTÓNIO M. BAPTISTA
Professor and Department Head
Director, Center for Coastal and
Land-Margin Research
Ph.D., Civil Engineering
Massachusetts Institute of
Technology, 1987
baptista@ccalmr.ogi.edu

RESEARCH INTERESTS
Integrated understanding and
prediction of hydrodynamic
and environmental processes
in estuaries and coasts.
Development of associated
criteria and technologies:
environmental observation and
forecasting systems, numerical
methods and models, physically-
based ecological indicators.

REPRESENTATIVE PUBLICATIONS
Baptista, A.M. “Environmental
Observation and Forecasting Systems.”
Encyclopedia of Physical Science and
Technology, 3rd Edition, Volume 5,
Academic Press, in press.
Myers, E.P. and A.M. Baptista,
“Numerical Techniques For Simulating
the 1983 Hokkaido Nansei-oki and 1964 Alaska Tsunamis,”
Oliveira A., A.B. Fortunato, and A.M. Baptista
“Mass Balance in Eulerian-
Lagrangian Transport Simulations in
Estuaries,” ASCE Journal of Hydraulic
Yang Z., A.M. Baptista, and J.
Darland, “Numerical Modeling of Flow
Characteristics in a Rotating Annular
Plume,” Dynamics of Atmospheres and
Baptista, A.M., M. Wilkin, P. Pearson,
P. Turner, C. McCandlish, and P.
Barrett, “Coastal And Estuarine
Forecast Systems: A Multi-Purpose
Infrastructure for the Columbia River,”
Earth System Monitor, 9(3), National
Oceanic and Atmospheric
Oliveira A. and A.M. Baptista,
“On the Role of Tracking in Eulerian-
Lagrangian Solutions of the Transport
Equation,” Advances in Water

ROBERT L. DONEKER, P.E.
Assistant Professor
Ph.D., Environmental Engineering
Cornell University, 1989
doneker@ese.ogi.edu

RESEARCH INTERESTS
Development of decision support
systems for environmental
simulation modeling, design
optimization, and natural
resource management. Current
research areas focus on
development of technology transfer
systems with emphasis on water
quality modeling and control of
point and nonpoint source
treated water.

REPRESENTATIVE PUBLICATIONS
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Jets’ by P.W. Roberts, A. Ferrier, and G.
Daviero, Journal of Hydraulic
Engineering, ASCE, vol. 125 No.3
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Doneker, “Using GLEAMS to Evaluate
the Agricultural Waste Application
Rule-Based Decision Support System
(AWRDS) Computer Program”. Water
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Design of Aquifer Pollutant Discharges,”
Journal of Water Resources Planning
and Management, ASCE, Vol. 117,
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Jirka, G.H., and R.L. Doneker
“Hydrodynamic Classification of
Submerged Single Port Discharges,”
Journal of Hydraulics Division, ASCE,
Jirka G.H., R.L Doneker, and T.O.
Barnwell, “CORMIX: A Comprehensive
Expert System for Mixing Zone Analysis
of Aquifer Pollutant Discharges.”
Water Science and Technology, 24,
No. 6, 267-274, 1991.
Doneker R.L., and G.H. Jirka,
“Schematization in Regulatory Mixing
Zone Analysis”, Journal of Water
Resources Planning and Management,
Doneker, R.L., and G.H. Jirka,
“CORMIX-GI Systems for Mixing Zone
Analysis of Brine Waste Water

DAVID A. JAY
Associate Professor
Ph.D., Physical Oceanography
University of Washington, 1987
djay@ese.ogi.edu

RESEARCH INTERESTS
River basin, estuarine, and
continental shelf processes,
turbulent mixing, tides and tidal
analysis. A unifying theme is the
influence of hydrodynamic
processes on ecosystems.

REPRESENTATIVE PUBLICATIONS
Cudaback, Cynthia N. and D. A. Jay,
2001, “Tidal asymmetry in an estuarine
pycnocline, 2”, Transport J. Geophys.
Res. 106: 2629-2652.
Cudaback, C. N., and D. A. Jay, 2000,
“Tidal asymmetry in an estuarine pycn-
ocline: Depth and thickness”, J.
Jay, D. A., W. R. Geyer and
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tidal analysis methods”, Coast.
Jay, D. A. and Flinchem, E. P., 1997,
“Interaction of fluctuating river flow
with a barotropic tide: A test of wavelet
tidal analysis methods”, J. Geophys.
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& C. Neaville, E.E. Hansen, S.M. Stearns,
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Release”, J. Environmental Quality, 30,
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Johnson, P.C., M. W. Kemblowski,
K. L. Johnson. “Assessing the signifi-
cance of subsurface contaminant vapor
migration to enclosed spaces: site-spe-
cific alternatives to generic estimates.”
Daily, W., A. Ramirez and R.L.
Johnson. “Cressh-hole electrical
imaging of a controlled saline tracer
injection.” J. Applied Geophysics, 44,
Johnson, P.C., R.L. Johnson,
C. Neaville, E.E. Hansen, S.M. Stearns,
and I.J. Dortch, “An Assessment of
Specific Alternatives to Generic
 Estimates,” Ground Water, 35(6),

RICHARD L. JOHNSON
Associate Professor and Director,
Center for Groundwater Research
Ph.D., Environmental Science
Oregon Graduation Center, 1985
rjohnson@ese.ogi.edu

RESEARCH INTERESTS
Physical and chemical behavior of
organic contaminants in the
air, soil, and water; analytical
organic chemistry; groundwater
transport, fate, and modeling of
contaminants in porous and
fractured porous media.

REPRESENTATIVE PUBLICATIONS
“Air Distribution During In Situ Air
Sparging: An Overview of Mathematical
Modeling”, J. Hazardous Materials
Johnson, K.L., J.F. Pankow, D. Bender,
C. Price and J. Zogorski. “To What
Extent Will Past MTBE Releases
Contaminate Community Water Supply
Wells?” Environ. Science and Technol.
Slater, L., A.M. Banley, W. Daily and
K.L. Johnson. “Cressh-hole electrical
imaging of a controlled saline tracer
injection.” J. Applied Geophysics, 44,
Johnson, P.C., R.L. Johnson,
C. Neaville, E.E. Hansen, S.M. Stearns,
and I.J. Dortch, “An Assessment of
Conventional In situ Air Sparging
Tests,” Ground Water, 35(6),
JAMES F. PANKOW  
Professor  
Ph.D., Environmental Engineering Science  
California Institute of Technology, 1978  
pankow@ese.ogi.edu

RESEARCH INTERESTS  
Physical and analytical chemistry of organic compounds and metals in natural waters and in the atmosphere; the formation and chemistry of atmospheric aerosols; the chemistry of nicotine in tobacco smoke.

REPRESENTATIVE PUBLICATIONS  


REINHOLD A. RASMUSSEN  
Professor  
Ph.D., Botany Plant Physiology  
Washington University, St. Louis, 1964  
rrrasmus@ese.ogi.edu

RESEARCH INTERESTS  
Atmospheric chemistry of trace gases; biogenic and anthropogenic emissions of trace gases and their roles in stratospheric ozone destruction and tropospheric ozone formation; measurements of trace gases at parts per trillion to parts per quadrillion levels; sources and sinks of isoprene and other hydrocarbons.

REPRESENTATIVE PUBLICATIONS  


PATRICIA L. TOCCALINO  
Assistant Professor and Director of Education  
Ph.D., Environmental Science and Engineering  
Oregon Graduate Institute of Science and Technology, 1992  
toccalino@ese.ogi.edu

RESEARCH INTERESTS  
Human and ecological risk assessments, water-quality assessments, optimization of hydrocarbon biodegradation in soil and subsurface systems, contaminant fate and transport in various environmental media.

REPRESENTATIVE PUBLICATIONS AND TECHNICAL REPORTS  


Toccalino, P. L. 1997. Evaluation of the Contained Burn of Two M88 NIKE Rocket Motors for Environmental Safety & Health Implications, Nevada Test Site X-Tunnel Facility (U25X), Las Vegas, NV.


PAUL G. TRATNYEK  
Associate Professor  
Ph.D., Chemistry  
Colorado School of Mines, 1987  
tratnyek@ese.ogi.edu

RESEARCH INTERESTS  
Mechanistic and kinetic aspects of the fate of organic pollutants in the environment; interactions of reactions involving pesticides, phenols, munitions, dyestuffs and chlorinated hydrocarbon solvents; chemical and microbiological processes in sediments, soils and groundwater as well as photochemical processes in surface waters; natural and engineered remediation systems.

REPRESENTATIVE PUBLICATIONS  


JOINT APPOINTMENTS

DR. J. FRED HOLMES
Electrical and Computer Engineering
OGI School of Science and Engineering

DR. JAMES HUNTZICKER
Center for Professional Development
OGI School of Science and Engineering

ADJUNCT FACULTY

DR. MARY ABRAMS
DEQ Laboratory Division
Oregon Department of Environmental Quality

DR. DAVID BOONE
Department of Environmental Biology, Portland State University

DR. NORMAN EDER
Conkling Fiskum & McCormick, Inc.

DR. WILLIAM FISH
Department of Environmental Sciences and Resources, Portland State University

DR. BRUCE HOPE
Environmental Toxicologist, Oregon Department of Environmental Quality

DR. ASLAM KHALIL
Department of Physics, Portland State University

KENNETH ROSENBAUM, J.D.
Environmental Law Institute (Visiting Scholar), Washington, D.C.

DR. JOHN C. WESTALL
Department of Chemistry, Oregon State University

RESEARCH SCIENTISTS

ARUN CHAWLA
Research Scientist
Ph.D., Civil Engineering, University of Delaware

WENTAI LUO
Research Scientist
Ph.D., Environmental Science and Engineering, Oregon Graduate Institute

TODD SANDERS
Research Scientist
Ph.D., Physical Oceanography, University of Delaware

DOUG WILSON
Research Scientist
Ph.D., Physical Oceanography, Memorial University of Newfoundland

YINGLONG (JOSEPH) ZHANG
Research Scientist
Ph.D., Applied Mathematics and Fluid Mechanics, University of Wollongong, Australia

MICHAEL ZULAUF
Research Scientist
Ph.D., Meteorology, University of Utah

SENIOR STAFF

BOB DALLUGE
Research Associate
B.S., Psychology, Washington State University

ANNA FARRENKOPF
Research Associate
Ph.D., Marine Studies, University of Delaware at Lewes

LORNE M. ISABELLE
Senior Research Associate
M.S., Chemistry, San Francisco State University

COLE MC CANDLISH
Scientific Programmer
M.S., Atmospheric Sciences, Oregon State University

ROSEMARIE MIEHR
Research Associate
Ph.D., Chemistry, Technical University, Munich, Germany

JIM MOHAN
Systems Manager
M.S., Management in Science and Technology, Oregon Graduate Institute

INGA O’BRIEN
Research Associate
B.S., Physical Oceanography, University of Michigan

ROBYN PHILLIPS
Research Associate
M.S., Environmental Management/Toxicology, Duke University

CHARLES SEATON
Research Assistant
M.S. Environmental Science & Engineering, Oregon Graduate Institute

BOB WATKINS
Research Technician
B.S., Chemical Engineering, Washington State University

MICHAEL WILKIN
Research Associate
B.S., Oceanography and Geology, University of Southampton, U.K.
THE DEPARTMENT OF MANAGEMENT IN SCIENCE AND TECHNOLOGY provides the rigorous educational preparation necessary for highly effective managerial- and professional-level work in industries, organizations and departments that have a strong technical, engineering, manufacturing or scientific orientation.

Our courses, certificate and master’s degree programs focus on managing people and processes and building effective and competitive organizations in the specific contexts of technology and science. Managing change and competing in the global marketplace are prominent themes in the MST program.

LEARN ON-LINE, ANYTIME, ANYWHERE

MST delivers challenging and engaging versions of its courses over the Internet. This is an excellent option for students facing time pressures or working in locations where travel to the OGI campus is not feasible. The course delivery system is based on interactive multimedia lectures and lessons, faculty-managed chat, and online discussions, all in a seamless browser-centric environment. Students can take individual courses, enroll in the Certificate in Management in Science and Technology program, or apply for the full Master of Science degree (currently only the Managing the Technology Company degree option is offered on-line). Courses offered on-line will have a “D” designation following the course number. For further information dial toll free in the U.S. 1-877-GO TO OGI (1-877-468-6644) or visit the MST on-line learning Web site: http://elearning.cenquest.com/

INDIVIDUAL COURSES IN MST

Each MST course has been designed as a valuable professional development experience for working professionals. Project Management, Quality Management, Building Effective Organizations in Science and Technology, for example, may be taken as stand-alone courses. We encourage non-matriculated students to join our courses for their own career development in specific areas.

CERTIFICATE OPTIONS

The MST department offers certificates in Management Studies and Technology, Building the General Manager, and Industrial Design.

MANAGEMENT STUDIES

MST offers a six-course certificate in Management Studies. The following five courses, plus an additional MST elective course chosen in consultation with a faculty advisor, are required:

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MST501/501D</td>
<td>Managerial and Financial Accounting for Science</td>
<td>4</td>
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<td>and Technology</td>
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<tr>
<td>MST503/503D</td>
<td>Marketing in Science and Technology</td>
<td>4</td>
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<tr>
<td>MST510/510D</td>
<td>Principles and Trends in Technology Management</td>
<td>3</td>
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<td>MST512/512D</td>
<td>Project Management</td>
<td>3</td>
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<tr>
<td>MST520/520D</td>
<td>Managing in Science and Technology</td>
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<td>Elective to be chosen after consultation</td>
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<td>with faculty advisor</td>
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BUILDING THE GENERAL MANAGER (BGM) A CERTIFICATE PROGRAM FOR SENIOR MANAGERS IN TECHNOLOGY-INTENSIVE COMPANIES

The program focuses on building general management skills needed to successfully manage the established but still-growing high-tech business, and can be completed in a series of long weekends over the course of one year.

The ideal BGM participant does not need an additional degree for career advancement, can spare the time only for a concentrated program, and wishes to leverage the learning experience to build a network of peers in other technology companies.

The three key areas of the BGM Certificate are: Business Management Foundations, which selectively draws on MST courses; and Executive Assessment and Coaching, which is incorporated into the program with pre- and post-assessment and jointly undertaken with incumbent companies; and Building Executive Leadership Skills, which serves as the core of the program.

BUILDING EXECUTIVE LEADERSHIP SKILLS CORE (6 CREDITS)

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<tr>
<td>MST541/541D</td>
<td>Seminar in Leadership Development</td>
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<tr>
<td>MST522/522D</td>
<td>Building Effective Organizations</td>
<td>3</td>
</tr>
</tbody>
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MST student Dave Kennedy presents a business plan for his Capstone Project.
In addition, four workshops, chosen in consultation with the firms employing each BGM participant, help build executive skills. Workshops conclude with a team project—a high-impact business project for the company. Nationally recognized instructors join the OGI faculty to teach these executive workshops. Titles include: Leading the Strategy Process; Mindset and Skills for Managing Globally; Managing Development Projects for Profits, Growth and Renewal; and Managing for Innovation and Leading Change.

### Industrial Design

This certificate program introduces participants to the full range of activities involved in the design of products for industry and the marketplace. The role of the ID process within the organization is addressed, as are the key elements of an effective design project from conceptualization to product manufacturing, product launch and marketing program.

Topics taught include new product development and design management strategy, application of CAD in product development (including CAD/CAE/CAM integration), and an overview of future development in technology for ID and manufacturing. During the previous year, certificate requirements included 40 contact-hours in Industrial Design, 40 contact-hours in Modeling Computer Aided Development, 20 contact-hours in management seminars, plus a number of site visits.

### Admission Requirements

Admission requirements are the same as the general requirements for the institution. In addition, the MST department requires:

- A bachelor, master or doctoral degree from an accredited institution
- A recommended cumulative undergraduate grade point average of 3.0
- A minimum of two years of full-time work experience-preferably at the professional, supervisory or managerial level-in a technical, scientific, business, or related area
- Three letters of recommendation, one of which should come from an employer or supervisor
- Recommended TOEFL score of 625 if English is not the applicant’s first language. Scores are not required for students who earned an undergraduate degree in the United States, or who have worked for a business for at least two years and where the primary business language is English
- GMAT or GRE scores are not required, except under certain circumstances

Part-time students may apply for admission to the M.S. program during any quarter. Full-time students must begin in the fall quarter.

### Degree Requirements

MST offers a non-thesis M.S. in Management in Science and Technology. Students elect one of three areas of concentration within the degree program: Managing the Technology Company, Computational Finance or Managing in the Software Industries. Students must complete a minimum of 53 credits with an average of 'B' or better; up to four courses or twelve credits taken in the department prior to matriculation may be used toward the degree requirements.

#### MST Core Sequence

All M.S. students must take the MST core sequence, consisting of the following courses or their equivalent (38 credits). The courses listed below are offered both on-campus and on-line. Either is acceptable for the M.S. in Management in Science and Technology degree. If you intend to take ONLY on-line courses, please see the Distance Degree Requirements after this section.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST500/500D</td>
<td>Managerial and Financial Accounting for Science &amp; Technology</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST502/502D</td>
<td>Financial Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST503/503D</td>
<td>Marketing: Planning for Market</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST510/510D</td>
<td>Principles and Trends in Management Technology</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST512/512D</td>
<td>Project Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST513/513D</td>
<td>Manufacturing Practices and Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST520/520D</td>
<td>Managing in Science and Technology</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST530/530D</td>
<td>Strategic Management and Planning</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST550/550D</td>
<td>Capstone Project: Business Plan</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST590/590D</td>
<td>Effective Business Writing for Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST591/591D</td>
<td>Professional Writing for Non-native Speakers</td>
<td>1 credit</td>
</tr>
</tbody>
</table>

### Area of Emphasis

All emphasis areas require the completion of the 34-credit M.S. core sequence. Specific courses required for each emphasis area are as follows:

#### Managing the Technology Company Sequence

Core Sequence plus three of the following MST Core Sequence plus three of the following five courses are required (9 credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST521/521D</td>
<td>Quality Management</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST514/514D</td>
<td>Issues in R&amp;D Management</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST522/522D</td>
<td>Building Effective Organizations in Science and Technology</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

#### Computational Finance Sequence

MST Core Sequence plus the following three courses are required (9 credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINS41</td>
<td>Principles of Modern Finance</td>
<td>3 credits</td>
</tr>
<tr>
<td>FINS51</td>
<td>Options and Futures I</td>
<td>3 credits</td>
</tr>
<tr>
<td>FINS51</td>
<td>Risk Management</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Electives: three of the following courses are required (9 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINS44</td>
<td>Investment and Portfolio Management</td>
<td>3 credits</td>
</tr>
<tr>
<td>FINS47</td>
<td>Global Markets and Foreign Exchange</td>
<td>3 credits</td>
</tr>
<tr>
<td>FINS52</td>
<td>Options and Futures II</td>
<td>3 credits</td>
</tr>
</tbody>
</table>
MST DISTANCE DEGREE REQUIREMENTS

The department of Management in Science and Technology recommends that students take at least two on-campus courses. A proctored comprehensive exam may be required at or near the completion of the MST Distance degree requirements. Students must complete a minimum of 52 credits with an average of B or better.

**MST DISTANCE CORE SEQUENCE**

All M.S. student must take the MST core sequence, consisting of the following courses or their equivalent (34 credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST501D</td>
<td>Managerial and Financial Accounting for Science and Technology</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST502D</td>
<td>Marketing Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST503D</td>
<td>Marketing in Science and Technology</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST506D</td>
<td>Principles and Trends in Technology Management</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Students should note that tuition for the CSE Computational Finance courses listed above (FINxxx) is higher than for other OGI courses.

MANAGING IN THE SOFTWARE INDUSTRIES SEQUENCE

MST Core Sequence plus the following two courses are required (6 credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST530D</td>
<td>Strategic Management and Planning</td>
<td>4 credits</td>
</tr>
<tr>
<td>MST500D</td>
<td>Capstone Project: Business Plan</td>
<td>4 credits</td>
</tr>
</tbody>
</table>

**DISTANCE DEGREE**

MST currently offers only the Managing the Technology Company emphasis to students who take only online classes.

MANAGING THE TECHNOLOGY COMPANY DISTANCE SEQUENCE

MST Distance Core Sequence plus three of the following four courses are required (9 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST510D</td>
<td>Quality Management</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST514D</td>
<td>Issues in R&amp;D Management</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST522D</td>
<td>Building Effective Organizations in Science and Technology</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST540D</td>
<td>International Management in Science and Technology</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Electives: any course in the above list not already taken and/or any of the following (9 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST521D</td>
<td>Human Resource Management in Science and Technology</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST544D</td>
<td>Strategic Alliances</td>
<td>3 credits</td>
</tr>
<tr>
<td>MST58XD</td>
<td>Special Topics</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Students may petition the MST department head for elective credits for other OGI academic courses relevant to the theory or practice of management.

YOU CAN COMPLETE YOUR ENTIRE DEGREE ONLINE!

**COURSE DESCRIPTIONS**

**MST 501, MST 501D Managerial and Financial Accounting for Science and Technology**

The course focuses on understanding and evaluating financial reports and information for use in making decisions, particularly as they pertain to managing in science, technology, engineering, and manufacturing. 4 credits

**MST 502, MST 502D Financial Management for Science and Technology**

The course combines a survey of the relevant aspects of micro- and macroeconomics with in-depth study of key concepts in financial management of a firm, financial structure and financial analysis of the firm, working capital management and short- and long-term financing. Particular attention is paid to valuation of investment alternatives through study of risk and rates of return, bond and stock valuation, and capital budgeting. The course is designed to achieve balance between understanding theoretical foundations and techniques of practical application. Prerequisite: MST 501. 4 credits

**MST 503, MST 503D Marketing in Science and Technology**

The course introduces the graduate student to the full range of issues and activities involved in the marketing of technology-based products. The role of marketing within the organization is addressed, as are the key elements of an effective marketing program. The course is organized to cover the full product introduction process, from market identification to product conception and definition, to market research, to competitive analysis, and ultimately, to product launch. Topics include pricing, sales and distribution alternatives, and marketing communications. To the extent possible, assignments utilize or draw from students’ work experiences in technology, engineering, manufacturing, and science. 4 credits

**MST 504, Marketing: Going to Market**

The overall goal of this course is to teach students to write a marketing plan that develops a product or service’s business model and persuasively makes the business case. This goal is achieved by using two strategies: by helping students understand and apply the critical concepts and principles driving the implementation of a high technology-oriented marketing plan, and by helping students acquire and develop the language, methodologies, models, processes, standards, tools, and skills for analyzing and dealing with the high technology opportunities and challenges facing marketing at the dawn of this new century. 3 credits

**MST 510, MST 510D Principles and Trends in Technology Management**

This course is about how companies choose, acquire, and develop the technologies that they use to develop, manufacture, deliver and support their products. We look at these practices both from the vendor and buyer points of view, and also consider internal technology development for internal use. Other topics addressed include profitably managing technology cycles; standards, technology forecasting; and the technology startup company. Related topics such as competitive analysis, managing researchers, and maintaining an innovative organizational atmosphere are dealt with in MST 503 and MST 514. The format includes lectures, discussions, guest speakers, and team and homework projects. 3 credits

**MST 511, MST 511D Quality Management**

The course covers total quality management (TQM) from the managerial vantage point—that is, both the behavioral and operations management aspects, excluding sophisticated statistical analysis, of TQM are addressed. Classroom discussion, based on the participants’ experiences and the assigned readings from the text and cases, is the primary source of learning for many students. Lectures are used but generally as a basis for a facilitated discussion led by the instructor. The limitations of TQM also are discussed, given the inherent risks of excessive optimism associated with any social trend or perceived panacea. 3 credits
MST 512, MST 512D Project Management
The course focuses on the managerial aspects of project selection and management. Topics addressed include planning, design, scheduling, implementation, control, evaluation, and termination. 4 credits

MST 513, MST 513D Manufacturing Practices and Management
Topics covered include practices and trends in the overall design, analysis, organization, and control of manufacturing operations, as well as relationships with vendors, suppliers, and customers. 3 credits

MST 514, MST 514D Issues in R & D Management
Participants examine issues in managing R&D and technological innovation in an environment of increasing time- and competence-based competition, a competition that is simultaneously global and local in both markets and technology, where competitors draw on an existing technology base that supports incremental innovation through radical innovation, and where quality is a given. Particular attention is given to R&D management issues in integrating technology into business strategy and operations, managing internal development and external sourcing of technology, seeking competitive advantage through collaborative advantage, and building new technical competence as a part of every project. Key trends, new conceptual frameworks, management tools and techniques, and best practices in R&D management are examined through presentation, interactive class discussions, selected readings, case studies, and a number of invited speakers from both small and large companies. 3 credits

MST 515 Supply Chain Management
This is a course in Supply Chain Management, a term which denotes a total system approach to the management of all of those activities involved in physically moving raw materials, inventory, and finished goods inventory from point of origin to point of consumption. Supply Chain Management (SCM) is a system approach to managing the entire flow of information, materials, products, and financial funds to and from suppliers and end-customers. 3 credits

MST 516 SCM – Advanced Modeling
This course will introduce the use of mathematical programming in supply chain modeling. The emphasis will be mainly on large-scale optimization of real-world supply chain distribution networks. The major skills taught are problem definition, model formulation, and solution analysis. We will teach the use of commercial software, which include the MAPLE algebraic modeling system for planning problems, What's BEST for decision-making, and GSCM for large mixed-integer programming network design. 3 credits

MST 517 Global Logistics and Financial Management
The global environment that characterizes the business world of today has pointed out the importance of developing strategies that go beyond the geographical boundaries of one country. Nowadays, it is not uncommon to see a company that develops a new product in the US manufactures it in Asia and sells it in Europe. Wage-rate differentials, expanding foreign markets, and improved transportation are breaking down barriers of time and space between countries, forcing the logistics function to take a global dimension. Global logistics is the response to the increasing integration of international markets as firms try to remain competitive.

The emphasis of the course is the operations and logistics function in firms that source, produce, distribute and market in multiple nations. The management of logistics in such firms differs from its domestic counterpart along several key dimensions. First, there is the need to be able to identify and analyze factors that differ across nations, which influence the effectiveness of this function. These include worker productivity, process adaptability, governmental concerns, transportation availability, culture and soon. In addition, because of the distances involved, transportation and distribution are of greater significance. Finally, these geographically dispersed set of facilities and markets must be integrated and manage to enhance the strategy of the business unit. Therefore, some of the sessions of the course will focus on cross-national decisions and others will focus on managing across nations. 3 credits

MST 520, MST 520D Managing in Science and Technology
This course focuses on developing participants' ability to understand and influence human behavior. Four theory-based frames are elaborated and used for understanding human behavior. Using the structural frame, we examine work design and redesign for individuals and groups, and consider the impact of restructuring. Using the human resource frame, we examine interpersonal and group dynamics, communication and creativity. Using the political frame, we consider power, conflict, and differences in the workplace. Using the symbolic frame, we examine the impact of individual leadership and corporate culture on organizational outcomes.

The course also examines the influence processes and network of relationships required for managing research scientists, engineers, and other professionals, as individuals and in teams, in a fast-changing environment. Self-assessment, networking, and developmental relationships are explored as means of developing influence and having impact within a technologically driven organization. 4 credits

MST 521, MST 521D Human Resource Management in Science and Technology
This course focuses on the development, implementation, and evaluation of human resource management (HRM) systems, and the relationship between an organization's HRM practices and the organization's effectiveness and competitive success. Specifically, the course addresses the choices an organization must make in three HRM policy areas: organization of work and employee influence; personnel flows and development; and measurement and rewards. We consider the perspectives of both the line manager and the HRM specialist in examining these three policy areas. The course also includes a limited overview of employment law, with a particular focus on recent cases and changes in employment legislation. 3 credits

MST 522, MST 522D Building Effective Organizations in Science and Technology
This course focuses on designing effective organizations and managing change in organizations in which engineering, manufacturing, and/or scientific technologies are critical. Tools for assessing the need for reorganization and implementing structural changes are emphasized. The course pays special attention to organizing for lateral coordination and integration, as this is a required capability in technology-intensive organizations. Students are invited to consider the relationship between organizational theory and practice. A range of theoretical perspectives is reviewed, and students are encouraged to compile their own approach by combining those presented. Extensive use is made of cases and actual examples drawn from the readings and from course participants' experiences. Taking MST 520 first is recommended. 3 credits

MST 523 New Product Development
Successful product development has been key to survival in today's competitive markets. This course was designed to address professionals who are in product development organizations or support such organizations. It has been seen that technology integration and creating innovative environments have been critical to developing profitable products in today's technology oriented companies. The course will review cases and published articles addressing key issues in new product development. Topics such as Disruptive Technologies, Technology Integration, Concurrent Engineering, and Managing Technological Innovation will be covered. 4 credits

MST 524 Digital Economy: Strategy for Success
The purpose of this course is to equip the student with a practical and conceptual understanding of what it takes to develop and maintain a competitive advantage in the new economy. We will look at it from several perspectives. We will start by investigating the fundamental changes that the Internet and other technologies introduce in the economy and how this completely changes the rules of the competitive game. We will then look at how entire industries and activities are being transformed and why.

In the second part of the course we will look at strategy from several angles. The first one will address the question of what a company should consider to develop its competitive advantage and its competitive strategy. The second angle will address the Internet marketing side or how to go to market and rise to the top. The third angle is addressing the question of how successful companies organize and what they do to operate at the "speed of change." Students will use the learning they acquire to develop a business concept to be presented at the last session. The course will be supported by a Web site, where course materials and resources will be made available. We will also carry discussions off-line. Several executives from local companies have been invited to share their experience in the dot-com world. 4 credits
MST 530, MST 530D Strategic Management and Planning
This course focuses on the analysis of the competitive environment and on the decision-making process leading to the formulation and implementation of strategy. Other topics include using time, knowledge, and technologies as competitive advantages, managing strategic change, and developing strategic plans. Prerequisites: MST 502, MST 503, MST 520. 4 credits

MST 531 Software Commercialization
This course examines the structure of the software industry, and problems of marketing privately developed software and commercializing software from the government and nonprofit sector. Because the business models for hardware and software companies are quite different, the course focuses on the special problems of marketing, entrepreneurship, globalization, and alliances experienced by software firms. Relationships between marketing strategy and development strategy also are examined. 3 credits

MST 540, MST 540D International Management in Science and Technology
Topics in this course include trends in the conduct of international business, the international business environment, the operation of multinational enterprises, international technology transfer, and the special considerations associated with managing on the international level. 3 credits

MST 541 Leadership and Negotiation
This course focuses on the negotiation and interpersonal communication skills required to exercise effective leadership. Topics include creating clarity about one's own values and mission, exercising influence through both formal and informal authority channels, and being a catalyst for change. 3 credits

MST 542 Seminar in Social Issues in Management
This course focuses on ethical dilemmas, social issues and responsibilities, and government regulations and influences. First, the course examines different frameworks for individual decision making in an organizational setting. Next, the impact of organizational policies and practices, and the words and actions of managers, on the behavior of individuals within those organizations is examined. Finally, the course focuses on the relationship between organizations and the societies in which they operate. We consider the perspectives of key stakeholders, including government regulators, community representatives, customers, employees, managers, and stockholders, and examine different views on corporate social responsibility. 3 credits

MST 543 Commercialization Practicum
Students will have the opportunity to work in teams with real technologies. Student teams will produce assessments and plans for bringing new technologies to market using Vijay Jolly’s Mind to Market Technology Commercialization and other frameworks such as a Total Life Cycle Planning approach. Wherever possible, industry advisors will mentor students in their area of expertise within the design, management, and product manufacturing process. Each team adopts a real technology held by Batelle-Pacific Northwest Laboratories, OHSU, OGI, Oregon Medical Laser Center, or others. Students will make one or more field trips to these institutions. The technologies may be in the areas of environmental, health, genetics, multimedia, computers or other fields. Each team’s final paper - which may include market research, a design for a manufacturable product, profiles of desired management teams, licensing plans, tech-marketing feasibility, and/or preliminary startup business plan, will be submitted to the institution that originated the technology. MST students may choose to use their 581 project as a preliminary exercise for the capstone project. 3 credits

MST 544, MST 544D Strategic Alliances
This course explores a model of implementing strategic alliances, business partnering and joint ventures originally outlined by Robert Lynch, senior partner of The Warren Company, in his book Business Alliances Guide (John Wiley and Sons, 1993). The book is a compilation of best practices in strategic alliance formation and implementation distilled from approximately 40 different high performance international and domestic strategic alliances. It offers a well-articulated framework, which is applicable across a broad range of alliance types. The objective of this course is to provide each student with an opportunity to learn practical, effective methods for forming, implementing and executing high-performance strategic alliances. 3 credits

MST 550 Capstone Project: Business Plan
In the program’s capstone course, students complete major integrative projects as members of teams. Prerequisites: MST 530 and approval of instructor. 4 credits

MST 58X, MST 58XD — Special Topics
Under this number, courses of particular relevance and interest to students and faculty are offered. Variable credits.

MST590, MST 590D Effective Business Writing for Management
This course will review several aspects of conventional punctuation and grammar that address the needs of the participants. In addition, attention is given to stylistics for clear, concise communication necessary in business writing. Class size is limited to ten students. 1 credit

MST 591, MST 591D Professional Writing for Non-native Speakers
An intensive review of English grammar and sentence structure with a focus on formal English for professional purposes. Some attention to the academic essay as well as business writing. Class size is limited to ten students. No prerequisite. 1 credit

Note: descriptions for Computational Finance courses, designated FINxxx, are found in the catalog under the Department of Computer Science and Engineering Course Description section.
REPRESENTATIVE PUBLICATIONS


Research Interests

Market research, marketing innovation and high-technology products, managing the new product development process, incubation and commercialization of new technologies, strategic and innovative use of computers.

Research Interests

Management of technology, and advanced lithography for semiconductor fabrication.

Representative Publications


Research Interests

The human side of technology transfer; work/family policies and practices; coaching faculty in the development and teaching of e-learnings courses.

Representative Publications:


**Jack Raiton**  
Senior Fellow  
MBA, Finance & Statistics  
University of Washington, 1967  
raiton@admin.ogi.edu

Jack Raiton has been VP and CFO at Planar Systems for the last four years, and also served as VP and CFO at Smith’s Home Furnishings. His prior experience includes working at Tektronix for about 22 years, the last 12 as the Corporate Controller and serving as Plant Controller for Fairchild Camera and Instruments. Jack earned his BS in Mathematics from Oregon State University in 1966 and his MBA in Finance and Statistics from the University of Washington in 1967. He attended Harvard University’s three-month Advanced Management Program, and passed the CPA exam in 1979.

**Areas of Expertise**  
Performance Measurement, Capital Structure, Stock Options and Incentive Plans, Forensic Accounting

**Adrian Roberts**  
Senior Advisor  
Ph.D., Metallurgy  
University of Manchester, England

Adrian Roberts is a consultant on technology management, specializing in R&D management and technology commercialization. Acting as advisor to Battelle Memorial Institute and other clients on technology projects and new business creation, Adrian was recently appointed Interim Director of Battelle-Pacific Northwest National Laboratories. This past year, he has contributed to the Center for Entrepreneurial Growth and has taught the MST course on Technology Management, as well as working with Brookhaven, Oak Ridge and Pacific Northwest National Laboratories on programs for the US Department of Energy.

**Areas of Expertise**  
Technology management, commercialization of technologies, R&D management, strategic planning.

**Nicole Steckler**  
Associate Professor  
Ph.D., Organizational Behavior  
Harvard University, 1990  
steckler@admin.ogi.edu

**Research Interests**  
Tools for diagnosing and improving leadership effectiveness, roles in implementing (and resisting) organizational change, interpersonal communication and influence in organizations, and lateral coordination in organizations.

**Representative Publications**


**Alvin H. Tong**  
Professor of Management  
Ph.D., Electrical Engineering  
University of Minnesota, 1967  
tong@admin.ogi.edu

Alvin Tong teaches Project Management and the Capstone Project (Business Plan) course, and has been with MST since 1996. Alvin served as a mentor for the 1999 student team, ArtCentral that won first place in the New Venture Championship 2000, a national/international business plan competition held in Beaverton, Oregon. Alvin has thirty years of working experience in the computer and related industry, which includes serving as chief operating officer of Acer, Inc., a Taiwan-based manufacturer of personal computers. While with Acer, he also served as President of their venture capital arm. Prior to Acer, he worked for fourteen years at IBM. In addition, he also had a significant role as the first deputy director-general of the Hsin-chu Science-Based Industrial Park (SBIP) in Taiwan. Alvin has conducted numerous management-training seminars and is frequently invited to speak and lecture on the subject of Globalization and Hi-Tech Science-Based Industrial Parks.

**Representative Publications**

ADJUNCT FACULTY

KEN ANTHONY
Rapid Innovations

JEAN CLAUDE BALLAND
JCB Associates

TUGRUL DAIM
Intel Corporation

DEAN DERRAH
Infocus Systems

RICHARD DORF
University of California at Davis

DAVID DRAKE
Catalyst Communications, Inc.

WILLIAM DRESSELHOUS
Dresselhaus Design Group

RICHARD FOURNIER
Oregon Health & Science University

RICHARD GOLDCAR
Covasoft

STEPHEN GOMES
Oregon Health & Science University

JULIAN GRESSER
LogosNet

JILL B. KELLY
Oregon Health & Science University

KEITH LARSON
Intel Corporation

RITA LAXTON-BENZAN
IMMEDIAD’s ChildRom Productions

KATHY MANGEL-DAVIS
Professionally Speaking

MICHAEL MCLEAN
AC Transit

DEIRDRE MENDEZ
University of Texas at Austin

MIGUEL MENDEZ
Oregon Health & Science University

PAUL NEWMAN
Cooper Mountain Research, Inc.

LYLE OCHS
Technology & Innovation Management Inc.

RICHARD PRINS
Group 3

JESSE REEDER
Leadership Dynamics

YONG-IN SHIN
Intel Corporation

JAY SHUTTER
Momentum Research Group

LESLE SMID
IBM

THOI TRUONG
Emery Worldwide

HARVEY UTECH
Oregon Health & Science University

JOHN WALLNER
Tektronix, Inc.

EUGENE Y. WEISSMAN
Weissman Associates
OHSU is an equal opportunity, affirmative action institution.

OHSU includes four schools, two hospitals, numerous primary care and specialty clinics, multiple research institutes, and several public service and outreach units.